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Agronomy

Field Research 2006

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Agricultural Experiment Station
and Cooperative Extension Service

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EXPERIMENT FIELD PERSONNEL

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KANSAS RIVER VALLEY EXPERIMENT FIELD

Introduction

The Kansas River Valley Experiment Field was established to study how to manage and use irrigation resources effectively for crop production in the Kansas River Valley. The Paramore Unit consists of 80 acres located 3.5 miles east of Silver Lake on US 24, then one mile south of Kiro, and 1.5 miles east on 17th street. The Rossville Unit consists of 80 acres located one mile east of Rossville or 4 miles west of Silver Lake on US 24.

Soil Description

Soils on the two fields are predominately in the Eudora series. Small areas of soils in the Sarpy, Kimo, and Wabash series also occur. The soils are well drained, except for small areas of Kimo and Wabash soils in low areas. Soil texture varies from silt loam to sandy loam, and the soils are subject to wind erosion. Most soils are deep, but texture and surface drainage vary widely.

2005 Weather Information

The frost-free season was 175 days at the Paramore Unit and 174 days at the Rossville Unit (173 days average). The last 32° F frost in the spring was on May 3 at both fields (average April 21). The first frost in the fall was on October 24 at the Rossville Unit and October 25 at the Paramore Unit (average October 11). Precipitation was about 4 inches above normal at both fields (Table 1). During the growing season, precipitation was above average at both fields in June, August, and September, and in July at the Paramore Unit. There were no days over 100 degrees. Some sudden death syndrome was observed in soybeans, but not as bad as in 2003 and 2004. Corn yields were excellent and soybean yields were good except for one variety that did not have good soybean cyst nematode resistance for the race on the Rossville Field.

Table 1. Precipitation at the Kansas River Valley Experiment Field, inches.

Month	Rossville Unit		Paramore Unit	
	2004-2005	30-Yr. Avg.	2004-2005	30-Yr. Avg.
Oct.	3.32	0.95	4.09	0.95
Nov.	1.18	0.89	2.32	1.04
Dec.	0.63	2.42	0.72	2.46
Jan.	6.00	3.18	2.24	3.08
Feb.	2.27	4.88	2.63	4.45
Mar.	0.72	5.46	0.90	5.54
Apr.	1.07	3.67	2.04	3.59
May	3.58	3.44	2.73	3.89
June	8.23	4.64	7.42	3.81
July	2.66	2.97	7.73	3.06
Aug.	9.53	1.90	6.67	1.93
Sep.	5.40	1.24	8.81	1.43
Total	39.19	35.64	39.49	35.23

CORN HERBICIDE PERFORMANCE TEST

Larry Maddux

Summary

This study was conducted at the Rossville Unit. Preemergence and two-pass herbicide applications were compared with applications of glyphosate alone. One application of glyphosate without a preemergence treatment did not give satisfactory weed control. Two applications gave good control of large crabgrass, Palmer amaranth, and common sunflower, but not ivyleaf morningglory. It generally took a two-pass program to get greater than 80% control of ivyleaf morningglory. Weed control with preemergence treatments would probably been better if sufficient rainfall for activation had been received sooner after their application.

Introduction

Chemical weed control and cultivation have been used to control weeds in row crops to reduce weed competition which can reduce yields. Timeliness of application is a major factor in determining effective weed control. Twenty-four herbicide treatments including preemergence, preemergence + postemergence, and glyphosate herbicide treatments were compared. The weeds evaluated in this test were large crabgrass (lacg), palmer amaranth (paam), common sunflower (cosf), and ivyleaf morningglory (ilmg)

Procedures

The test was conducted on a Eudora silt loam soil previously cropped to soybeans at the Rossville Unit. It included four preemergence (PRE) treatments, sixteen preemergence + postemergent (two-pass) treatments, and four glyphosate postemergent treatments: early post (EP), mid-post (MP), late post (LP), and early + late post. The test site had a pH of 6.9 and an organic matter content of 1.1%. DeKalb DKC6381RR hybrid corn was planted April 27 at 30,000 seeds/a in 30-inch rows. Anhydrous ammonia at 150 lbs N/a was applied preplant, and 120 lbs/a of 10-34-0 fertilizer was banded at planting. Herbicides were broadcast in 15 gal/a with 8003XR flat fan nozzles at 17 psi. The experimental design was a randomized complete block with three replications per treatment. PRE applications were made April 27. EP treatments were applied May 30 to 6 leaf corn, seedling to 1" lacg, 1-3" paam, and 1-6" cosf and 1-2" ilmg. The MP treatments were applied June 8 to 7 leaf corn, 1-2" lacg, 2-5" paam, a few 2-8" cosf, and seedling ilmg. LP treatments were applied June 11 to 1-3" lacg, 1-5" paam, 3-10" cosf, and 1-3" ilmg. Populations of all four weed species were moderate to heavy. However, weed populations were generally fairly light at postemergence time in plots receiving a preemergence treatment. Plots were not cultivated. The weed control ratings reported were made July 19. The first significant rainfall after PRE herbicide application was on May 12 (2.65 inches). On the two days following PRE application, 0.15 inch of rain was received. The plots were irrigated as needed. The test was harvested September 21 using a modified John Deere 3300 plot combine.

Results

Rainfall of 0.15 inch occurred over the two days immediately after planting. An additional 0.10 inch was received on May 7 & 8. It wasn't until May 12 that a significant rainfall was received (2.65 inch) and an additional 0.40 inch was received on May 13. No crop injury was observed. Excellent control of paam and cosf was obtained with all treatments (Table 2). Control of lacg was best with treatments containing postemergence applications of Callisto or glyphosate treatments. It took two applications of Roundup Weathermax (when no PRE was applied) to get acceptable weed control, although the one MP application resulted in good control of lacg, paam, and cosf. Eighty percent or better control of ilmg was only obtained with treatments containing Lumax or Lexar (PRE) as well as Bicep II Magnum (PRE) followed by (fb) Callisto + Aatrex or Touchdown Total, Fultime and Keystone (PRE) fb Glyphomax XRT, Harness Extra (PRE) fb Permit + Aim, and Guardsman Max (PRE) fb Buctril + Atrazine. If sufficient activating rainfall would have been received sooner after PRE application, the PRE treatments would probably have given better lacg , and possibly ilmg, control. There was a large variation in grain yield, but because of the large LSD (0.05) of 58 bu/a, there were few significant differences attributable to the herbicide treatments. Soil variability was considered to be the main contributing factor for the large LSD.

Table 2. Effects of pre- and post-emergence herbicides on injury, weed control, and grain yield of corn, Kansas River Valley Experiment Field, Rossville, KS, 2005.

Treatment[1]	Rate, product/a	Appl Time[2]	Percent Weed Control, July 19[3]				Grain Yield, bu/a
			lacg	paam	cosf	ilmg	
Untreated check		---	0	0	0	0	71
Lumax	2.5 qt	PRE	70	98	99	65	158
Lumax + AAtrex	2.5 qt + 1.0 qt	PRE	68	99	99	80	154
Lexar	3.0 qt	PRE	63	99	99	58	189
Lexar + Princep 4FL	3.0 qt + 1.0 qt	PRE	63	96	99	52	189
Camix *fb*	1.6 qt	PRE	78	99	99	65	164
Touchdown Total	24 oz	MP					
Lumax *fb*	2.0 qt	PRE	78	99	99	90	152
Touchdown Total	24 oz	MP					
Lexar *fb*	2.26qt	PRE	75	99	99	82	177
Touchdown Total	24 oz	MP					
Camix + Touchdown Total	1.6 qt + 24 oz	EP	82	99	99	55	209
Lumax + Touchdown Total	2.0 qt + 24 oz	EP	78	99	99	82	194
Lexar + Touchdown Total	2.26qt + 24 oz	EP	82	99	99	80	179
Dual II Magnum *fb*	1.33pt	PRE	78	99	99	0	178
Touchdown Total	24 oz	MP					
Bicep II Magnum *fb*	2.1 qt	PRE	87	99	99	82	196
Callisto + Aatrex	3.0 oz + 0.5 qt	MP					
Bicep II Magnum *fb*	1.75 qt	PRE	80	99	99	83	233
Touchdown Total	24 oz	MP					
Lexar *fb*	1.5 qt	PRE	93	99	99	95	217
Lexar	1.5 qt + 24 oz	EP					
Fultime *fb*	2.5 qt	PRE	85	99	99	90	220
Glyphomax XRT	24 oz	MP					
Keystone *fb*	2.0 Qt	PRE	87	96	96	92	230
Glyphomax XRT	24 oz	MP					
Harness Xtra 5.6 *fb*	2.25 qt	PRE	77	99	99	85	203
Permit + Aim	0.67 oz + 0.5 oz	MP					
Guardsman Max *fb*	2.0 qt	PRE	62	99	99	95	209
Buctril + Atrazine	2.0pt	MP					
Harness Xtra 5.6 *fb*	1.2 qt	PRE	90	99	99	65	223
Roundup Weathermax	22 oz	MP					
Roundup Weathermax	22 oz	EP	73	99	99	27	195
Roundup Weathermax	22 oz	MP	80	99	99	10	169
Roundup Weathermax	22 oz	LP	30	99	99	40	119
Roundup Weathermax *fb*	22 oz	EP	95	99	99	57	151
Roundup Weathermax	22 oz	LP					
LSD(.05)			10	3	2	28	58

[1] Postemergence treatments had surfactants added as per label recommendations.
[2] PRE = preemergence; EP = early postemergence; MP = mid-postemergence; LP = late postemergence.
[3] lacg = large crabgrass; paam = palmer amaranth; cosf = common sunflower; ilmg = ivyleaf morningglory.

SOYBEAN HERBICIDE PERFORMANCE TEST

Larry Maddux

Summary

This study was conducted at the Rossville Unit to compare some two-pass herbicde treatments with two applications of glyphosate. Flexstar application caused some crop injury, but it did not affect yield. The two-pass glyphosate treatment had the best weed control, probably because of the lack of adequate early activation of the preemergence herbicides. However, several other treatments had almost equivalent or satisfactory weed control. Control of ilmg was poor with most treatments. Yields were low and variable because of lack of the proper soybean cyst nematode race resistance. There were no significant yield differences between treatments.

Introduction

Chemical weed control and cultivation have been used to control weeds in row crops to reduce weed competition which can reduce yields. Treatments in this test included an untreated check, two applications of Touchdown Total (glyphosate), one conventional two-pass treatment (Boundary, preemergence (PRE) + Flexstar + Fusion early postemergence (EP)), and nine treatments of a preemergence herbicide followed by a glyphosate treatment. The weeds evaluated in these tests were large crabgrass (lacg), palmer amaranth (paam), common sunflower (cosf), and ivyleaf morningglory (ilmg)

Procedures

This test was conducted on a Eudora silt loam soil previously cropped to corn. The test site had a pH of 6.9 and an organic matter content of 1.1%. Garst 3812/N soybean was planted May 19 at 144,000 seeds/a in 30-inch rows and 10-34-0 fertilizer was banded at 120 lbs/a. Herbicides were broadcast at 15 gal/a, with 8003XR flat fan nozzles at 17 psi. A randomized complete block design with three replications per treatment was used. Preemergence (PRE) applications were made May 20. Early postemergence (EP) treatments were applied June 21 to 4 - 5 trifoliate soybean, 1-3" lacg, 1-10" paam, 1-10" cosf, and 1-3" ilmg. Mid-postemergence (MP) treatments were applied July 2 to 1-4" lacg; 2 - 12" paam; 3 - 12" cosf; and 1- 4" ilmg. The late postemergence (LP) treatments were applied July 11. Weed sizes were: lacg, 1-5"; paam, 1-14"; cosf, 1-14"; and ilmg, 1-6". Populations of all 4 weeds were moderate to heavy. Plots were not cultivated. The injury ratings reported were made on July 1 and the weed control ratings were made July 18. The first significant rainfall after PRE herbicide application was on June 3 (2.31 inches). The plots were irrigated as needed and were harvested October 19 using a modified John Deere 3300 plot combine.

Results

A significant rain of 2.31" occurred on June 3. Prior to that, the largest rainfall events were 0.12 and 0.07 inches on May 25 and 27. Therefore, the PRE treatments were not well activated until June 3.

Significant crop injury was observed with the EP treatment containing Flexstar, but it appeared to have no effect on grain yield (Table 4). However, yields were low and variable. This was attributed to the fact that, although the soybean variety used was nematode resistant, it did not have good resistance to our specific race of soybean cyst nematode (SCN).

Control of paam and cosf overall was very good to excellent. The conventional treatment of Boundary followed by (fb) Flexstar + Fusion had the poorest control of paam (80%).

The control of lacg was good to excellent with the exception of the Boundary fb Flexstar + Fusion and the Boundary fb Touchdown Total treatments which only had 77 and 68% control, respectively. Control of ilmg was poor to fair with only one treatment (Touchdown Total fb Touchdown Total) attaining greater than 80% control. This was probably because of the lack of timely activation of the PRE herbicides, some of which would normally have activity on ilmg. The untreated check was not harvestable because of weeds, especially cosf. As mentioned earlier, yields were low because of the lack of proper SCN race resistance.

Table 4. Effects of herbicide application on injury, weed control, and grain yield of soybean, Kansas River Valley Experiment Field, Rossville, KS, 2005.

Treatment[1]	Rate, product/a	Appl Time[2]	Injury, July 1 %	Percent Weed Control, July 18[3]				Grain Yield, bu/a
				lacg	paam	cosf	ilmg	
Untreated check		---	0	0	0	0	0	0
Boundary *fb*	1.5 pt	PRE	12	77	80	99	0	24.9
Flexstar + Fusion	16 oz + 10 oz	EP						
Boundary *fb*	1.5 pt	PRE	0	68	93	98	50	13.0
Touchdown Total	24 oz	EP						
Boundary *fb*	1.5 pt	PRE	0	87	87	99	73	25.7
Touchdown Total + FirstRate	24 oz + 0.3 oz	EP						
Touchdown Total *fb*	24 oz	EP	0	99	99	99	83	22.7
Touchdown Total	19 oz	EP						
FirstRate + Valor *fb*	0.3 oz + 1.5 oz	PRE	0	90	98	99	75	14.6
Glyphomax XRT	24 oz	EP						
FirstRate *fb*	0.3 oz	EP	0	85	99	99	72	20.1
Glyphomax XRT	24 oz	LP						
Pendimax + FirstRate *fb*	3.0 pt + 0.3 oz	EP	0	88	98	99	35	23.2
Glyphomax XRT	24 oz	EP						
Pendimax + Python *fb*	3.0 pt + 0.8 oz	LP	0	92	97	99	63	29.2
Glyphomax XRT	24 oz	EP						
Intrro *fb*	2.0 qt	PRE	0	92	97	99	10	26.1
Roundup WeatherMax	22 oz	EP						
Intrro + Valor *fb*	2.0 qt + 1.50oz	PRE	0	97	99	99	70	26.1
Roundup WeatherMax	22 oz	EP						
Dual II Magnum + FirstRate *fb*	1.3 pt + 0.6 oz	PRE	0	93	98	99	53	25.4
Touchdown Total	24 oz	EP						
LSD(.05)			1	8	7	1	28	18

[1] Postemergence treatments had surfactants added (COC, UAN, &/or AMS) according to label recommendations.
[2] PRE = preemergence (5/20); EP = early postemergence (6/21); MP = Mid-postemergence (7/2); LP = Late postemergence (7/11).
[3] lacg = large crabgrass; paam = palmer amaranth; cosf = common sunflower; ilmg = ivyleaf morningglory.

MACRONUTRIENT FERTILITY ON IRRIGATED CORN AND SOYBEANS IN A CORN/SOYBEAN ROTATION

Larry D. Maddux

Summary

A corn-soybean cropping sequence was evaluated from 1983- 005 (corn planted in odd years) for the effects of N, P, and K fertilization. From this study, it was determined that no more than 160 lbs N/a was required to obtain optimum corn yields. N fertilization at 160 lbs N/a decreased soil pH and Bray-1 P when compared to no N applied. P & K fertilization maintained medium to high soil test levels. A significant average corn yield increase to P fertilization was not observed. A 6 bu/a average corn yield increase was observed from 1983-95 with K fertilization. N, P & K fertilization of corn increased the yield of the following soybean crop from 2 to almost 5 bu/a on the average.

Introduction

A study was initiated in 1972 at the Topeka Unit to evaluate the effects of nitrogen (N), phosphorus (P), and potassium (K) on irrigated soybeans. In 1983, the study was changed to a corn/soybean rotation with corn planted in odd years. Study objectives are to evaluate the effects of applications of N, P, and K made to a corn crop on (a) grain yields of corn and the following soybean crop and (b) soil test values.

Procedures

The initial soil test in March 1972 on this silt loam soil was 47 lbs/a of available P and 312 lbs/a of exchangeable K in the top 6 in. of the soil profile. Rates of P were 50 and 100 lbs P_2O_5/a (1972-1975) and 30 and 60 lbs P_2O_5/a (1976-2005), except in 1997 when a starter of 120 lbs/a of 10-34-0 (12 lbs N/a + 41 lbs P_2O_5/a) was applied to all plots (also applied to soybeans in 1998). Rates of K were 100 lbs K_2O/a (1972-1975), 60 lbs K_2O/a (1976-1995), and 150 lbs K_2O/a (1997-2005). N Rates included a factorial arrangement of 0, 40, and 160 lbs of preplant N/a (with single treatments of 80 and 240 lbs N/a). The 40 lbs N/a rate was changed to 120 lbs N/a in 1997. N, P, and K treatments were applied every year to soybeans (1972-1982) and every other year (odd years) to corn (1983 -1995, 1999-2005). Soil samples were taken to a depth of 6 inches in the spring of 2005 (before fertilizer was applied to the corn) and analyzed for pH, Bray-1 P, exchangeable K, and organic matter content.

Corn hybrids planted in mid-April were BoJac 603 (1983), Pioneer 3377 (1985, 1987, 1989), Jacques 7820 (1991 and 1993), Mycogen 7250CB (1995), DeKalb 626 (1997, 1999), Golden Harvest 2547 (2001), Pioneer 33R77 (2003); and DeKalb DKC 63-81RRYG (2005). Soybean varieties planted in early to mid-May were Douglas (1984), Sherman (1986, 1988, 1990, 1992, 1996, and 1997); Edison (1994), IA 3010 (2000), Garst 399RR (2002), and Stine 3982-4 (2004). Herbicides were applied preplant and incorporated each year in both corn and soybeans. The plots were cultivated and irrigated as needed. A plot combine was used for harvesting grain yields.

Results

Soil samples taken in the spring of 2005 showed that soil pH decreased from 7.0 with no N applied to 6.7 with 160 lbs N/a (Table 5). Bray-1 P also decreased from 23.1 ppm with no N to 17.7 ppm with 160 lbs N/a. N fertilization had no effect on Exchangeable K or organic matter content. The Bray-1 P level had decreased to 7.7 ppm with no added P, and had a 34.3 ppm level with the high P fertilization rate. P fertilization had no effect on soil pH, exchangeable K, or organic matter. Exchangeable K dropped to 177 ppm compared to 258 ppm with K fertilization. K fertilization had no effect on soil pH, Bray-1 P, or organic matter.

Average corn yields for 1983-1995 (7 years) and for 1997-2005 (5 years) are shown in Table 6. A good N response was obtained with 160 lbs N/a with fertilization at 240 lbs N/a resulting in little additional yield. In the 1997-2005 average, corn fertilized with 120 lbs N/a yielded only 5 bu/a less than that fertilized with 160 lbs N/a. The average corn yields for both time periods did not show a significant response to P fertilization. However, a yield response was obtained in a few years (yearly data not shown). K fertilization showed a significant average yield increase of 6 bu/a in the 1985-95, but only a non-significant increase of 3 bu/a in 1997- 2005.

Soybeans showed a good response to the fertilizer previously applied to corn. There was a 3.1 and 2.9 bu/a average yield increase to N application at 160 lbs N/a for the two time periods, while phosphorus increased average yield by 4.6 and 3.3 bu/a and potassium fertilization resulted in average yield increases of 2.3 bu/a for both time periods.

Table 5. Effects of N, P, and K applications on soil pH, Bray-1 P, exchangeable K, and organic matter in a corn-soybean cropping sequence, Topeka, Spring 2005.

Fertilizer Applied[1]			Soil	Bray-1	Exchangeable	Organic
N	P_2O_5[2]	K_2O	pH	P	K	Matter
---------------------lbs/a---------------------				ppm	ppm	%
0	0	0	7.1	8.5	181	1.3
0	0	60/150	7.1	10.0	279	1.2
0	50/30	0	7.0	22.5	181	1.3
0	50/30	60/150	7.0	21.0	247	1.2
0	100/60	0	7.0	41.0	188	1.4
0	100/60	60/150	7.0	35.5	247	1.3
160	0	0	6.7	5.5	174	1.2
160	0	60/150	6.6	6.8	267	1.3
160	50/30	0	6.7	12.8	160	1.3
160	50/30	60/150	6.7	20.5	270	1.3
160	100/60	0	6.7	29.8	179	1.3
160	100/60	60/150	6.7	30.8	235	1.2
LSD(.05)			0.1	9.3	30	NS
NITROGEN MEANS:						
0			7.0	23.1	221	1.3
160			6.7	17.7	214	1.3
LSD(.05)			0.1	3.3	NS	NS
PHOSPHORUS MEANS:						
	0		6.9	7.7	225	1.3
	50/30		6.9	19.2	214	1.3
	100/60		6.9	34.3	212	1.3
LSD(.05)			NS	3.3	NS	NS
POTASSIUM MEANS:						
		0	6.9	20.0	177	1.3
		60/150	6.9	20.8	258	1.2
LSD(.05)			NS	NS	8	NS

[1] Fertilizer applied to corn in odd years 1983 - 2005 and to soybeans for 11 years prior to 1983 (the first number of two is the rate applied to corn from 1983 - 1995).

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

Table 6. Effects of nitrogen, phosphorus, and potassium applications on corn yields in a corn-soybean cropping sequence, Topeka.

Fertilizer Applied[1]			Corn Yield		Soybean Yield	
N	P_2O_5[2]	K_2O	1983 - 1995	1997 - 2005	1984 - 1996	1998 - 2004
---------------------lbs/a----------------------			----------------------------------- bu/a -----------------------------------			
0	0	0	87	96	63.9	50.3
0	0	60/150	86	98	65.6	53.6
0	50/30	0	93	112	69.0	54.9
0	50/30	60/150	86	95	69.8	54.9
0	100/60	0	84	95	69.6	54.4
0	100/60	60/150	92	99	72.3	59.1
40/120	0	0	129	186	66.3	54.4
40/120	0	60/150	126	181	67.7	56.5
40/120	50/30	0	123	183	66.7	54.7
40/120	50/30	60/150	138	196	72.7	59.1
40/120	100/60	0	117	187	70.8	56.1
40/120	100/60	60/150	132	196	71.4	57.2
160	0	0	171	186	68.8	55.8
160	0	60/150	177	184	70.0	55.9
160	50/30	0	168	181	70.5	55.3
160	50/30	60/150	181	203	73.8	58.8
160	100/60	0	167	201	71.3	59.1
160	100/60	60/150	178	202	74.2	60.0
80	50/30	60/150	151	180	71.5	60.0
240	50/30	60/150	182	203	71.7	59.3
LSD(.05)			18	25	5.1	4.6
NITROGEN MEANS:						
0			88	99	68.4	54.6
40/120			127	188	69.3	56.3
160			174	193	71.5	57.5
LSD(.05)			8	11	2.2	1.9
PHOSPHORUS MEANS:						
	0		129	155	67.0	54.4
	50/30		131	162	70.4	56.3
	100/60		128	163	71.6	57.7
LSD(.05)			NS	NS	2.2	1.9
POTASSIUM MEANS:						
		0	127	158	68.6	55.0
		60/150	133	161	70.9	57.3
LSD(.05)			6	NS	1.8	1.5

[1] Fertilizer applied to corn in odd years 1983 - 2005 and to soybeans for 11 years prior to 1983 (the first number of two is the rate applied to corn from 1983 - 1995).

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

EAST CENTRAL KANSAS EXPERIMENT FIELD

Introduction

The research program at the East-Central Kansas Experiment Field is designed to enhance the area's agronomic agriculture. Specific objectives are (1) to identify the top performing varieties and hybrids of wheat, corn, grain sorghum, and soybean; (2) to quantify the amount of tillage necessary for optimum crop production; (3) to evaluate weed control practices using chemical, non-chemical, and combination methods; and (4) to test fertilizer rates, sources and application methods for crop performance and environmental effects.

Soil Description

Soils on the field's 160 acres are Woodson. The terrain is upland and level-to-gently rolling. The surface soil is a dark, gray-brown silt loam to silty clay loam and the subsoil is dense clay which makes the soil somewhat poorly drained. The soil is derived from old alluvium. Water-intake is slow, averaging less than 0.1 in. per hour when saturated. This makes the soil susceptible to water runoff and sheet erosion.

2005 Weather Information

Precipitation during 2005 totaled 43.04 inches, which was 6.26 inches above the 35-yr average (Table 1). Rainfall during March and April was 3.88 inches below average, but cumulative rainfall for May, June, July, and August was 11.11 inches above average.The coldest temperatures during 2005 occurred in January and December with 12 days in single digits and two days below zero. The overall coldest day was 12ºF below zero on December 9. There were 30 days during the summer in which temperatures exceeded 90 degrees. The hottest day in 2005 was August 4, with a temperature of 97ºF. The hottest seven-day period in 2005 was June 24 through June 30, when daily temperatures averaged 93ºF. The last freeze in the spring was May 10 (average, April 18) and the first killing frost in the fall was October 26 (average, October 21). The number of frost-free days was 168, compared with the long-term average of 185.

Table 1. Precipitation at the East-Central Experiment Field, Ottawa, Kansas, inches.

Month	2005	35-yr. avg.	Month	2005	35-yr. avg.
January	3.35	1.03	July	3.74	3.37
Februar	2.07	1.32	August	8.08	3.59
March	0.99	2.49	Septembe	2.35	3.83
April	1.12	3.50	October	2.63	3.43
May	5.37	5.23	November	0.80	2.32
June	11.32	5.21	December	1.22	1.45
Annual Total				43.04	36.78

STRIP-TILL AND NO-TILL TILLAGE FERTILIZATION SYSTEMS EVALUATED FOR CORN

K.A. Janssen, W.B. Gordon, and R.E. Lamond

Summary

Strip-till and no-till tillage/fertilization systems were evaluated for corn at the East-Central Kansas Experiment Field during 2003-2005. Averaged across all tillage and fertilizer systems and years, fall strip-till with under-the-row fertilizers performed best and resulted in increased plant stands and higher corn grain yields compared to no-till. There was no evidence that fertilizers strip-till applied in the fall performed inferior to fall strip-till and spring planter- banded fertilizer.

Introduction

Row-crop agriculture in East Central and Southeast Kansas must find ways to offset rising fuel and fertilizer costs and because of environmental pressures must also reduce sediment and nutrient losses via crop land runoff. Possible management strategies are cutting back on tillage (a big user of fuel and a significant factor in increased soil loss) and sub-surface banding of fertilizers (which is important for improving fertilizer-use efficiency and to reduce nutrient losses via surface water runoff). Water samples from edge-of-field runoff studies show that no-till farming practices with fertilizers injected below the soil surface can significantly reduce sediment and total P losses in runoff (Janssen et al. 2000). However, in East-Central and Southeast Kansas, no-till can be a challenge because of frequent spring rains and an abundance of imperfectly drained soils. The extra residue and the slower soil drying associated with no-till can keep no-till fields cooler and wet longer in the spring and that can delay planting and slow early-season crop development. Non-irrigated corn in East-Central and Southeast Kansas must be planted early (middle March - early April) and grow quickly in order to produce grain before hot and dry conditions occur in the middle to later part of July. Any delay in corn planting and reduced corn growth can have a negative effect on corn production. Application of starter fertilizers to enhance early-season corn growth can offset some of the slowed early corn development with no-till (Niehues et al. 2004), but delays in planting, reduced plant stands, and the inconvenience of having to apply starter fertilizers at planting remains a deterrent to the acceptance of no-till. Presently, there is less than 6 percent of the total corn acreage planted no-till in the East-Central and Southeast regions of Kansas (Conservation Technology Information Center, 2005 Survey).

Strip-tillage, on the other hand, is a compromise conservation tillage system. It is a system that includes some tillage, but only where the seed rows are to be planted. Row-middles are left untilled. The tilled in the row strips provide a raised, loosened seed bed, which improves drainage, warming, and drying. Strip-tillage also allows fertilizers to be precision applied under the row which can provide a starter fertilizer effect without the bother of having to apply fertilizers at planting-time. Strip-tillage with fertilizers injected under the row would seem to be desirable for planting corn early.

The objectives of this study were (1) to evaluate the performance of strip-tillage with no-till for corn using different fertilizer N timing and placement methods, and (2) to access the effects of fall strip-till with fall applied N-P-K-S fertilizers verses fall strip-till and all at planting time banded fertilizers.

Procedures

This study was conducted at the East-Central Kansas Experiment Field near Ottawa, KS on an imperfectly drained Woodson silt loam soil from 2003 to 2005 . The field site had been managed no-till for five years prior to starting this study . The tillage and the fertilizer treatments and the dates that the treatments were established are shown in Table 2. The experiment design was a randomized complete block with four replications. The crop preceding the 2003 corn study was corn and the crops preceding the 2004 and 2005 corn crops were soybeans. Burn-down herbicides were applied each year for pre-plant weed control and consisted of 1qt/a atrazine 4L + 0.66pt/a 2,4-D LVE + 1 qt/a COC. Corn planting was on April 10, 2003, April 15, 2004, and April 13, 2005. The corn hybrid planted was Pioneer 35P12 all years. Seed-drop was 23,500 seeds per acre. After planting, pre-emergence herbicides were applied which included 0.5 qt/a atrazine 4L and1.33 pt/a Dual II Magnum. The effects of the tillage and fertilizer treatments were evaluated by taking plant stand counts, measuring early-season corn growth, and measuring grain yields. Plant counts were made by counting all of the plants in the center two rows of each plot. Early-season corn growth was measured by harvesting, drying and weighing the plant tissue from six randomly selected corn plants at the 6-leaf corn growth stage from each plot. Grain yields were measured by machine harvesting and weighing the corn from the center two rows of corn from each four-row, 10- ft x 40-ft plot. Harvest was on August 28, 2003; September 10, 2004; and September 8, 2005.

Results

The 2003 corn-growing season was hot and dry. Rainfall during April, May, and June was normal, but July and most of August were very hot and dry. There were 48 days during the summer of 2003 in which air temperatures exceeded 90°F. In 2004, rainfall was well distributed and there was no visual indication of any moisture stress. Also, there were only 13 days in 2004 in which air temperatures exceeded 90°F. In 2005, a series of 29 to 30°F freezing temperatures occurred from April 30 through May 3. Evidence of freeze damage was more severe in the no-till plots then in strip-till. However, because the growing point was still below the surface of the soilmost of the freeze-damaged plants survived. The remainder of the 2005 corn growing season was normal with temperatures periodically exceeding 90°F and moisture declining through late June, July and early August.

Plant Populations and Early Corn Growth

The tillage and fertilization systems produced statistically significant differences in plant stands and early corn growth. The tillage treatments affected plant populations more than the fertilizer applications (Table 2, Figure 1). Plant populations overall tended to be better and emergence was more uniform for corn planted using strip-tillage than with no-till. When averaged across all fertilizer treatments for 2003, plant populations were 15% greater with strip-till compared to no-till. In 2004, strip-till stands were 7% improved compared to no-till, and in 2005 plant-stands were increased 10% with strip-till compared to no-till. Hendrix et al. (2004) also reported that tillage affected corn plant populations, with strip-till and conventional tillage having higher plant populations than no-till. The rates of N fertilizer and the placement and timing of the fertilizer applications had basically no effect on plant stands. (Figure 1).

In addition to strip-tillage having a positive effect on plant stands compared to no-till, strip-tillage also increased early-season plant growth. In 2003, V6 plant-dry-weights, when averaged across all N rates (0,40,80,and 120 lb/a N) were 25% greater with strip-till and fall applied fertilizer and

39% greater with strip-till and planter banded fertilizer, compared to no-till (Table 2). Overall, the strip-tillage treatment with all of the fertilizer banded at planting produced the most early-season plant growth. In 2004, both strip-till and no-till with fertilizers banded at planting produced more early-season plant growth than strip-till with all fertilizers banded below the row. In 2005, the effects of the tillage and fertilizer treatments were overall similar to that in 2003. Averaged across all growing seasons, the best overall early-season corn plant growth occurred with the strip-till system and with 40 lb/a N along with P, K and S fertilizer applied at planting. As the rate of N in the fertilizer planter mix was increased, early-season plant growth diminished, suggesting possibly some sensitivity to planter band N rates higher than 40 lb/a in strip-till (Figure 2).

Yield

The tillage and fertilizer treatments produced statistically significantly differences in corn yield. Strip tillage produced generally higher yields compared to no-till except in 2003, when strip-till with 80 and 120 lb/a N rates at planting yielded less than comparable no-till treatments (Table 2). In 2003, strip-tillage without fertilizer increased corn yield 12 bushels/a compared to no-till. In 2004 and 2005, yields were increased by 9 and 10 bu/a, respectively. There was no evidence that fertilizer applied in the fall performed worse than that applied at planting time. However, the combination treatment of fall strip-tillage fertilizer plus planter banded fertilizer (80-15-2.5-2.5 fall + 40-15-2.5-2.5 at planting) verall produced the highest three-year average yield.

In summary, the traditional strip-till fertilization system with all of the fertilizer injected below the row proved to be practical and attractive. Strip-till produced overall higher grain yields compared to no-till. Strip-tillage should eliminate some difficulties associated with no-till, and afford many of the environmental and moisture conservation benefits of no-till.

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Table 2. Treatment mean effects for corn plant population, v6 plant dry matter, and grain yields.

Treatments Tillage x (N-P-K-S, lb/a	Plant Population x 1000 2003	2004	2005	V6 Dry Matter Grams/plant 2003	2004	2005	Grain Yield Bu/a 2003	2004	2005
Strip-Till + Strip-till Banded Fertilizer (5" below the row)									
Check 0-0-0-0	21.1	22.1	22.8	2.6	10.0	9.2	78	53	62
40-30-5-5	21.1	22.2	20.3	6.6	12.2	18.1	86	123	91
80-30-5-5	21.2	21.9	22.0	7.1	13.9	15.6	96	160	112
120-30-5-5	21.8	21.7	22.5	7.2	12.7	15.1	91	161	122
80-15-2.5-2.5 fall + 40-15-2.5-2.5 at planting	21.1	21.9	22.2	7.8	17.8	15.2	89	167	133
Strip-Till + Planter Banded Fertilizer (2.5x2.5 from seed row)									
40-30-5-5	21.0	22.4	21.3	9.1	17.6	18.0	90	116	91
80-30-5-5	21.3	22.1	20.6	7.6	18.1	16.2	88	144	108
120-30-5-5	22.2	22.1	20.9	6.7	16.7	12.4	78	160	118
No-Tillage + Planter Banded Fertilizer (2.5x2.5 from seed row)									
Check 0-0-0-0	18.4	20.2	19.3	2.4	8.5	8.5	66	44	52
40-30-5-5	18.8	21.1	18.4	6.2	16.9	15.7	80	101	82
80-30-5-5	18.8	20.3	18.9	5.4	15.8	14.6	90	133	99
120-30-5-5	18.1	21.1	18.9	4.8	16.5	12.8	86	149	117
No-Tillage + Preplant Deep-banded Fertilizer (15" centers x 4" de[th)									
120-30-5-5	18.9	20.1	22.4	4.8	15.0	16.1	87	163	109
LSD 0.05	2.4	1.9	2.4	3.0	1.7	2.3	9	17	10

2003

Fall strip-till and fall banded fertilizer: 11/2/02. Pre-plant deep banded fertilizer, no-till: 3/26/03. Planter-banded fertilizer: 4/10/03.

2004

Fall strip-till and fall banded fertilizer: 12/2/03. Pre-plant deep-banded fertilizer, no-till: 4/14/04. Planter-banded fertilizer: 4/15/04.

2005

Fall (*Spring*) strip-till and spring banded fertilizer: 4/01/05. Pre-plant deep-banded fertilizer, no-till: 4/01/05. Planter-banded fertilizer: 4/13/05.

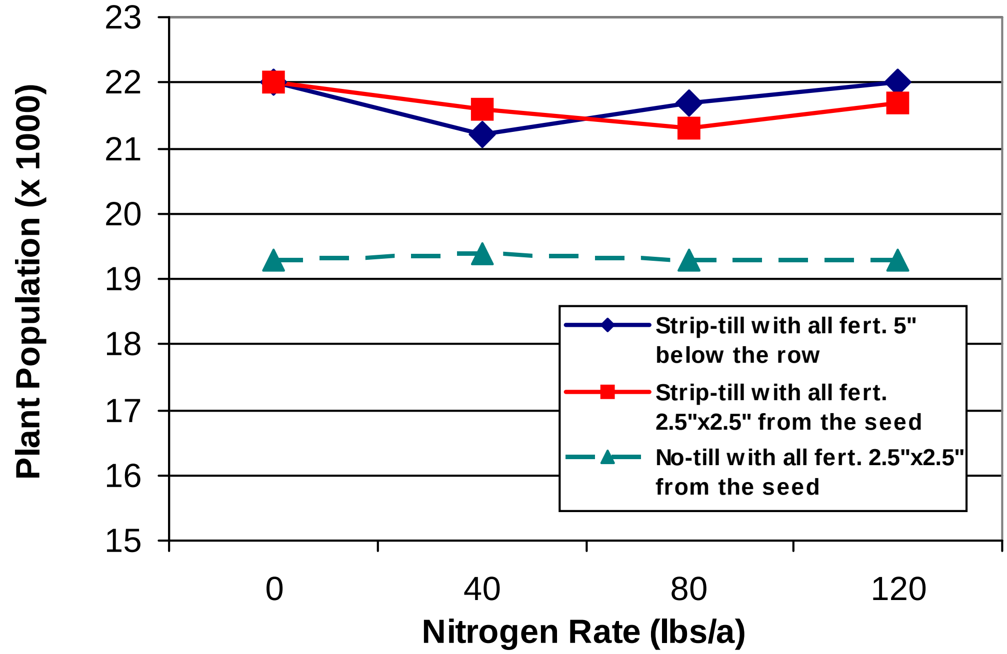

Figure 1. Three-year-average corn plant populations as affected by tillage, N rate, timing and placement of fertilizer.

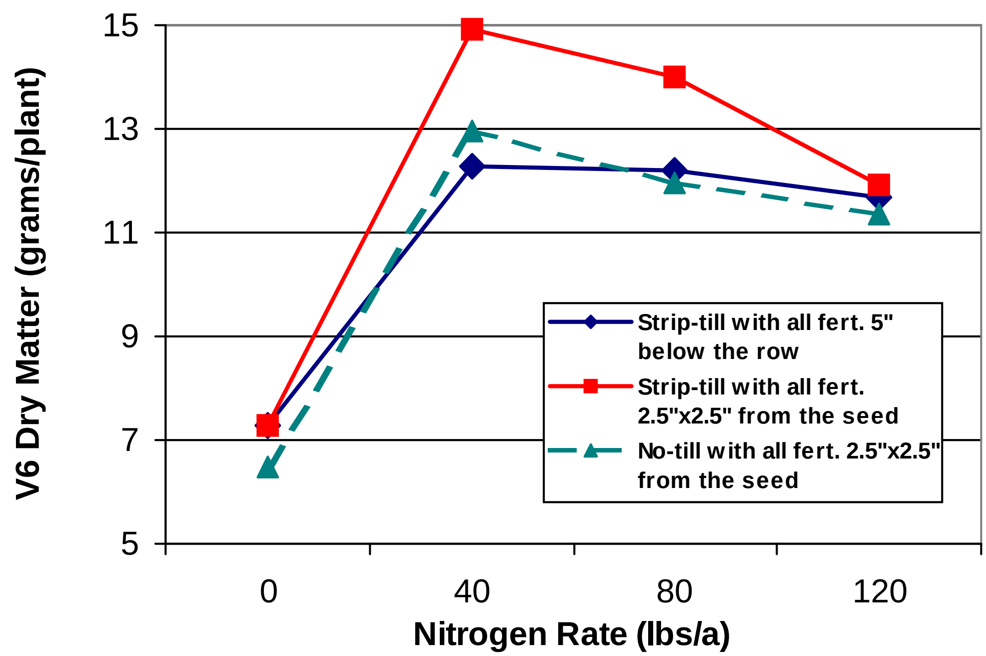

Figure 2. Three-year-average early-season corn growth as affected by tillage, N rate, timing and placement of fertilizer.

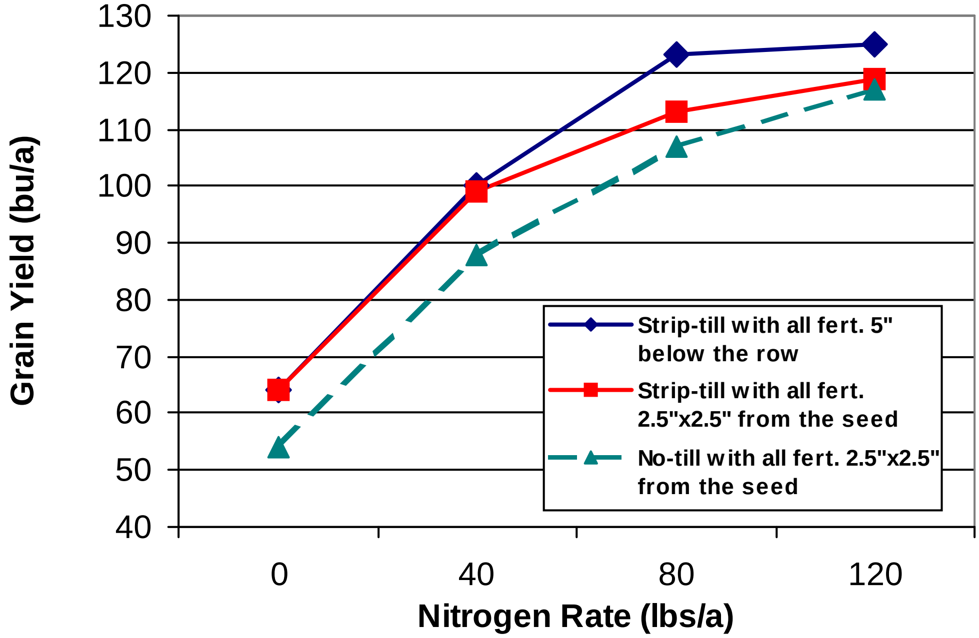

Figure 3. Three-year-average corn grain yields as affected by tillage, N rate, timing and placement of fertilizer.

PERFORMANCE TRIALS WITH DOUBLE-CROP SOYBEANS PLANTED NO-TILL FOLLOWING WHEAT

Keith A. Janssen and Gary L. Kilgore

Introduction

Planting soybeans no-till after wheat in order to save precious time and moisture, as well as using Roundup Ready soybean technology for weed control, has reduced some of the difficulties previously associated with planting double-crop soybeans. Generally, the key to a successful double-crop soybean planting is to plant as quickly as possible after wheat harvest and to plant soybean varieties that will utilize the full double-crop soybean growing season. This study evaluates group III, IV and early group V Roundup Ready soybean varieties planted no-till after wheat.

Procedure

Five double-cropped soybean varieties were evaluated in 2003, six in 2004 and four in 2005. Seeding was with a no-till planter at approximately 165,000 seeds per acre in 30 inch rows. No fertilizer was applied, but P and K soil test levels were good and the prior wheat crops all received P and K fertilizers. Roundup Weather Max at 22 oz/a was sprayed for weed control one or two times depending on the amount of weed and volunteer wheat pressure. Planting and harvest dates, soybean plant and pod heights, and dates when varieties were mature (pods dry) are shown in the accompanying data tables.

Results

Yields for individual varieties for individual years ranged from 17.2 to 44.4 bu/a during the three-year period. Moisture was the predominant yield- limiting factor in 2003, delayed planting (wet soil) was a problem in 2004, but 2005 had near ideal planting and growing conditions. The varieties that performed best, overall, tended to be the longer-season varieties.

Table 3. No-till double-crop soybean variety performance test, 2003, Ottawa, KS.

Variety	Yield	Maturity	Plant height	Pod height
	bu/a @ 13%	month/day	inch	inch
Syngenta S40-R9	23.1	10-23	20.5	4.2
Pioneer 94B13	21.4	10-24	19.5	3.2
Pioneer 93B80	20.3	10-20	19.0	3.2
Pioneer 93B85	18.1	10-20	17.2	2.7
Stine S4442-4	17.6	10-25	17.2	2.6
LSD 0.05	1.8	1	2.1	0.7

Planting date: July 7, 2003 Harvest date: October 30, 2003

Table 4. Double-crop soybean variety performance test, 2004, Ottawa, KS.

Variety	Yield	Maturity	Plant height	Pod height
	bu/a @ 13%	month/day	inch	inch
Midland 9A432NRS	20.8	10-28	22.8	2.5
NK S40-R9	20.7	10-27	22.8	2.5
Stine 5142-4	20.3	10-28	22.8	2.8
Midland 9A485XRR	18.9	10-28	23.0	3.0
Stine 4842Y	17.4	10-30	22.0	2.8
NK S46-W8	17.2	10-29	23.0	3.0
LSD 0.05	2.8	0.9	NS	NS

Planting Date: July 14, 2004 (planted into a wet seed bed)   Harvest Date: December 14, 2004

Table 5. Double-crop soybean variety performance test, 2005, Ottawa, KS.

Variety	Yield	Maturity	Test wt.	Plant height	Pod height
	bu/a @ 13%	month/day	lb/bu	inch	inch
Midland 9A462NRS	44.4	10-17	55.9	34.0	5.0
Pioneer 94M30	40.0	10-14	56.1	27.2	3.9
Midland 9A432NRS	39.2	10-12	56.0	27.5	4.2
Pioneer 93M92	35.5	10-12	56.1	26.0	3.9
LSD 0.05	6.6	-3	NS	1.9	0.6

Planting Date: June 24, 2005   Harvest Date: October 12, 2005

EVALUATION OF LUMAX AND CAMIX ON GRAIN SORGHUM

Larry Maddux

Summary

This study was conducted at the Cornbelt Field in 2002 and at the East-Central Field in 2003 and 2004. It evaluated the tolerance of Concep III treated grain sorghum to the use rate and two times the use rate of Lumax, Camix, and Bicep II Magnum. No injury was observed with the application of the 20 EPP and 10 EPP treatments, but in two of the three years, slight injury (5 - 17%) was observed with the double rate of Camix and Lumax. However, no yield differences were observed. In other studies in Kansas, greater yields were observed with the PRE treatments and a slight yield reduction was observed. These studies combined with other studies in Kansas were instrumental in obtaining a Section 18 use permit for Lumax applied 7 - 14 days preplant. Users should obtain a label before using Lumax on grain sorghum. It is recommended to approach the use of Lumax on sorghum with caution. Most of the studies conducted during 2003-2005 were largely under optimum conditions. As with any new herbicide, we should expect some surprises, and the 2006 preliminary data show greater injury at the East Central Experiment Field than was obtained in these studies.

Introduction

Chemical weed control and cultivation have been used to control weeds in row crops to reduce weed competition which can reduce yields. The development of weeds resistant to some of the herbicides used on grain sorghum and the lack of new herbicide options prompted this study. Lumax is a premix of Dual II Magnum, Callisto, and atrazine. Camix is a premix of Dual II Magnum and Callisto. The inclusion of Callisto introduces new chemistry (mesotrione) with a new mode of action that, if crop tolerance is acceptable, would increase the spectrum of weed control in grain sorghum. There were several sites located across the state of Kansas.

Procedures

This study was started in 2003 at the Cornbelt Experiment Field near Powhattan. With the closure of that field in Dec. 2003, the study was conducted at the East-Central Field in 2004 and 2005. Treatments consisted of three application timings: 20 days before planting (20 EPP), 10 days before planting (10 EPP), and preemergence (PRE). Three herbicides were compared: Lumax, 2.5 and 5.0 qt/a; Camix, 2.0 and 4.0 qt/a; and Bicep II Magnum, 2.1 and 4.2 qt/a. The rates used were the normal use rate and two times the normal use rate. Applications were made as follows: 20 EPP (5/13/03, 4/22/04, 4/15/05); 10 EPP (5/22/03, 5/4/04, 4/27/05); PRE (5/29/03, 5/24/04, 5/11/05). The PRE application in 2004 was delayed by wet weather. Garst 5382 Concep treated grain sorghum was planted at 70,000 sds/a on May 29, 2003, on a Grundy silty clay loam soil with a pH of 6.5 and an organic matter content of 3.1 percent. Pioneer 84G62 Concep treated seed was planted at 64,400 sds/a on May 24, 2004 and May 11, 2005, on a Woodson silt loam soil with a pH of 6.9 and an organic matter content of 2.6 percent. The growing season was drier than normal at the Cornbelt Field in 2003, but the East Central Experiment Field site had good moisture both years. The plots were harvested October 23, 2003, October 25, 2004, and September 24, 2005 with a modified John Deere 3300 plot combine.

Results

No injury was observed at the Cornbelt Field in 2003 with the 20 EPP and 10 EPP application timings at either the normal use rate or the double rate (Table 6). However, with the PRE application, the double rate of Lumax resulted in a 17% injury rating and the double rate of Camix resulted in a 10% injury rating. In 2004, at the East Central Exp. Field, no injury was observed with any herbicide or application timing. Injury similar to that observed at the Cornbelt Field in 2003 was observed at the East Central Field in 2005. However, the severity of injury was a little less, with only 5% injury being observed with the double rate of both Lumax and Camix. However, no difference in yield was observed with any of the treatments (Table 7). Atother sites in Kansas, greater injury was observed, mainly with the PRE treatrments, and some slight yield decreases were observed.

Weed pressures were light on these sites. The main emphasis of this study was to evaluate the tolerance of Concept-treated grain sorghum to Lumax and Camix. However, from visual observations, Lumax gave a little better weed control than did Bicep II Magnum.

These studies, as well as the many other studies conducted in Kansas by K-State personnel, were instrumental in the approval of a section 18 emergency exemption allowing Lumax herbicide use on grain sorghum in Kansas for 2006. When applied according to the label and after proper activation, this herbicide controls annual grass (not including shattercane) and broadleaf weeds in grain sorghum, including triazine resistant, glyphosate-resistant, and ALS resistant Palmer amaranth and waterhemp. It is an indemnified label, meaning that end users must accept all responsibility for failure to perform and for crop damage from Lumax use on sorghum. Applicators must be in possession of the label at the time of application. The label can be accessed online at www.farmassist.com only after indicating acceptance of liability.

Table 6. Effect of herbicide and application time on sorghum injury, Cornbelt Experiment Field, 2003 and East Central Experiment Field, 2004 and 2005.

Treatment	Rate	Application	Sorghum Injury		
	Product/a	Time	2003	2004	2005
			-----------------------Percent-----------------------		
Untreated Check	---	---	0	0	0
Lumax	2.5 qt	20 EPP	0	0	0
Lumax	5.0 qt	20 EPP	0	0	0
Camix	2.0 qt	20 EPP	0	0	0
Camix	4.0 qt	20 EPP	2	0	0
Bicep II Magnum	2.1 qt	20 EPP	0	0	0
Bicep II Magnum	4.2 qt	20 EPP	0	0	0
Lumax	2.5 qt	10 EPP	0	0	0
Lumax	5.0 qt	10 EPP	3	0	0
Camix	2.0 qt	10 EPP	0	0	0
Camix	4.0 qt	10 EPP	0	0	3
Bicep II Magnum	2.1 qt	10 EPP	0	0	0
Bicep II Magnum	4.2 qt	10 EPP	0	0	0
Lumax	2.5 qt	PRE	0	0	0
Lumax	5.0 qt	PRE	17	0	5
Camix	2.0 qt	PRE	2	0	0
Camix	4.0 qt	PRE	10	0	5
Bicep II Magnum	2.1 qt	PRE	0	0	0
Bicep II Magnum	4.2 qt	PRE	0	0	0
LSD (0.05)			8	---	1

Table 7. Effect of herbicide and application time on sorghum yield, Cornbelt Exp. Field, 2003 and East Central Exp. Field, 2004 and 2005.

Treatment	Rate	Application	Sorghum yield		
	Product/a	Time	2003	2004	2005
			------------------------ bu/a ------------------------		
Untreated Check	---	---	76	66	52
Lumax	2.5 qt	20 EPP	86	100	93
Lumax	5.0 qt	20 EPP	82	100	94
Camix	2.0 qt	20 EPP	75	97	87
Camix	4.0 qt	20 EPP	79	100	90
Bicep II Magnum	2.1 qt	20 EPP	80	100	81
Bicep II Magnum	4.2 qt	20 EPP	79	96	72
Lumax	2.5 qt	10 EPP	79	65	88
Lumax	5.0 qt	10 EPP	69	102	95
Camix	2.0 qt	10 EPP	87	102	93
Camix	4.0 qt	10 EPP	79	107	86
Bicep II Magnum	2.1 qt	10 EPP	77	97	82
Bicep II Magnum	4.2 qt	10 EPP	79	103	92
Lumax	2.5 qt	PRE	78	97	81
Lumax	5.0 qt	PRE	77	109	88
Camix	2.0 qt	PRE	74	96	88
Camix	4.0 qt	PRE	72	93	95
Bicep II Magnum	2.1 qt	PRE	81	86	98
Bicep II Magnum	4.2 qt	PRE	69	90	96
LSD (0.05)			14	16	15

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EXPERIMENT FIELD PERSONNEL

Mark M. Claassen, Agronomist-in-Charge
Lowell Stucky, Plant Science Technician II
Kevin Duerksen, Plant Science Technician I

Supporting Agencies and Companies

BASF
Monsanto
NC+
Pioneer
Sorghum Partners, Inc.
Syngenta
Triumph Seed Co.

HARVEY COUNTY EXPERIMENT FIELD

Introduction

Research at Harvey County Experiment Field deals with many aspects of dryland crop production on soils of the Central Loess Plains and Central Outwash Plains of central and south-central Kansas, and is designed to directly benefit the agricultural industry of the area. The focus is primarily on wheat, grain sorghum, and soybean, but research is also conducted on alternative crops such as corn and sunflower. Investigations include variety and hybrid performance tests, chemical weed control, reduced tillage/no-tillage systems, crop rotations, cover crops, fertilizer use, and planting practices, as well as disease and insect resistance and control.

Soil Description

The Harvey County Experiment Field consists of two tracts. The headquarters tract (North Unit), 75 acres immediately west of Hesston on Hickory St., is all Ladysmith silty clay loam with 0-1% slope. The second tract (South Unit), located 4 miles south and 2 miles west of Hesston, is composed of 142 acres of Ladysmith, Smolan, Detroit, and Irwin silty clay loams, as well as Geary and Smolan silt loams. All have 0-3% slope. Soils on the two tracts are representative of much of Harvey, Marion, McPherson, Dickinson, and Rice Counties, as well as adjacent areas. These are deep, moderately well to well-drained, upland soils with high fertility and good water-holding capacity. Water run-off is slow to moderate. Permeability of the Ladysmith, Smolan, Detroit, and Irwin series is slow to very slow, whereas permeability of the Geary series is moderate.

2004-2005 Weather Information

Consecutive rainy days before mid-October delayed wheat planting. Within a week thereafter, rainfall totaled 1.87 inches. November had above-normal rainfall, but December turned quite dry. Average October and November temperatures were near normal, but December temperatures were well above average. Wheat emerged in 7 to10 days after planting. Fall wheat development was good, but somewhat less than usual tillering was observed.

Beginning with heavy rainfall in early January, winter precipitation was substantially above normal. Coldest temperatures of the winter occurred in early and mid-January, as well as very briefly in early February. Mean temperatures were slightly below normal in January and March, but February temperatures averaged 3 °F above normal. Wheat survival was good.

Rainfall was well below normal in April, but somewhat above normal in May. The first seventeen days of June were characterized by wet weather. Mean temperatures were about 1 °F cooler than normal in April, normal in May, and slightly above normal in June. Preharvest rains resulted in light wheat test weights.

Soil-borne mosaic and spindle streak mosaic symptoms appeared in some varieties at the beginning of March. The presence of both diseases was confirmed by laboratory analysis. Mosaic symptoms in susceptible varieties persisted, causing reduction in plant height, delayed heading, and yield reduction. Light to moderate powdery mildew on some varieties was observed, along with light tan spot, in early May. Stripe rust also was noted on some varieties at that time. Leaf rust became the dominant disease after mid-May.

Weather and soil conditions permitted timely corn planting, with light rains following. Freezing temperatures on April 24 and 30, as well as on May 2, caused loss of corn leaves, but generally did not result in mortality of seedlings. Wheat damage from freezing temperatures occurred in the region, but there was no significant injury on station. Persistent rains in early June seriously impacted field work and delayed planting of row crops that had not been planted earlier in May. At the North Unit, a brief hail storm on June 30 shredded leaves of corn and other row crops. In July and August, average temperatures were 2.1 to 2.7 °F below normal. During these months, there were only 2 days with temperatures at or above 100 °F. July rainfall was somewhat below normal, resulting in periods of limited drought stress. August brought abundant rains, mainly in the second half of the month as corn approached maturity. Early September was dry and set the stage for ideal row crop harvesting conditions. Both grain sorghum and soybean matured before the first fall freeze. Neck rot occurred in some grain sorghum plots, but lodging was generally negligible.

Freezing temperatures occurred last in the spring on May 2. First fall frost occurred on October 23. The frost-free season of 174 days was about 6 days longer than normal.

Table 1. Monthly precipitation totals, inches - Harvey Co. Experiment Field, Hesston, Kansas.[1]

Month	N Unit	S Unit	Normal	Month	N Unit	S Unit	Normal
	2004				2005		
October	3.49	2.98	2.95	March	3.07	3.08	2.71
November	2.36	1.89	1.68	April	1.29	1.49	2.84
December	0.21	0.21	1.01	May	5.42	6.00	4.83
				June	10.07	9.86	4.72
	2005			July	3.28	3.49	3.59
January	2.68	3.06	0.79	August	5.29	7.01	3.88
February	1.76	1.75	1.08	September	1.69	1.19	2.99
Twelve-month total					40.61	42.01	33.07
Departure from 30-year Normal at N. Unit					7.54	8.94	

[1] Three experiments reported here were conducted at the South Unit: *Effects of Late-maturing Soybean and Sunn Hemp Summer Cover Crops and Nitrogen Rate on No-till Grain Sorghum after Wheat; Soybean for Forage*; and *Herbicides for Weed Control in Corn*. Three experiments in this report were conducted at the North Unit: *Reduced Tillage and Crop Rotation Systems with Wheat, Grain Sorghum, Corn, and Soybean; No-till Crop Rotation Effects on Wheat, Corn, Grain Sorghum, Soybean, and Sunflower;* and *Planting Date, Hybrid Maturity, and Plant Population Effects in No-till Corn*. One experiment, *Effects of Chloride Rate on No-till Continuous Wheat and Grain Sorghum*, was divided between units, with the wheat portion conducted at the North Unit and the grain sorghum trial at the South Unit.

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

M.M. Claassen

Summary

Tillage-system effects on continuous wheat, continuous grain sorghum, and annual rotations of wheat with row crops were investigated for a ninth consecutive year. As in most seasons, tillage in alternate years did not affect no-till wheat after row crops. Crop-rotation effects on wheat yield were significant. Wheat in rotation with soybean, corn, and grain sorghum averaged 71.6, 56.5, and 51.2 bu/a, whereas continuous wheat averaged 33.4 bu/a over all tillage systems. Continuous wheat with no-till yielded 44.1 bu/a versus 26.2 and 29.8 bu/a for chisel and burn systems, respectively. Wheat stand loss from surface water accumulation occurred in continuous wheat chisel and burn plots. Corn and soybean averaged 79.5 and 29.1 bu/a, respectively. Overall effects of tillage systems on row crops were not significant. Crop rotation and planting date had a major influence on sorghum production. Sorghum after wheat averaged 81.4 bu/a, 14.9 bu/a more than continuous sorghum. May planting produced 16.9 bu/a more than June planting of monoculture sorghum.

Introduction

Crop rotations facilitate reduced-tillage practices, while enhancing control of diseases and weeds. 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 soybean 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 soybean can be planted earlier in the spring and harvested earlier in the fall than sorghum, thereby providing 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 monoculture wheat and grain sorghum systems.

Procedures

Three tillage systems were maintained for continuous wheat, two for each row crop (corn, soybean, 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

Wheat after Sorghum

WG-NTV = No-till after V-blade (V-blade, sweep-treader, mulch treader) for sorghum

WG-NTNT = No-till after No-till sorghum

Wheat after Soybean

WS-NTV = No-till after V-blade (V-blade, sweep-treader, mulch treader) for soybean

WS-NTNT = No-till after No-till soybean

Continuous Wheat

WW-B = Burn (burn, disk, field cultivate)

WW-C = Chisel (chisel, disk, field cultivate)

WW-NT = No-till

Corn after Wheat

CW-V = V-blade (V-blade, sweep-treader, mulch treader)

CW-NT = No-till

Sorghum after Wheat

GW-V = V-blade (V-blade, sweep-treader, mulch treader)

GW-NT = No-till

Soybean after Wheat

SW-V = V-blade (V-blade, sweep-treader, mulch treader)

SW-NT = No-till

Continuous Sorghum

GG-C = Chisel (chisel, sweep-treader, mulch treader)

GG-NT = No-till

Continuous wheat, no-till plots were sprayed with Roundup[1] Original Max + 2,4-D_A + Clarity[2] + ammonium sulfate (AMSU) (33 oz + 3 oz + 1.7 lb/a) on July 20. Additional fallow application of Roundup Original Max + 2,4-D_A + AMSU (16 oz + 16 oz + 0.5 lb/a) was made on August 31. This treatment without 2,4-D was repeated for WW-NT on October 22.

For WC-NT, late-season weeds and volunteer growth in corn stubble were sprayed in early October with Roundup Original Max + 2,4-D_{LVE} 6 EC + AMSU (22 oz + 4 oz + 0.5 lb/a).

Variety Overley was planted on October 22 in 8-inch rows at 90 lb/a with a CrustBuster no-till drill equipped with double disk openers. Wheat was fertilized with 121 lb N/a and 35 lb P_2O_5/a as preplant, broadcast ammonium nitrate and in-furrow diammonium phosphate at planting. Because of stand loss from excess moisture in WW-B and WW-C, these plots were overseeded with Overley at 120 lb/a on December 31. No herbicides were used on wheat in any of the tillage and cropping systems. Wheat was harvested on June 27, 2005.

No-till corn after wheat plots received the same fallow herbicide treatments as WW-NT during the summer. Roundup Ultra Max II + Clarity + AMSU (22 oz + 2.5 oz + 1 lb/a) was applied on March 14. Early preplant application of Dual[3] II Magnum + atrazine 90DF + crop oil concentrate (COC) at 1.6 pt + 1.11 lb + 1 qt/a was made 4 weeks before planting. Weeds and volunteer wheat were controlled during the summer through the early winter period in CW-V plots with three tillage operations. A light Roundup Ultra

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[1]Roundup is a registered trademark of Monsanto.
[2]Clarity is a registered trademark of BASF.
[3]Dual, AAtrex, Concep, and Cruiser are registered trademarks of Syngenta.

MaxII application in mid-March, plus a tillage operation just before planting, was necessary for final weed control and seedbed preparation. Corn was fertilized with 110 lb N/a as ammonium nitrate broadcast before planting. An additional 14 lb N/a and 37 lb P_2O_5/a were banded 2 inches from the row at planting. A White no-till planter with double-disk openers on 30-inch centers was used to plant Poncho[4] 250-treated Pioneer 35P12 at approximately 18,700 seeds/a on April 16, 2005. CW-V plots were sprayed shortly after planting with Dual II Magnum + AAtrex 4L at 1.33 pt + 0.75 qt/a for preemergence weed control. Row cultivation was not used. Corn was harvested on September 2.

No-till sorghum after wheat plots received the same fallow (July through mid-March) herbicide treatments as no-till corn. An early preplant application of Dual II Magnum + AAtrex 90DF + 2,4-D $_{LVE}$ 6EC + Clarity + COC (1.33 pt + 0.83 lb + 2.66 oz + 2 oz + 1 qt/a) was made on April 23. At that time, all continuous NT sorghum plots were treated with Dual II Magnum + AAtrex 90DF + Roundup Original Max + 2,4-D $_{LVE}$ 6EC + AMSU (1.33 pt + 1.67 lb + 28 oz + 0.67 pt + 2.6 lb). GG-NT_{June} plots required a follow-up application of Roundup Original Max + AMSU (22 oz + 2.6 lb/a) on June 21. GW-V plots were managed like CW-V areas during the fallow period between wheat harvest and planting. Between crops, all GG-C_{May} plots were tilled once in the fall (chisel) and twice in the spring (mulch treader and sweep-treader). GG-NT_{June} plots required two additional spring tillage operations because of delayed planting. Sorghum was fertilized like corn, but with a total of 115 lb N/a. Pioneer 8500 treated with Concep III safener and Cruiser insecticide was planted at 42,000 seeds/a in 30-inch rows on May 20, 2005. A second set of continuous sorghum plots was planted on June 24. Preemergence herbicides for sorghum in tilled plots were as follows: GW-V: 1.33 pt/a Dual II Magnum + 0.83lb/a AAtrex 90DF; and GG-C_{May} and GG-C_{June}: 1.33 pt/a Dual II Magnum + 1.11 lb/a AAtrex 90DF. Sorghum was not row cultivated. May- and June-planted sorghum were harvested on September 13 and October 18, respectively.

Fallow weed control procedures through mid-March for no-till soybean after wheat were the same as for CW-NT and GW-NT. SW-V tillage treatments were similar to those indicated for GW-V. Asgrow AG3302 RR soybean was planted at 7 seeds/ft in 30-inch rows on May 6. After planting, weeds were controlled in all soybean plots with Roundup Ultra Max II + AMSU (17 oz + 2.6 lb/a) on May 23, and with Roundup Original Max + AMSU (22 oz + 2.6 lb/a) on June 20. Soybean was harvested on September 22, 2005.

Results

Wheat

Crop residue cover in wheat after corn, sorghum, and soybean averaged 78, 77, and 58%, respectively (Table 2). WW-B, WW-C, and WW-NT averaged 8, 27, and 75% residue cover after planting, respectively. Most wheat emerged 10 to 13 days after planting. Where wheat followed a row crop, stands averaged 99 to 100% complete in November and were not affected by tillage system or previous crop. Similar stands occurred in WW-NT. WW-B and WW-C plots had slower emergence, and ultimately poorer stands. These treatments exhibited poorer internal soil drainage, resulting in water ponding and mortality of seedlings after

[4]Poncho is a registered trademark of Bayer.

heavy fall rains. Benefit of overseeding wheat in December was impeded by unusually heavy rainfall in early January. Although final stands in WW-B and WW-C were reasonable, wheat tillering in these plots was limited and plant development was delayed. Cheat control was generally good to excellent, except for WW-C. Plant N concentration in wheat at late boot-early heading stage was highest in WW-B and WW-C. Among remaining treatments, plant N was highest in wheat after soybean (1.35%). Heading date occurred one day earlier in wheat after soybean than in wheat after corn or sorghum and two days earlier than WW-NT. Yields were highest in wheat rotated with soybean, corn, and sorghum, averaging 71.6, 56.5, and 51.2 bu/a, respectively. No-till continuous wheat yielded substantially less, at 44.1 bu/a. Tillage-system effects on wheat yield were not significant in any of the row crop rotations. In continuous wheat, no-till yield was 16.1 bu/a better than with the burn and chisel treatments. Crop rotation effect on test weight was significant, with slightly greater values in wheat after corn and soybean than after grain sorghum or in continuous wheat.

Row Crops

Corn, sorghum, and soybean following wheat had an average of 34, 28, and 24%, respectively, crop residue cover after planting in V-blade systems (Table 3). Where these row-crops were planted NT after wheat, crop residue cover ranged from 81 to 92%, with the greatest residue cover in CW-NT. The chisel system in May-planted continuous sorghum resulted in 11% more ground cover than the V-blade system in sorghum after wheat. Over the past nine years, the respective averages for GG-C $_{May}$ and GW-V ground cover have been 37 and 35%, respectively, whereas GG-C_{June} has averaged 25% ground cover. In keeping with long-term averages, NT sorghum after wheat averaged 11% more ground cover than did May-planted NT continuous sorghum. GG-NT_{June} had 21% less ground cover than GG-$NT_{May,}$ compared with a long-term difference of 12%.

In corn, tillage system did not affect stands, ears per plant, or grain test weight. No-till delayed silking by two days, decreased leaf nutrient level by 0.36% N and tended to reduce yield, but not significantly at p =0.05.

In sorghum after wheat, tillage system had no significant effect on stand, days to half bloom, grain test weight, and yield. Leaf N levels were ample with both tillage systems, but were somewhat higher in GW-V than in GW-NT. Also, the number of heads per plant was slightly larger in GW-V. Within the same planting date, continuous sorghum showed little or no effect from tillage system on any of the variables measured.

Crop rotation and planting date both had large effects on grain sorghum. Following wheat in rotation, sorghum had 0.16 more heads/plant and produced 81.4 bu/a, 14.9 bu/a more than continuous sorghum produced when planted on the same date. June-planted continuous sorghum reached bloom stage 8 days earlier, had 0.08 more heads/plant, and yielded an average of 16.9 bu/a less, with 3.7 lb/bu lower test weight, than May-planted continuous sorghum.

Soybean averaged 29.1 bu/a, close to the long-term mean production. Tillage system did not affect soybean yield.

Table 2. Effects of row crop rotation and tillage on wheat, Harvey County Experiment Field, Hesston, Kansas, 2005.

Crop Sequence[1]	Tillage System	Crop Residue Cover [2]	Yield[3] 2005	Yield[3] 9-Yr	Test Wt	Stand[4] Nov	Stand[4] Apr	Head-ing[5]	Plant N[6]	Cheat Control[7]
		%	bu/a		lb/bu	%		date	%	----%----
Wheat-corn	V-blade	76	58.0	56.7	58.8	100	100	5	1.19	94
(No-till)	No-till	80	55.0	57.6	58.4	100	100	6	1.14	100
Wheat-	V-blade	72	51.2	47.9	57.8	100	100	4	1.12	93
sorghum	No-till	82	51.3	47.6	57.8	100	100	5	1.04	100
(No-till)										
Wheat-	V-blade	58	73.9	57.2	58.7	99	99	4	1.31	100
soybean	No-till	59	69.4	59.7	58.4	100	100	4	1.40	99
(No-till)										
Continuous	Burn	8	29.8	47.4	57.6	41	91	12	1.77	96
wheat	Chisel	27	26.2	45.1	57.4	31	89	12	1.76	73
	No-till	75	44.1	47.9	57.5	96	97	6	1.19	91
LSD .05		8	9.8	8.9	0.9	10	6	3.1	0.19	NS
LSD .10		6	8.1	7.4	0.8	8	5	2.5	0.16	NS
Main effect means:										
Crop Sequence										
Wheat-corn		78	56.5	57.1	58.6	100	100	5	1.16	97
Wheat-sorghum		77	51.2	47.7	57.8	100	100	5	1.08	96
Wheat-soybean		58	71.6	58.4	58.6	99	99	4	1.35	100
Continuous wheat		51	35.1	46.5	57.4	64	93	9	1.48	82
LSD .05		6	6.9	6.2	0.6	4	4	1.9	0.13	NS
Rotation Tillage system										
No-till/V-blade		69	61.0	53.9	58.5	100	100	5	1.21	96
No-till/no-till		74	58.6	55.0	58.2	100	100	5	1.19	99
LSD .05		NS	NS	NS	NS	NS	NS	NS	NS	NS

[1] Wheat planted no-till after row crop. Crop sequence main-effect means exclude continuous wheat-burn treatment. Tillage main-effect means 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] Stands evaluated on November 22 and April 21.

[5] Date in May on which 50% heading occurred.

[6] Whole-plant N levels at late boot to early heading.

[7] Visual rating of cheat control just before harvest.

Table 3. Effects of wheat rotation and reduced tillage on corn, grain sorghum, and soybean, Harvey County Experiment Field, Hesston, KS, 2005.

Crop Sequence	Tillage System	Crop Residue Cover [1]	Yield[2] 2005	Yield[2] Mult-Yr	Test Wt	Stand	Maturity[3]	Ears or Heads/ Plant	Leaf N[4]
		%	-----bu/a-----		lb/bu	1000's/a	days		%
Corn-wheat	V-blade	34	85.1	74.3	58.0	16.5	73	0.95	2.23
	No-till	92	73.8	68.6	58.0	15.9	75	0.96	1.87
LSD .05		9	NS	NS	NS	NS	0.8	NS	0.21
Sorghum-wheat	V-blade	28	81.4	90.9	58.8	34.7	67	1.30	2.72
	No-till	81	81.5	92.5	59.1	33.9	66	1.19	2.36
Contin. sorghum (May)	Chisel	39	67.0	74.1	59.8	35.6	67	1.09	2.15
	No-till	70	66.0	74.7	59.3	35.1	67	1.06	2.20
Contin. sorghum (June)	Chisel	15	49.5	63.4	55.5	33.4	60	1.12	2.47
	No-till	49	49.7	66.5	56.2	33.9	59	1.20	2.44
LSD .05[5]		9	11.5	14.8	0.62	1.8	1.4	0.10	0.31
Soybean-wheat	V-blade	24	30.6	28.2	—	—	137	—	—
	No-till	84	27.6	27.4	—	—	137	—	—
LSD .05		5	NS	NS	—	—	NS	—	—
Main effect means for sorghum:									
Crop sequence									
Sorghum-wheat		54	81.4	91.7	59.0	34.3	66	1.24	2.53
Contin. sorghum (May)		54	66.5	74.4	59.5	35.3	67	1.08	2.18
Contin. sorghum (June)		32	49.6	64.9	55.8	33.6	59	1.16	2.46
LSD .05		6	8.1	10.5	0.44	1.2	1.0	0.07	0.22
Tillage system									
V-blade/chisel		27	65.9	76.1	58.0	34.6	64	1.17	2.45
No-till/no-till		66	65.7	77.9	58.2	34.3	64	1.15	2.33
LSD .05		5	NS	NS	NS	NS	NS	NS	NS

[1] Crop residue cover estimated by line transect after planting.

[2] Means of four replications adjusted to 15.5% moisture (corn), 12.5% moisture (sorghum) or 13% moisture (soybean).

Multiple-year averages: 1997-1999, 2001-2005 for corn and 1997-2005 for sorghum and soybean.

[3] Maturity expressed as follows: corn - days from planting to 50% silking; grain sorghum - number of days from planting to half bloom.

[4] Sorghum flag leaf at late boot to early heading.

[5] LSDs for comparisons among means for continuous sorghum and sorghum after wheat treatments.

NO-TILL CROP ROTATION EFFECTS ON WHEAT, CORN, GRAIN SORGHUM, SOYBEAN, AND SUNFLOWER

M.M. Claassen and D.L. Regehr

Summary

A field experiment consisting of eleven 3-yr, no-till crop rotations was initiated in 2001 in central Kansas on Ladysmith silty clay loam. Cropping systems involving winter wheat (W), corn (C), grain sorghum (GS), double-crop grain sorghum ([GS]), soybean (SB), double-crop soybean ([SB]), and sunflower (SF) are as follows: W-C-SB, W-[SB]-C-SB, W-SB-C, W-GS-SB, W-[SB]-GS-SB, W-[GS]-GS-SB, W-GS-SF, W-[SB]-GS-SF, W-[GS]-GS-SF, GS-C-SB, and GS-GS-GS. Data collection to determine cropping system effects commenced in 2004. In 2005, highest W yields occurred in W-C-SB and W-GS-SB rotations, with 83.7 and 79.6 bu/a, respectively. In rotations where W followed SB or SF, yields averaged 77.9 and 72.2 bu/a. Following an unusually large corn yield in 2004, W after C produced 11.6 and 5.9 bu/a less than after SB and SF, respectively. Row crops, particularly C, suffered hail damage in late June. Corn averaged 79.9 bu/a without crop rotation effect. Grain sorghum grain production did not differ significantly among rotations. Grain sorghum averaged 81.9 bu/a, whereas [GS] had comparable yields of 78.4 bu/a. Soybean produced an average yield of 28.3 bu/a without significant differences among the seven rotations. Unlike 2004, SB was not adversely affected by an antecedent GS crop versus following W or C. Double-crop soybean averaged 15.4 bu/a and showed no meaningful response to crop rotation. Sunflower yielded 1734 lb/a with no rotation effect.

Introduction

The number of acres devoted to no-till crop production in the U.S. has risen steadily over the past 10 years, most notably since 2002. In 2004, according to the Conservation Technology Information Center, no-till was used on 62.4 million acres, nearly 23% of the cropland. Kansas currently ranks seventh in the nation, with 4.2 million acres of no-till annual crops representing 21.2% of planted acres. Soil and water conservation issues; cost of labor, fuel, and fertilizers; changes in government farm programs; development of glyphosate-tolerant crops; and lower glyphosate herbicide cost have all contributed to no-till adoption by growers.

Research has shown that crop rotation reduces pest control costs, enhances yields, and contributes significantly to successful no-till crop production. Selection of appropriate crop rotations brings adequate diversity of crop types to facilitate the realization of these benefits and also provides sufficient water-use intensity to take full advantage of available moisture.

In central and south-central Kansas, long-term no-till research on multiple crop rotations is needed to determine their profitability and reliability. The experiment reported here includes 10 three-year rotations. Nine of these involve winter wheat, corn or grain sorghum, and soybean or sunflower. One rotation consists entirely of row crops. Continuous grain sorghum serves as a monoculture check treatment. Double-crop soybean and grain sorghum after wheat are used as intensifying components in five of the rotations. One complete cycle of these rotations was completed in 2003. Official data collection began in 2004.

Procedures

The experiment site was located on a Ladysmith silty clay loam where no-till soybean had been grown in year 2000. Lime was applied according to soil test recommendation and incorporated by light tillage in late fall of that year. Detailed soil sampling was done in early April 2001, just before establishment of the cropping systems. Average soil test values at that time included: pH 6.2, organic matter 2.7%, available phosphorus (P) 46 lb/a, and exchangeable potassium 586 lb/a.

Eleven crop rotations were selected to reflect adaptation across the region. These involved winter wheat (W), corn (C), grain sorghum (GS), double-crop grain sorghum ([GS]), soybean (SB), double-crop soybean ([SB]), and sunflower (SF) as follows: W-C-SB, W-[SB]-C-SB, W-SB-C, W-GS-SB, W-[SB]-GS-SB, W-[GS]-GS-SB, W-GS-SF, W-[SB]-GS-SF, W-[GS]-GS-SF, GS-C-SB, and GS-GS-GS. A randomized complete-block design was used, with four replications of 31 treatments annually representing each crop in each rotation.

Corn plots to be planted to wheat were sprayed with Roundup Original Max + 2,4-D_{LVE} 6EC + AMSU (22 oz + 4 oz + 0.5 lb/a) on October 2, 2004, to control volunteer crop growth and/or late emerged weeds. Overley wheat was planted into corn and soybean stubble on October 22 in 8-inch rows at 90 lb/a with a CrustBuster no-till drill equipped with double-disk openers. Wheat was fertilized with 121 lb N/a and 35 lb P_2O_5/a as preplant broadcast ammonium nitrate and as in-furrow diammonium phosphate at planting. No herbicides were used on wheat in any of the cropping systems. Wheat was harvested on June 24, 2005.

Wheat plots to be planted to corn were sprayed with Roundup Original II + AMSU (1.5 qt + 1.7 lb/a) on July 13 and with Roundup Original Max + 2,4-D_A + AMSU (16 oz + 16 oz + 0.5 lb/a) on August 31, 2004. Wheat and [SB] plots to be planted to corn were treated with Roundup Ultra Max II + Clarity + AMSU (22 oz + 2.5 oz + 1 lb/a) on March 14. These areas and those where corn followed grain sorghum received an application of atrazine 90DF + Dual II Magnum + COC (1.67 lb + 1.6 pt + 1 qt/a) on March 19. Soybean plots to be planted to corn and then rotated to wheat were sprayed with Roundup Ultra Max II + atrazine 90DF + Dual II Magnum + AMSU + COC (17 oz + 1.11 lb + 1.6 pt + 2.6 lb + 1 qt/a) on the same day. A White no-till planter with double-disk openers on 30-inch centers was used to plant Poncho 250-treated Pioneer 35P12 at approximately 18,700 seeds/a on April 16, 2005. All corn was fertilized with14 lb N/a and 37 lb P_2O_5/a, banded 2 inches from the row at planting. Corn after wheat, [SB], and grain sorghum received 111 lb N/a, and corn after soybean received 81 lb N/a as 28-0-0, injected in a band 10 inches on either side of each row during the third week of May. Corn was harvested on September 2, 2005.

Plots to be planted to grain sorghum were treated the same as corn during the preceding summer. Wheat, [GS], and [SB] plots to be planted to grain sorghum were treated with Roundup Ultra Max II + Clarity + AMSU (22 oz + 2.5 oz + 1 lb/a) on March 14. Following wheat, sorghum plots received atrazine 90DF + Dual II Magnum + 2,4-D_{LVE} 6EC + COC (1.6 lb + 1.33 pt + 1.33 oz + 1 qt/a) on April 23. Remaining plots were treated on the same day with Roundup Original Max + atrazine

90DF + Dual II Magnum + 2,4-D_{LVE} 6EC + AMSU (28 oz + 1.1 or 1.6 lb + 1.33 pt + 0.67 pt + 2.6 lb/a).

Sorghum Partners KS 585 treated with Cruiser insecticide and Concep safener was planted at 42,000 seeds/a in 30-inch rows, with 14 lb N/a and 37 lb P_2O_5/a banded 2 inches from the row on May 20. Sorghum after W, GS, [GS], and [SB] received an additional 76 lb/a of N, and sorghum after SB received 46 lb/a of N. Both rates were injected as 28-0-0 in a band 10 inches from the row in June. Sorghum was harvested on September 13, 2005.

Double-crop grain sorghum had a preplant application of Roundup Original Max + AMSU (33 oz + 1.3 lb/a) on July 11. Pioneer 85G57 was planted like KS 585 on July 11. An additional 46 lb/a of N was injected on August 9. Postemergence application of atrazine 4L + COC (1.5 qt + 1 qt/a) was made with drop nozzles on August 10. Double-crop grain sorghum was harvested on October 27.

Wheat plots to be planted to soybean were treated with Roundup applications in July and August like those for corn and sorghum. Corn plots to be planted to soybean were sprayed with Roundup Original Max + 2,4-D_{LVE} 6EC + AMSU (16 oz + 0.67 qt + 0.5 lb/a) on October 2, 2004. Spring preplant weed control where soybean followed wheat consisted of treatment with Roundup Ultra Max II + Clarity + AMSU (22 oz + 2.5 oz + 1 lb/a) on March 19. All remaining plots were sprayed with Roundup Original Max + 2,4-D_{LVE} 6EC + AMSU (22 oz + 2.7 oz + 2.6 lb/a) on April 23. Asgrow AG3302 RR soybean was planted at 122,000 seeds/a in 30-inch rows on May 5. During the season, Roundup at 22 oz/a was applied June 15 and repeated in combination with Select herbicide at 8 oz/a on July 16. Soybean was harvested on September 23.

Double-crop soybean had a preplant application of Roundup Original Max + AMSU (33 oz + 1.3 lb/a) on July 11. Asgrow AG3302 RR soybean was planted as a double crop at 122,000 seeds/a in 30-inch rows on the same day. Double-crop soybean was sprayed with Roundup Original Max II + AMSU (22 oz + 2.6 lb/a) on August 31, and was harvested on October 27, 2005.

All sunflower plots were sprayed with Roundup Original Max + 2,4-D_{LVE} 6EC + AMSU (22 oz + 2.7 oz + 2.6 lb/a) on April 23. After an extended wet period, Roundup Ultra Max II + Dual II Magnum + AMSU (33 oz + 1.67 pt + 2.6 lb/a) was applied on June 20. Triumph s672 sunflower was planted at 22,000 seeds/a, with 14-37-0 fertilizer banded 2 inches from the row, on June 24. An additional 56 lb/a of N was injected on July 25. Sunflower was harvested on October 6.

Results

Wheat

Wheat stand establishment was excellent. Heading tended to be slightly later and plant heights slightly greater in wheat after corn or soybean than after sunflower (Table 4). Plant N concentrations differed among crop rotations, but averaged 0.14% less following sunflower than following corn or soybean. Wheat yields were highest in W-GS-SB and W-C-SB, ranging from 79.6 to 83.7 bu/a, respectively. When averaged over all rotations, wheat after soybean and sunflower averaged 77.9 and 72.2 bu/a. Following an unusually large corn yield in 2004, wheat after corn produced 11.6 and 5.9 bu/a less than after these broadleaf row crops. Grain test weights averaged 58.6 lb/bu and were not affected by crop rotation. Grain protein ranged from 11.3 to 12.3% among rotations and tended to be lowest in wheat following sunflower.

Corn

Corn emerged about 9 days after planting. Final corn populations averaged 16,200 plants/a (Table 5) and were not significantly affected by crop rotation. Corn generally reached the half-silking stage at 72 days after planting. Leaf N averaged 2.33%, with no significant rotation effect. Lodging, presumably greater because of hail damage, ranged from 12 to 30%, without consistent relationship to crop rotation. Corn yields averaged 79.9 bu/a, without rotation effect.

As covariates, plant population and lodging only accounted for about 4% of yield variation beyond any effect of crop rotation. Test weight averaged 57.9 lb/bu, and the number of ears/plant ranged from 0.89 to 1.1, again without rotation effect.

Grain sorghum

Grain sorghum planting was completed a few days ahead of an extended period of wet weather that began in late May. Emergence occurred rapidly, at 5 days after planting. Final populations ranged from 35,200 to 38,300 plants/a. Lowest full-season sorghum plant counts occurred in W-[GS]-GS-SF, whereas populations were quite uniform across the remaining rotations. On average, full-season grain sorghum reached half-bloom stage at 66 days after planting. In W-[GS]-GS-SB, W-[GS]-GS-SF, and continuous GS, half bloom occurred two to three days later than in the other crop rotations. Leaf N levels averaged 3.23% and were not affected by crop rotation. The average yield of full-season grain sorghum was 81.9 bu/a, with no significant crop-rotation effect. Grain test weight averaged 60.3 lb/bu, with minor differences among rotations. Heads/plant ranged from 1.17 to 1.35. Lowest head counts tended to occur in rotations in which GS followed GS or [GS]. Lodging was generally minor, with a high of 7% in the W-GS-SF rotation.

Double-crop grain sorghum stands averaged 29,600 plants/a and reached half bloom in 53 days after planting. Leaf N averaged 3.07%. Remarkably, double-crop grain production was similar to that of the full-season crop. Yields averaged 78.4 bu/a, with a test weight of 55.7 lb/bu. Double-crop grain sorghum produced 1.68 heads/plant, with no lodging. Crop rotations had no effect on any of the variables measured in [GS].

Soybean

Soybean emerged 12 days after planting. Stands were excellent with very minor differences among rotations (Table 6). Full-season soybean plant heights ranged from 22 to 25 inches. Soybean tended to be tallest following wheat and shortest after grain sorghum. Yields averaged 28.3 bu/a and were not affected significantly by crop rotation. Unlike results in 2004, soybean yields following grain sorghum were at least as high as after other crops. There was no lodging.

Double-crop soybean stands averaged 99%. Plant heights averaged 18 inches. Double-crop soybean reached maturity at 102 days after planting and averaged 15.4 bu/a. No lodging occurred. Crop rotations did not significantly affect any of the [SB] variables measured.

Sunflower

Sunflower emerged 7 days after planting. Populations averaged 11,570 plants/a. Triumph s672 NuSun short-stature sunflower reached half-bloom stage at 56 days and an average height of 33 inches. Yields averaged 1734 lb/a, with 6% lodging. None of these variables were affected by crop rotation.

Table 4. Effects of crop rotation on no-till wheat, Harvey County Experiment Field, Hesston, Kansas, 2005.

Crop	Crop Rotation[1]	Yield[2] 2005	Yield[2] 2004	Test Wt	Stand	Heading[3]	Plant ht	Plant N[4]	Grain Protein
		-------bu/a------		lb/bu	%	date	inches	%	%
Wheat	W-C-SB	83.7	57.8	58.9	100	35	40	1.10	12.2
	W-[SB]-C-SB	76.3	65.2	58.9	100	34	38	1.17	12.3
	W-SB-C	66.3	59.6	58.4	100	35	38	1.21	11.9
	W-GS-SB	79.6	63.4	58.9	100	34	37	1.27	12.1
	W-[SB]-GS-SB	74.8	65.0	58.7	100	34	38	1.27	11.7
	W-[GS]-GS-SB	74.4	59.9	58.5	100	34	37	1.24	12.1
	W-GS-SF	74.6	51.8	58.6	100	34	38	1.13	11.5
	W-[SB]-GS-SF	72.5	56.1	58.6	100	33	37	1.10	11.5
	W-[GS]-GS-SF	69.3	53.9	58.4	100	34	37	0.98	11.3
	LSD 0.05	6.9	7.7	NS	NS	0.7	1.1	NS	0.67
	LSD 0.10	5.7	6.4	NS	NS	0.6	0.9	NS	0.56
	Preceding crop main effect means:								
	Corn	66.3	59.6	58.4	100	35	38	1.21	11.9
	Soybean	77.9	62.3	58.8	100	34	38	1.21	12.1
	Sunflower	72.2	53.9	58.5	100	33	37	1.07	11.5
	LSD 0.05[5]	4.4	4.5	NS	NS	0.4	NS	0.12	0.38
	LSD 0.10[5]	3.6	3.8	0.28	NS	0.3	0.7	0.10	0.31

[1] C = corn, GS = grain sorghum, SB = soybean, SF = sunflower, W = wheat, and [ ] = double crop.

[2] Means of four replications adjusted to 12.5% moisture.

[3] Days after March 31 on which 50% heading occurred.

[4] Whole-plant N levels at late boot to early heading.

[5] Estimate based on the average number of crop sequences involving the same preceding crop = 3.0.

Table 5. Effects of crop rotation on no-till corn and grain sorghum, Harvey County Experiment Field, Hesston, Kansas, 2005.

Crop	Crop Rotation[1]	Yield[2] 2005	Yield[2] 2004	Test Wt	Stand	Maturity[3]	Ears or Heads/ Plant	Lodging	Leaf N[4]
		-----bu/a-----		lb/bu	1000/a	date		%	%
Corn	W-C-SB	82.5	142.5	58.4	15.7	72	0.97	12	2.46
	W-[SB]-C-SB	80.4	144.2	57.8	17.5	72	0.91	28	2.37
	W-SB-C	79.7	133.4	56.9	14.5	73	1.10	23	2.18
	GS-C-SB	76.9	138.2	58.6	17.2	72	0.89	30	2.31
	LSD 0.05	NS	8.1	NS	NS	NS	NS	NS	NS
	LSD 0.10	NS	6.6	NS	NS	NS	NS	NS	NS
Sorghum	W-GS-SB	83.9	107.8	60.5	37.2	65	1.35	1	3.29
	W-[SB]-GS-SB	81.3	101.9	60.6	38.3	64	1.28	2	3.25
	W-[GS]-GS-SB	82.9	98.1	60.2	38.1	67	1.17	0	3.23
	W-GS-SF	77.0	108.6	59.8	37.5	64	1.37	7	3.21
	W-[SB]-GS-SF	80.2	98.2	60.2	37.5	65	1.38	2	3.14
	W-[GS]-GS-SF	84.5	102.0	60.4	35.2	67	1.28	0	3.26
	GS-C-SB	84.1	102.9	60.7	36.5	65	1.32	1	3.16
	GS-GS-GS	81.1	98.6	60.1	36.8	67	1.17	0	3.28
[Sorghum]	W-[GS]-GS-SB	77.3	78.5	55.6	30.4	53	1.63	0	3.11
	W-[GS]-GS-SF	79.5	79.1	55.7	28.8	53	1.73	0	3.03
	LSD 0.05	NS	9.1	0.6	3.1	1.0	0.14	4	NS
	LSD 0.10	NS	7.6	0.5	2.6	0.8	0.12	3	NS
	Preceding crop main effect means:								
Sorghum	Wheat	80.4	108.2	60.2	37.4	64	1.36	4	3.25
	[Soybean]	80.8	100.1	60.4	37.9	64	1.33	2	3.20
	Soybean	84.1	102.9	60.7	36.5	65	1.32	1	3.16
	[Sorghum]	83.7	100.1	60.3	36.6	67	1.22	0	3.24
	Sorghum	81.1	98.6	60.1	36.8	67	1.17	0	3.28
	LSD 0.05[5]	NS	NS	NS	NS	0.9	0.11	NS	NS
	LSD 0.10[5]	NS	6.0	NS	NS	0.7	0.09	NS	NS

[1] C = corn, GS = grain sorghum, SB = soybean, SF = sunflower, W = wheat, and [ ] = double crop.

[2] Means of four replications adjusted to 15.5% moisture (corn) or 12.5% moisture (grain sorghum).

[3] Maturity expressed as: corn - days from planting to 50% silking; grain sorghum - days from planting to half bloom.

[4] N level of the ear leaf plus one in corn and of the flag leaf in sorghum.

[5] Estimate based on the average number of crop sequences involving the same preceding crop to full-season grain sorghum = 1.6.

Table 6. Effects of crop rotation on no-till soybean and sunflower, Harvey County Experiment Field, Hesston, Kansas, 2005.

Crop	Crop Rotation[1]	Yield[2] 2005	Yield[2] 2004	Stand[3]	Plant Ht	Maturity[4]	Lodging
		----------bu/a----------			inches	date	%
Soybean	W-C-SB	29.1	61.7	100	23	137	0
	W-[SB]-C-SB	29.3	62.1	100	24	138	0
	W-SB-C	27.3	61.2	100	25	137	0
	W-GS-SB	29.3	55.2	100	23	138	0
	W-[SB]-GS-SB	28.8	56.0	100	22	139	0
	W-[GS]-GS-SB	29.6	53.6	100	22	138	0
	GS-C-SB	24.8	62.7	100	23	138	0
[Soybean]	W-[SB]-C-SB	14.9	11.6	100	18	103	0
	W-[SB]-GS-SB	13.5	13.3	97	17	102	0
	W-[SB]-GS-SF	17.8	14.8	100	19	102	0
	LSD 0.05	5.9	NS	2	2.0	1.3	NS
	LSD 0.10	4.9	NS	1	1.7	1.1	NS
	Preceding crop main effect means:						
	Wheat	27.3	61.2	100	25	137	0
	Corn	27.7	62.2	100	23	138	0
	Sorghum	29.2	54.9	100	22	138	0
	LSD 0.05[5]	NS	NS	NS	1.2	0.9	NS
	LSD 0.10[5]	NS	5.6	NS	1.0	0.8	NS
Sunflower	W-GS-SF	1819	2311	12.5	34	56	6
	W-[SB]-GS-SF	1602	2098	11.6	32	56	10
	W-[GS]-GS-SF	1782	1984	10.6	33	56	3
	LSD 0.05	NS	NS	NS	0.9	NS	NS
	LSD 0.10	NS	NS	NS	0.7	NS	NS

[1] C = corn, GS = grain sorghum, SB = soybean, SF = sunflower, W = wheat, and [ ] = double crop.

[2] Means of four replications adjusted to 13% moisture (soybean) or 10% moisture (sunflower in lb/a).

[3] Stand expressed as a percentage for soybean and as plant population in thousands per acre for sunflower.

[4] Sunflower maturity expressed as number of days from planting to half bloom.

[5] Estimate based on the average number of crop sequences involving the same preceding crop to full-season soybean = 2.3.

EFFECTS OF LATE-MATURING SOYBEAN AND SUNN HEMP SUMMER COVER CROPS AND NITROGEN RATE ON NO-TILL GRAIN SORGHUM AFTER WHEAT

M.M. Claassen

Summary

Late-maturing Roundup Ready® soybean and sunn hemp drilled in wheat stubble at 60 and 10 lb/a, respectively, produced an average of 2.11 and 3.19 ton/a of above-ground dry matter. Corresponding nitrogen (N) yields of 90 and125 lb/a were potentially available to the succeeding grain sorghum crop. Following cover crops, grain sorghum leaf N concentrations were generally higher at all but the highest rate of fertilizer N. When averaged across N fertilizer rates, soybean and sunn hemp significantly increased sorghum leaf nutrient levels, by 0.15% N and 0.16% N, respectively. Cover crops did not affect grain sorghum plant population, the length of time to reach half bloom, or grain test weight. Soybean increased sorghum yields at all but the 90 lb/a N rate, whereas sunn hemp in the rotation improved yields at all N rates. The positive effect of soybean and sunn hemp cover crops was seen in respective sorghum yield improvements of 9.7 and 13.4 bu/a when averaged over N rate. Averaged over cropping systems, yields increased significantly with each 30 lb/a increment of fertilizer N.

Introduction

Research at the KSU Harvey County Experiment Field over an 8-year period explored the use of hairy vetch as a winter cover crop following wheat in a winter wheat-sorghum rotation. Results of long-term experiments showed that, between September and May, hairy vetch can produce a large amount of dry matter, with an N content on the order of 100 lb/a. But significant disadvantages also exist in the use of hairy vetch as a cover crop. These include the cost and availability of seed, interference with the control of volunteer wheat and winter annual weeds, and the possibility of hairy vetch becoming a weed in wheat after sorghum.

New interest in cover crops has been generated by research in other areas showing the positive effect that these crops can have on the overall productivity of no-till systems. In a 2002 pilot project at Hesston, a Group VI maturity soybean grown as a summer cover crop after wheat produced 2.25 ton/a of above-ground dry matter and an N yield of 87 lb/a potentially available to the succeeding crop. Soybean cover crop did not affect grain sorghum yield in the following growing season but, when averaged over N rate, resulted in 0.15% N increase in flag leaves.

In the current experiment, late-maturing soybean and sunn hemp, a tropical legume, were evaluated as summer cover crops for their impact on no-till sorghum grown in the spring following wheat harvest. In the first cycle of these rotations, the two cover crops produced N yields of 146 and 119 lb/a, respectively. Sunn hemp increased grain sorghum yields by 10.6 bu/a, whereas soybean did not impact sorghum grain production in a season with considerable drought stress. Data presented for 2005 represent the second cycle of wheat-grain sorghum rotations, without and with soybean and sunn hemp cover crops.

Procedures

The experiment was established on a Geary silt loam site that had been used for hairy vetch cover crop research in a wheat-sorghum rotation from 1995 to 2001. In keeping with the previous experimental design, soybean and sunn hemp were assigned in 2002 to plots where vetch had been grown, and the remaining plots retained the no-cover-crop treatment. The existing factorial arrangement of N rates on each cropping system also was retained. The second cycle of these cropping systems with summer cover crops was initiated after wheat harvest in 2004.

Weeds in wheat stubble were controlled with Roundup Ultra Max II herbicide applied 9 days before cover crop planting. Asgrow AG7601 Roundup Ready® soybean and sunn hemp seed were treated with respective rhizobium inoculants and were no-till planted in 8-inch rows with a CrustBuster stubble drill on July 9 at 60 lb/a and 10 lb/a, respectively. Sunn hemp began flowering in mid-September and was terminated at that time by a combination of rolling with a crop roller and application of 22 oz/a of Roundup Ultra Max II. Soybean was rolled after initial frost in early October. Forage yield of each cover crop was determined by harvesting a 3.28 ft^2 area in each plot just before termination. Samples were subsequently analyzed for N content.

Weeds were controlled during the fallow period after cover crops with Roundup Ultra Max II, 2,4-D_{LVE} and Clarity. Pioneer 8500 grain sorghum treated with Concep-safener and Cruiser insecticide was planted at approximately 42,000 seeds/a on May 23, 2005. Atrazine and Dual II Magnum were applied preemergence for residual weed control shortly after sorghum planting.

All plots received 37 lb/a of P_2O_5 banded as 0-46-0 at planting. Nitrogen fertilizer treatments were applied as 28-0-0, injected at 10 inches from the row on June 27, 2005. Grain sorghum was combine harvested on September 15.

Results

During the 9 days preceding cover crop planting, rainfall totaled 1.82 inches. The next rains occurred about two weeks after planting, when 4 inches were received over a 3-day period. Stand establishment was good with both soybean and sunn hemp. Although July rainfall in 2004 was above normal, August and September were drier than usual. Late-maturing soybean reached an average height of 24 inches, showed limited pod development, and produced 2.11 ton/a of above-ground dry matter with an N content of 2.11% or 90 lb/a (Table 7). Sunn hemp averaged 72 inches in height and produced 3.19 ton/a with 1.95% N or 125 lb/a of N. Soybean and sunn hemp suppressed volunteer wheat to some extent, but failed to give the desired level of control ahead of the wheat planting season.

Grain sorghum emerged on May 30, 2005, with final stands averaging 31,795 plants/a. In July and August, average temperatures were 2.1 to 2.7 ^oF below normal, whereas September was 2.7 ^oF warmer than usual. During these months, there were only 2 days with temperatures at or above 100 ^oF. July rainfall was somewhat below normal, resulting in periods of limited drought stress. August brought abundant rains totaling 7 inches, mainly in the second half of the month. September was dry, with less than half of the long-term average rainfall.

Cover crops had no effect on sorghum population or the length of time from planting to half bloom. Both cover crops significantly increased leaf N concentration. Across N rates, these increases averaged 0.15% N and 0.16% N, respectively, for soybean and sunn hemp. The positive effect of cover crops on sorghum leaf N concentration was significant at each level of fertilizer N except the 90 lb/a rate following soybean. Cover crops tended to increase the number of heads/plant slightly. When averaged over N rate, soybean and sunn hemp significantly increased grain sorghum yields, by 9.7 and 13.4 bu/a, respectively. Sorghum test weights were not affected by cover crops. Nitrogen rates increased the number of sorghum heads/plant and the N content of sorghum leaves. Leaf N increased with each 30 lb/a increment of N fertilizer in all crop rotations except with the highest N rate in sorghum following soybean. Fertilizer N effect on sorghum grain yields followed the same trend as observed in leaf N levels. The main effect of fertilizer N on yield was highly significant, with an increase of 10 bu/a with the last 30 lb/a increment.

Table 7. Effects of soybean and sunn hemp summer cover crops and nitrogen rate on no-till grain sorghum after wheat, Hesston, Kansas, 2005.

Cover Crop	N Rate[1]	Cover Crop Yield[2] Forage	Cover Crop Yield[2] N	Grain Sorghum Grain Yield	Bushel Wt	Stand	Half[3] Bloom	Heads/ Plant[4]	Leaf N[5]
	lb/a	ton/a	lb/a	bu/a	lb	1000's/a	days	no.	%
None	0	----	----	49.2	55.2	32.9	68	0.91	1.86
	30	----	----	74.0	55.3	32.9	66	1.06	2.31
	60	----	----	84.5	55.5	32.3	67	1.15	2.66
	90	----	----	96.9	55.9	29.7	66	1.40	2.88
Soybean	0	2.30	93	73.4	55.8	34.2	66	1.01	2.20
	30	2.02	87	81.3	55.3	31.4	66	1.17	2.57
	60	2.53	109	92.8	55.5	29.9	66	1.29	2.75
	90	1.59	69	96.3	55.8	30.8	67	1.36	2.79
Sunn hemp	0	2.95	116	71.7	55.7	32.2	66	1.06	2.07
	30	3.10	118	87.2	55.2	33.3	65	1.12	2.60
	60	3.26	130	92.7	55.6	31.4	67	1.23	2.80
	90	3.47	136	106.7	56.2	30.5	66	1.49	2.92
LSD .05		0.71	32	9.7	NS	3.4	NS	0.17	0.16
Means: Cover Crop/ Termination									
None		----	----	76.2	55.4	32.0	67	1.13	2.43
Soybean		2.11	90	85.9	55.6	31.6	66	1.21	2.58
Sunn hemp		3.19	125	89.6	55.7	31.8	66	1.23	2.59
LSD .05		0.35	16	4.9	NS	NS	NS	0.09	0.08
N Rate									
0		2.62	105	64.8	55.6	33.1	67	0.99	2.04
30		2.56	102	80.8	55.3	32.5	66	1.12	2.49
60		2.89	119	90.0	55.5	31.2	67	1.23	2.73
90		2.53	103	100.0	56.0	30.3	66	1.42	2.86
LSD .05		NS	NS	5.6	NS	2.0	NS	0.10	0.09

[1] N applied as 28-0-0 on June 27, 2005.

[2] Oven dry weight and N content for sunn hemp and soybean on September 17 and October 4, 2004, respectively.

[3] Days from planting (May 23, 2005) to half bloom.

[4] Main effect of cover crop on heads/plant significant at p=0.06.

[5] Flag leaf at late boot to early heading.

EFFECTS OF CHLORIDE RATE ON NO-TILL CONTINUOUS WHEAT AND GRAIN SORGHUM

M.M. Claassen

Summary

Experiments were conducted to determine crop response to chloride (Cl) rates in continuous no-till wheat and grain sorghum on soils testing low in Cl. Ammonium chloride (6-0-0-16.5) was broadcast on wheat in early spring and on sorghum preemergence at rates providing 10, 20, and 30 lb/a of Cl. Consistent with soil test results, levels of Cl in leaves of both crops were low in plots receiving no Cl fertilizer. Each increment of Cl fertilizer significantly increased the concentration of Cl in crop leaves. Wheat yields increased by a maximum of 7.6 bu/a with 20 lb/a of Cl. Grain sorghum yields also were highest at 20 lb/a of Cl, with an increase of 4.7 bu/a versus the check treatment receiving no Cl.

Introduction

Chloride (Cl) is known to be an essential plant nutrient. It plays an important role in the uptake of nutrient cations and in the dynamics of plant water utilization. Although it is required in small amounts, deficiencies or sub-optimal levels can result in yield reduction. Significant yield increases in wheat, corn, and grain sorghum from Cl application in Kansas have been most consistent when soil Cl levels are less than 4 parts per million at a soil depth of 0 to 24 inches.

One of the benefits of Cl is its apparent effect in reducing the severity of plant diseases. Chloride fertilization in wheat has been shown to suppress fungal diseases such as tan spot, leaf rust, and stripe rust. In grain sorghum and corn, it has been found to suppress stalk rot. The current interest in using stacked crop rotations (consecutive years of the same crop) to enhance the economics of no-till systems raises concern about plant disease control, particularly in wheat. The most notable disease in continuous no-till wheat is tan spot.

The experiments reported here were conducted to assess the benefits of Cl fertilization in continuous no-till wheat and grain sorghum on soils low in Cl.

Procedures

Wheat

The site was located on Ladysmith silty clay loam soil (North Unit), with soil Cl of 2.4 parts per million at 0 to 24 inches. The area had been cropped to no-till wheat in 2003-2004. Jagger wheat was no-till planted on October 21, 2004, at 90 lb/a. The basic fertilizer program on the site provided 120-35-0 lb/a of N-P-K, applied as 18-46-0 banded with the seed and 46-0-0 broadcast in early spring. Chloride rates of 0, 10, 20, and 30 lb/a were broadcast as ammonium chloride (6-0-0-16.5) on 4- to 6-inch wheat on March16, 2005. Leaf samples for nutrient analyses were collected at late boot to early heading on May 7. Plots were combine harvested on June 24, 2005.

Grain Sorghum

Location of the grain sorghum project also was on Ladysmith silty clay loam soil, about 5 miles distant (South Unit) from the previous site. Soil test indicated 1.9 parts per million Cl at 0 to 24 inches. The previous crop was no-till grain sorghum. Pioneer 8500 grain sorghum was no-till planted May 30, 2005, at 42,000 seeds/a in 30-inch rows. The site was fertilized with 18-46-0 banded 2 inches from the row at planting, and 28-0-0 injected 10 inches from the row on July 1, for a total of 90-37-0 lb/a. Chloride rates of 0, 10, 20, and 30 lb/a were broadcast as ammonium chloride (6-0-0-16.5) preemergence to sorghum on June 2. Leaf samples for nutrient analyses were collected at the 6- to 8-leaf stage on June 29. Plots were harvested on September 22.

Results

Wheat

Wheat planting was delayed by rains. Tan spot disease was present throughout the growing season. Leaf rust was significant after mid-May. Leaf Cl concentration without Cl fertilizer reflected low soil Cl (Table 8). Increases in leaf Cl were significant with each 10-lb increment of Cl fertilizer. Yields also increased significantly, with a maximum benefit of 7.6 bu/a at 20 lb/a of Cl. Grain test weight was not affected by Cl treatments.

Grain Sorghum

Heavy rains totaling 9.85 inches occurred during the first two weeks after Cl application. Sorghum developed with no observed diseases of significance. There was essentially no lodging (Table 9). Consistent with soil test results, Cl concentration was low in leaves of sorghum without Cl fertilizer. As in wheat, Cl concentration in sorghum leaves increased significantly with each increment of Cl fertilizer. Cl treatments had no meaningful effect on crop maturity. Sorghum grain yields were very good, increasing by a maximum of 4.7 bu/a with 20 lb/a of Cl. Grain test weights increased slightly with Cl fertilizer.

Table 8. Effects of chloride fertilization on no-till continuous winter wheat, Hesston, Kansas, 2005.[1]

Cl[2]	Grain Yield[3]	Bushel Wt	Leaf [4] N	P	K	Cl
lb/a	bu/a	lb	%	%	%	%
0	29.9	55.1	3.09	0.190	1.40	0.057
10	32.5	54.5	3.17	0.199	1.59	0.138
20	37.5	55.3	3.20	0.192	1.56	0.166
30	33.1	55.1	3.13	0.199	1.59	0.259
LSD .05	3.9	NS	NS	NS	0.15	0.031

[1] All data are the means of four replications.

[2] Broadcast as ammonium chloride (6-0-0-16.5) on 4- to 6-inch wheat March 16.

[3] Yields adjusted to 12.5% moisture.

[4] Flag leaf and flag leaf minus one at late boot to early heading (May 7).

Table 9. Effects of chloride fertilization on no-till continuous grain sorghum, Hesston, Kansas, 2005.[1]

Cl[2]	Grain Yield[3]	Bushel Wt	Half Bloom	Lodg-ing	Leaf [4]			
					N	P	K	Cl
lb/a	bu/a	lb	DAP	%	-------------------------%-------------------------			
0	101.9	57.3	63	0	2.68	0.258	2.47	0.090
10	104.3	56.7	64	0	2.66	0.244	2.41	0.351
20	106.6	56.8	64	0	2.71	0.243	2.33	0.611
30	105.3	56.9	64	0	2.82	0.253	2.26	0.774
LSD 0.10	2.9	0.4	0.4	NS	NS	NS	0.15	0.059

[1] All data are the means of eight replications.

[2] Broadcast as ammonium chloride (6-0-0-16.5) preemergence to sorghum June 2.

[3] Yields adjusted to 12.5% moisture.

[4] Uppermost expanded leaf at 6- to 8-leaf stage June 29.

PLANTING DATE, HYBRID MATURITY, AND PLANT POPULATION EFFECTS IN NO-TILL CORN

M.M. Claassen and D.L. Fjell

Summary

Three Pioneer corn hybrids, 38H67, 35P12, and 33B51, representing 97-, 105-, and 111-day maturities, were planted in a soybean rotation under no-till conditions on March14, April 4, and April 16, with final populations of 14,000, 18,000, and 22,000 plants/a. The growing season was punctuated by hail at the end of June, but otherwise offered less drought stress than usual for corn. All treatment factors significantly affected corn. Planting date had the largest effect on length of time to reach half-silk stage. March14 and April 4 planting dates delayed silking by 25 and 8 days versus April 16 planting. Corn yields averaged 106 bu/a when planted in mid-March, but declined by 6 and 10% with successive plantings in April. Hybrid 38H67 produced an average of 95 bu/a, whereas the later-maturing 35P12 and 33B51 had 3 and 13% larger yields. Yields increased with plant population, averaging 11 and 22% more at 18,000 and 22,000, respectively, than at 14,000. In 2004, yields were largest with the latest planting date; in 2005, highest yield of 124 bu/a occurred with the earliest planting. In both years, maximum yields occurred with latest-maturing hybrid and highest plant population. Treatment effects on grain test weight were minor, but early planting dates resulted in slightly higher test weights than the mid-April planting. Number of ears/plant was 9 and 2% larger in corn planted on March 14 and April 4, respectively, versus the April 16 planting date. Ears/plant declined with increasing hybrid maturity and increasing plant population.

Introduction

In central and south-central Kansas, dryland corn often does not perform as well as grain sorghum under existing seasonal weather conditions, which usually involve some degree of drought. Nevertheless, corn is preferred as a rotational crop by some producers because earlier growth termination and harvest facilitate the planting of double-crop no-till wheat in rotations. Genetic gains in corn drought tolerance, as well as no-till planting practices that conserve soil moisture, have encouraged producer interest in growing corn despite increased risk of crop failure.

Planting date, hybrid maturity, and plant population all have a major effect on dryland corn production. Recent research at this location indicated that highest dryland yields occurred at plant populations of 14,000 or 18,000 plants/a. This experiment was initiated in 2004 to determine if drought effects on no-till corn can be minimized by early planting dates, use of hybrids ranging in maturity from 97 to 111 days, and plant populations of 14,000 to 22,000.

Procedures

The experiment was conducted on a Ladysmith silty clay loam site that had been cropped to no-till soybean in 2004. Corn was fertilized with 95 lb/a of N and 37 lb/a of P_2O_5 as 18-46-0 banded close to the row before planting and as 28-0-0 injected in a band 10 inches on either side of each row in mid-May. The experiment design was a split-plot, with planting-date main plots and subplots with factorial combinations of three hybrids and three plant populations in four replications. Pioneer 38H67, 35P12, and 33B51, representing maturities of 97, 105, and 111 days to black layer, respectively, were no-till planted at approximately 26,000 seeds/a into moist soil on March14, April 4, and April 16. Weeds were controlled with a March 11 application of 1.67 lb/a atrazine 90DF + 22 oz/a Roundup Ultra Max II + 1.7 lb/a AMSU + 1 qt/a crop oil concentrate, followed by 1.6 pt/a Dual II Magnum broadcast 8 days later. Corn was hand thinned to specified populations of 14,000, 18,000, and 22,000 plants/a. Evaluations included maturity, plant height, lodging, ear number, yield, and grain test weight. Plots were combine harvested on September 2.

Results

Rainfall totaled 3.01, 0.88, and 0.39 inches during the first 10 days after the respective planting dates. Corresponding intervals from planting to emergence were 25, 12, and 7 days. Averaged across planting date, plant populations before hand thinning were 94 to 97% of the planting rate. Low temperatures of 31 °F on April 24 and 30, as well as 30 °F on May 2, caused some corn leaf injury but did not affect stands. Mean temperatures were about 1 °F cooler than normal in April, normal in May, and slightly above normal in June. In July and August, average temperatures were 2.1 to 2.7 °F below normal. During these months, there were only 2 days with temperatures at or above 100 °F. Rainfall was well below normal in April, nearly 1 inch above normal in May, and dominated the first seventeen days of June. July rainfall was somewhat below normal, resulting in periods of limited drought stress. August brought abundant rains, mainly in the second half of the month as corn approached maturity.

Length of time to reach half-silk stage increased with early planting and hybrid maturity but, on average, was not affected by plant populations. March 14 and April 4 planting dates delayed silking by 25 and 8 days versus April 16 planting (Table 10). Average hybrid differences in silking date ranged from 2 to 4 days.

Corn yields were significantly affected by planting date, hybrid, and plant population. Among the possible two-way interactions between these treatment variables, only planting date x hybrid was significant. Corn yield averaged 106, 100, and 95 bu/a when planted on March14, April 4, and April 16, respectively. Average yields for 38H67, 35P12, and 33B51 were 95, 98, and 108 bu/a. Plant populations of 14,000, 18,000, and 22,000 produced an average of 90, 100, and 110 bu/a. Yields of all hybrids were maximized by the earliest planting and declined with succeeding planting dates. At the last planting date, yield of 38H67 was reduced 5.6 to 8.6 bu/a more than that of 35P12 and 33B51, respectively. Highest yield of 124 bu/a occurred with 33B51 planted on March 14 with a population of 22,000.

Test weights averaged 58.2 lb/bu. Although treatment main effects on test weight were significant, the differences were relatively small. Planting date was the most influential, with the earliest plantings resulting in slightly higher test weights than the mid-April planting. Number of ears/plant was higher (1.08) with the March 14 planting than with the other planting dates, decreased with the later-maturing hybrids, and also declined with increasing plant population. Plant heights were not affected by planting date or plant population, but increased by 4 to 5 inches with later-maturing hybrids. Treatment effects on lodging were substantial. The April 16 planting averaged 33% lodging, three times greater than the earlier plantings. Hybrids 35P12 and 33B51 averaged 23% lodging, versus 7% with 38H67. Successive increases in plant population increased lodging significantly.

Table 10. Dryland no-till corn hybrid response to planting date and plant populations, Harvey County Experiment Field, Hesston, KS, 2005.

Planting[1] Date	Hybrid[2]	Plant Popu-lation	Yield[3] 2005	Yield[3] 2004	Mois-ture	Bu Wt	Ears/ Plant	Days to Silk[4]	Plant Ht	Lodg-ing
		no./a	------bu/a------		%	lb/bu			inches	%
March 14	38H67	14,000	92	100	13.1	57.9	1.38	95	79	5
		18,000	103	110	13.4	58.0	1.22	94	79	4
		22,000	112	112	13.1	57.7	1.07	95	81	5
	35P12	14,000	92	108	13.3	58.3	1.03	96	86	4
		18,000	105	121	13.8	58.3	1.03	96	84	14
		22,000	114	127	13.1	58.8	1.00	96	86	28
	33B51	14,000	98	121	14.2	58.3	1.04	98	90	4
		18,000	113	135	14.3	58.9	0.97	98	89	10
		22,000	124	142	13.6	59.3	0.99	99	86	26
April 4	38H67	14,000	84	127	13.4	58.4	1.07	77	80	1
		18,000	98	119	13.3	58.5	1.00	77	82	2
		22,000	107	130	13.1	58.2	0.99	77	83	3
	35P12	14,000	86	111	13.3	58.8	1.01	79	85	4
		18,000	98	127	13.8	59.2	0.99	79	86	18
		22,000	106	137	13.5	59.3	0.98	79	86	25
	33B51	14,000	102	134	13.6	58.4	1.05	81	87	3
		18,000	105	141	13.9	58.1	1.00	81	86	13
		22,000	114	146	13.5	58.6	1.00	81	86	24
April 16	38H67	14,000	77	112	13.0	57.9	1.11	68	84	9
		18,000	83	124	13.0	57.9	0.97	68	85	15
		22,000	100	132	13.2	58.1	0.95	68	83	22
	35P12	14,000	86	117	13.4	58.0	1.04	71	84	27
		18,000	95	137	13.7	58.3	0.98	71	84	54
		22,000	99	144	13.8	58.0	0.95	71	82	54
	33B51	14,000	96	129	14.3	56.2	1.01	73	85	10
		18,000	103	150	14.1	56.8	0.96	73	84	33
		22,000	115	164	14.1	58.0	0.97	73	84	67
LSD .05 Means in same DOP[4]			7.5	8.5	0.64	0.80	0.05	0.7	3	14
Means in different DOP			8.1	10.5	0.78	0.83	0.06	1.1	4	18
DOP*Hybrid[5]			0.04	0.004	0.06	0.0001	0.0001	0.01	0.0001	0.01
DOP*Population[6]			NS	0.001	NS	NS	0.02	NS	NS	0.01
Hybrid*Population[7]			NS	0.002	NS	0.02	0.0001	NS	NS	0.0001

(cont. next page)

Table 10 (cont.). Dryland no-till corn hybrid response to planting date and plant populations, Harvey County Experiment Field, Hesston, KS, 2005.

Planting[1] Date	Hybrid[2]	Plant Population	Yield[3] 2005	Yield[3] 2004	Moisture	Bu Wt	Ears/ Plant	Days to Silk[4]	Plant Ht	Lodging
		no./a	------bu/a------		%	lb/bu			inches	%
	Main effect means:									
	Planting Date									
	March 14		106	120	13.5	58.4	1.08	96	84	11
	April 4		100	130	13.5	58.6	1.01	79	85	10
	April 16		95	134	13.6	57.7	0.99	71	84	33
	LSD 0.05		4.0	6.8	NS	0.35	0.03	0.9	NS	12
	Hybrid									
	38H67		95	118	13.2	58.1	1.08	80	81	7
	35P12		98	125	13.5	58.5	1.00	82	85	25
	33B51		108	140	13.9	58.0	1.00	84	86	21
	LSD 0.05		2.5	2.8	0.21	0.27	0.02	0.2	1	5
	Plant Population									
	14,000		90	118	13.5	58.0	1.08	82	84	7
	18,000		100	129	13.7	58.2	1.01	82	84	18
	22,000		110	137	13.4	58.4	0.99	82	84	28
	LSD .05		4.0	2.8	0.50	0.35	0.03	NS	NS	12

[1] DOP. Actual 2004 planting dates were March 18, April 2, and April 15.

[2] Pioneer brand.

[3] Average of 4 replications adjusted to 56 lb/bu and 15.5% moisture.

[4] Days from planting to 50% silking.

[5] Probability of planting date effect varying with hybrid; NS = not significant.

[6] Probability of planting date effect varying with plant population; NS = not significant.

[7] Probability of hybrid effect varying with plant population; NS = not significant

SOYBEAN FOR FORAGE

M.M. Claassen

Summary

Four grain-type soybean varieties from maturity groups III to VII and nine forage-type lines or varieties from maturity groups V to VII were grown under no-till conditions to evaluate their utility for forage production. Soybean was planted in early June after a wet weather delay. Although not totally devoid of moisture stress, the growing season was sufficiently favorable for soybean to produce the highest dry matter yields obtained over the last three years. Forage soybean reached a maximum of 61 inches, and averaged 15 inches taller than grain-type soybean in the same maturity groups. Forage variety Derry produced the highest yield of 3.24 tons/a of dry matter. Other entries in the top yield group were Hutcheson, 97 VA 5, SG 13 #53, Tyrone and XB 32 with dry matter yields of 2.88 to 3.11 tons/a. As a group, forage types produced 0.36 tons/a more than the grain-type varieties. Hutcheson, a grain-type soybean, yielded more than all forage types except Derry. These two varieties also had the highest total N yields, 144 to 152 lb/a.

Introduction

Soybean represents a potentially valuable alternative crop for growers in central and south-central Kansas. It can provide helpful broadleaf and legume diversity to adapted crop rotations that typically emphasize wheat and grain sorghum. Such diversity aids in the disruption of pest cycles. Particularly attractive is the ease with which wheat can be no-till planted into soybean stubble after late summer or early fall harvest. But the economics of soybean production can be difficult in a full-season or double-crop setting when summer drought stress results in low yield and poor grain quality. Little attention has been given to the potential for soybean as a forage crop in this area of the state. This investigation was initiated in 2003 to determine the forage production characteristics of several grain-type and forage-type soybean varieties.

Procedures

The experiment site was located on Irwin silty clay loam and had been cropped to wheat in 2004. Four grain-type soybean varieties from maturity groups III to VII and nine forage types from maturity groups V to VII were no-till planted in four, 30-inch rows per plot on June 7 and 8, 2005, at 137,000 seeds/a. Five of the forage-type soybean entries were experimental lines obtained via the USDA forage soybean breeding program at Beltsville, Maryland. Of these, XB 32, 7P116, and 97 VA 5 were evaluated for the first time here in 2004; 8GH 85-2 and SG 13 #53 were new entries in 2005. Weeds were controlled with a May 20 application of 22 oz/a Roundup Original Max + 1.33 oz/a 2,4-D_{LVE} 6EC + 0.77 lb/a AMSU and a subsequent application of 22 oz/a Roundup Original Max + 1.66 pt/a Dual II Magnum + 4 oz/a Sencor[5] 75 DF + 1.3 lb/a AMSU immediately after planting. To determine forage yield, subplot areas were hand harvested at a height of three inches above the soil surface when the most mature

[5] Sencor is a registered trademark of Bayer.

pods were approximately 1.5 inches long. Actual harvest dates were August 13 (Asgrow AG3302 RR), August 29 (KS 4702 sp, Tara, Laredo, and 7P116), and September 12 (all remaining entries).

Results

After hard rains, soybean emerged 9 days after planting. Final stands ranged from 66,800 to 130,700 plants per acre and differed significantly among varieties (Table 11), but variation in stands only accounted for about 5% of the variation in forage yield beyond the effect attributed to varieties. Plant heights ranged from 28 inches for Asgrow AG3302 RR to 61 inches for forage line 8GH 85-2. Notably, grain-type varieties in maturity groups V through VII averaged 15 inches shorter than forage types in the same maturity range. Derry had the highest yield of 3.24 tons/a of dry matter. Other varieties in the top yield group were Hutcheson, 97 VA 5, SG 13 #53, Tyrone, and XB 32, with dry matter yields of 2.88 to 3.11 tons/a. As a group, the forage types produced 0.36 tons/a more than the grain-type varieties. But Hutcheson, a grain type, yielded more than all the forage types except Derry. Both of these varieties had relatively low plant populations. Moisture content ranged from 67 to 78%, with an average of 71%.

Forage N concentrations differed somewhat among varieties, with the highest level of N in Asgrow AG3302 RR. This was attributable to a lower forage yield by this variety. Highest N yields were achieved by Derry and Hutcheson, at 152 and 144 lb/a, respectively. Asgrow AG3302 RR and Laredo had lowest N yields, 80 and 97 lb/a. Laredo, XB 32, and 8GH 85-2 had 20, 15, and 5% lodging, respectively; the remaining varieties had none.

Table 11. Soybean variety forage production, Harvey County Experiment Field, Hesston, Kansas, 2005.

Brand	Variety	Maturity Group	Plant Population	Plant Ht	Forage Yield[1] 2005	Forage Yield[1] 2-yr[2]	Lodging	Moisture	----N----	
			1000's	Inch	------ton/a------			%	%	lb/a
Grain-type										
Asgrow	AG3302 RR	III	122.0	28	1.37	---	0	78	2.91	80
Public	KS 4702 sp	IV	87.1	34	2.51	1.96	0	73	2.56	128
Public	Hutcheson	V	66.8	39	3.11	2.57	0	70	2.32	144
Asgrow	AG7601 RR	VII	106.0	41	2.63	---	0	67	2.26	119
Forage-type[3]										
Public	Tara	IV	68.2	56	2.43	---	0	74	2.08	101
Public	Laredo	---	103.1	52	2.12	2.00	20	74	2.29	97
Public	Derry	VI	81.3	53	3.24	2.62	0	69	2.36	152
Public	Tyrone	VII	119.1	55	2.93	2.68	0	70	1.94	113
Public	XB 32	V	130.7	53	2.88	2.74	15	69	2.10	121
Public	7P116	VI	92.9	52	2.54	2.41	0	74	2.32	118
Public	8GH 85-2	VI	106.0	61	2.68	---	5	68	2.18	116
Public	SG 13 #53	VII	97.3	60	2.92	---	0	68	2.00	117
Public	97 VA 5	VII	113.3	59	3.09	2.74	0	70	2.04	126
LSD .05			31.3	3	0.42	---	3	2	0.21	19
Main effect means for soybean type:										
Grain			95.5	35	2.40	---	0	72	2.51	118
Forage			101.3	55	2.76	---	4	71	2.14	118
LSD .05			NS	2	0.21	---	3	NS	0.09	NS

[1] Dry matter yield.

[2] 2004 and 2005.

[3] None of the forage-type soybean varieties have the Roundup Ready® trait.

HERBICIDES FOR WEED CONTROL IN CORN

M.M. Claassen

Summary

Nineteen herbicide treatments were evaluated for crop tolerance and weed control efficacy in corn, with focus on application timing effects of mesotrione (Callisto[6])- and glyphosate (Roundup and Touchdown)-based products. Weed competition consisted of dense large crabgrass and moderate Palmer amaranth and domestic sunflower populations. All treatments involving mesotrione-based products as well as Bicep II Magnum preemergence were highly effective in controlling large crabgrass and Palmer amaranth. Early control of domestic sunflower was superior with mesotrione-based products. Roundup Ultra Max II was effective on all species, and time of application was not significant in the control of Palmer amaranth and domestic sunflower. However, single applications of Roundup Ultra Max II alone tended to give slightly less control of Palmer amaranth. Also, Roundup Ultra Max II tended to be more effective on large crabgrass with delayed application.

Corn showed no injury symptoms of consequence. All herbicide treatments significantly increased corn yields by an average of 42 bu/a in comparison with the untreated check. Yield differences among herbicide treatments were not significant. The herbicide treatments represented a wide range of input cost.

Introduction

In recent years, Callisto has been one of the newer herbicides to join the arsenal of herbicides available to corn growers. Premix options with Callisto include Camix , Lumax and Lexar. Camix contains 3.34 lb S-metolachlor (Dual II Magnum) + 0.33 lb mesotrione/gal; Lumax contains 2.68 lb S-metolachlor + 1 lb atrazine + 0.268 lb mesotrione/gal. Lexar has 1.74 lb S-metolachlor + 1.74 lb atrazine + 0.224 lb mesotrione/gal. This experiment evaluated weed control with mesotrione based preemergence and postemergence treatments for broad spectrum weed control in combination with and in comparison with glyphosate products applied at different stages of crop and weed development.

Procedures

Winter wheat was grown on the experiment site in 2004. Soil was a Geary silt loam with pH 6.3 and 2.0% organic matter. The site was maintained without tillage until preparations for this experiment commenced just before planting. A mulch treader and field cultivator were used to prepare the seedbed and incorporate Palmer amaranth and large crabgrass seed that was broadcast over the area to enhance the uniformity of weed populations. Domestic sunflower also was planted across all plots in 30-inch rows. Corn was fertilized with 125 lb N and 37 lb P_2O_5/a. NC+ 4574RB was planted into moist soil at

[6] Callisto, Touchdown, Bicep, Camix, Lumax, and Lexar are registered trademarks of Syngenta.

approximately 18,700 seeds/a in 30-inch rows on April 20, 2005. Seedbed condition was excellent. All herbicides were broadcast in 15 gal/a of water, with three replications per treatment (Table 12). Preemergence (PRE) applications were made shortly after planting with AI TeeJet 110025-VS nozzles at 30 psi. Early postemergence (EPOST), postemergence (POST), and late postemergence (LPOST) treatments were applied with Greenleaf TurboDrop TDXL025 venturies in combination with Turbo Tee 11005 nozzles at 30 psi on May 20, May 28 and June 6, respectively. On these dates, large crabgrass was 0.5 to 2 inches, 0.5 to 3 inches, and 1 to 7 inches in height. Palmer amaranth was 0.5 to 1.5 inches, 1 to 6 inches, and 3 to 16 inches. Domestic sunflower was 3 to 5 inches, 5 to 10 inches, and 13 to 18 inches, respectively. Plots were not cultivated. Crop injury and weed control were rated several times during the growing season. Corn was harvested on September 12, 2005.

Results

Corn emerged in 14 days. During the first 10 days after planting and preemergence herbicide application, rainfall totaled 0.44 inch. Significant rains occurred during the week before each of the respective postemergence treatments. Corn reached the early-silking stage at the end of June. None of the herbicides caused any corn injury.

Dense populations of large crabgrass developed, along with moderate populations of Palmer amaranth and domestic sunflower. Large crabgrass control was excellent to perfect throughout the growing season with all preemergence herbicides. Roundup Ultra Max II tended to be more efficacious with delay in time of application. This timing effect was significant, with excellent, good, and fair control of large crabgrass with late postemergence, postemergence, and early postemergence applications, respectively.

Camix, Lexar, Lumax, and Harness[7] Xtra preemergence totally controlled Palmer amaranth at the evaluation in late May. Bicep II Magnum also gave excellent, but slightly less, initial Palmer amaranth control. All treatments provided excellent season-long Palmer amaranth control, but single applications of Roundup Ultra Max II alone resulted in slightly less control. Effect of Roundup time of application on Palmer amaranth was not significant.

Initial sunflower control in late May was excellent after application of Camix, Lexar, and Lumax; fair to good with Bicep II Magnum; and generally poor with Harness Xtra preemergence. Postemergence components of treatments resulted in perfect, full-season control of sunflower in all cases. Roundup Ultra Max II was equally effective at all times of application.

Dryland corn yields were very good for this location. Herbicide treatments increased corn yields by an average of 42 bu/a. Yield differences among these treatments tended not to be significant. Corn test weights did not reflect any significant herbicide effect.

The costs of the herbicide treatments differed substantially, ranging from $15.85 to $39.34/a.

[7] Harness is a registered trademark of Monsanto.

Table 12. Weed control in corn, Harvey County Experiment Field, Hesston, Kansas, 2005.

Herbicide Treatment[1]	Product Form	Rate/a	Unit	Timing[2]	Injury 5/30	Lacg[3] Control 9/12	Paam[4] Control 9/12	Dosf[5] Control 9/12	Yield	Cost[6]
					%	%	%	%	bu/a	$/a
1 Lumax	3.94 SE	2.5	qt	PRE	0	100	99	100	96	26.77
2 Lumax +	3.94 SE	2.5	qt	PRE	0	100	100	100	101	29.31
AAtrex	4 L	1	qt	PRE						
3 Lexar	3.7 SE	3	qt	PRE	0	100	100	100	109	25.19
4 Lexar +	3.7 SE	3	qt	PRE	0	100	99	100	92	29.20
Princep	4 L	1	qt	PRE						
5 Camix +	3.67 SE	1.6	qt	EPOST	0	100	100	100	102	35.33
Touchdown Total +	4.17 SL	24	fl oz	EPOST						
AMSU		2.5	lb	EPOST						
6 Lumax +	3.94 SE	2	qt	EPOST	0	100	100	100	108	33.74
Touchdown Total +	4.17 SL	24	fl oz	EPOST						
AMSU		2.5	lb	EPOST						
7 Lexar +	3.7 SE	2.26	qt	EPOST	0	100	100	100	96	31.48
Touchdown Total +	4.17 SL	24	fl oz	EPOST						
AMSU		2.5	lb	EPOST						
8 Camix	3.67 SE	1.6	qt	PRE	0	100	99	100	114	39.34
Touchdown Total +	4.17 SL	24	fl oz	POST						
AMSU		2.5	lb	POST						
9 Lumax	3.94 SE	2	qt	PRE	0	100	99	100	102	37.75
Touchdown Total +	4.17 SL	24	fl oz	POST						
AMSU		2.5	lb	POST						
10 Lexar	3.7 SE	2.26	qt	PRE	0	100	99	100	103	35.49
Touchdown Total +	4.17 SL	24	fl oz	POST						
AMSU		2.5	lb	POST						
11 Dual II Magnum	7.6 EC	1.33	pt	PRE	0	99	99	100	101	35.73
Callisto +	4 SC	3	fl oz	POST						
AAtrex +	4 L	0.5	qt	POST						
COC +		1	% v/v	POST						
UAN		2.5	% v/v	POST						
12 Bicep II Magnum	5.5 SC	2.1	qt	PRE	0	100	100	100	103	38.51
Callisto +	4 SC	3	fl oz	POST						
AAtrex +	4 L	0.5	qt	POST						
COC +		1	% v/v	POST						
UAN		2.5	% v/v	POST						

(cont. next page)

Table 12. (cont.) Weed control in corn, Harvey County Experiment Field, Hesston, Kansas, 2005.

Herbicide Treatment[1]	Product					Lacg[3]	Paam[4]	Dosf[5]		
					Injury	Control	Control	Control		
	Form	Rate/a	Unit	Timing[2]	5/30	9/12	9/12	9/12	Yield	Cost[6]
					%	%	%	%	bu/a	$/a
13 Roundup Ultra Max II +	4.5 SL	22	fl oz	EPOST	0	75	98	100	103	15.85
AMSU		2.5	lb	EPOST						
14 Roundup Ultra Max II +	4.5 SL	22	fl oz	POST	0	84	96	100	106	15.85
AMSU		2.5	lb	POST						
15 Roundup Ultra Max II +	4.5 SL	32	fl oz	LPOST	0	93	98	100	100	18.41
AMSU		2.5	lb	LPOST						
16 Harness Xtra	6 L	1.2	qt	PRE	0	97	99	100	93	33.44
Roundup Ultra Max II +	4.5 SL	22	fl oz	POST						
AMSU		2.5	lb	POST						
17 Roundup Ultra Max II +	4.5 SL	22	fl oz	POST	0	99	99	100	105	25.86
AMSU		2.5	lb	POST						
Roundup Ultra Max II +	4.5 SL	22	fl oz	LPOST						
AMSU		2.5	lb	LPOST						
18 Bicep II Magnum	5.5 SC	1.75	qt	PRE	0	100	99	100	106	33.29
Touchdown Total +	4.17 SL	24	fl oz	POST						
AMSU		2.5	lb	POST						
19 Lexar	3.7 SE	1.5	qt	PRE	0	100	100	100	87	29.83
Lexar +	3.7 SE	1.5	qt	EPOST						
NIS		0.25	% v/v	EPOST						
20 Untreated					0	0	0	0	59	
LSD .05					NS	2	2	NS	25	

[1] AMSU = ammonium sulfate. COC = Farmland Crop Oil Plus. NIS = Pen-A-Trate II nonionic surfactant. UAN = urea ammonium nitrate, 28%N.

[2] PRE= preemergence on April 20; EPOST = early postemergence on May 20; POST = postemergence on May 28; and LPOST = late postemergence on June 6.

[3] Lacg =large crabgrass.

[4] Paam = Palmer amaranth. Weed population included some redroot pigweeds.

[5] Dosf = domestic sunflower.

[6] Total herbicide cost based on prices from an area supplier and spraying cost of $4.01 per acre per application. Treatments involving glyphosate include an added seed cost of $25/unit ($5.84/a) for the glyphosate-tolerant trait.

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EXPERIMENT FIELD PERSONNEL

W.B. Gordon, Agronomist-in-Charge
Mike R. Larson, Plant Science Technician
A. Dean Milner, Plant Science Technician

IRRIGATION AND NORTH CENTRAL KANSAS EXPERIMENT FIELDS

Introduction

The 1952 Kansas legislature provided a special appropriation to establish the Irrigation Experiment Field to serve expanding irrigation development in north-central Kansas. The original 35-acre field was located 9 miles northwest of Concordia. In 1958, the field was relocated to its present site on a 160-acre tract near Scandia in the Kansas-Bostwick Irrigation District. Water is supplied by the Miller canal and stored in Lovewell Reservior in Jewell County, Kansas, and Harlan County Reservoir at Republican City, Nebraska. In 2001, a linear sprinkler system was added on a 32-acre tract 2 miles south of the present Irrigation Field. In 2002 there were 125,000 acres of irrigated cropland in north-central Kansas. Current research on the field focuses on managing irrigation water and fertilizer in reduced-tillage and crop-rotation systems.

The 40-acre North Central Kansas Experiment Field, located 2 miles west of Belleville, was established on its present site in 1942. The field provides information on factors that allow full development and wise use of natural resources in north-central Kansas. Current research emphasis is on fertilizer management for reduced-tillage crop production and management systems for dryland, corn, sorghum, and soybean production.

Soil Description

The predominant soil type on both fields is a Crete silt loam. The Crete series consists of deep, well-drained soils that have a loamy surface underlain by a clayey subsoil. These soils developed in loess on nearly level to gently undulating uplands. The Crete soils have slow to medium runoff and slow internal drainage and permeability. Natural fertility is high. Available water holding capacity is approximately 0.19 inches of water per inch of soil.

2005 Weather Information

Table 1. Climatic data for the North Central Kansas Experiment Fields.

	Rainfall, inches			Temperature, ^{0}F		Growth Units	
	Scandia 2005	Belleville 2005	Average 30-year	Daily Mean 2006	Avg Mean	2005	Average
April	4.2	4.3	2.3	54	52	263	217
May	1.8	1.6	3.7	63	63	454	421
June	5.3	5.1	4.6	75	73	702	679
July	7.1	5.7	3.4	78	78	788	807
August	4.8	4.2	3.4	75	77	728	780
Sept	0.3	0.3	3.6	71	68	628	538
Total	23.5	21.2	20.9			3563	3442

USE OF STRIP TILLAGE FOR CORN PRODUCTION IN KANSAS

W.B. Gordon

Summary

Conservation-tillage production systems are being used by an increasing number of producers. Early-season plant growth and nutrient uptake can be poorer in no-till than in conventional-tillage systems. Strip tillage may offer many of the soil-saving advantages of the no-till system while establishing a seed-bed that is similar to that of conventional tillage. Field studies were conducted at Belleville, Kansas, to compare the effectiveness of strip tillage and no-till, and to assess the effects of fall versus spring applications of N-P-K-S fertilizer on growth, nutrient uptake, and yield of corn.

The 2003 growing season was characterized by rainfall that was considerably less than normal. Corn yields were severely reduced by the hot, dry conditions. Even though grain yields were low, strip tillage improved early-season growth and nutrient uptake of corn. Strip tillage shortened the time from emergence to mid-silk by 7 days and also reduced grain moisture content at harvest. Strip tillage plots yielded 15 bu/a more than no-till plots did. In 2004, the growing season was nearly ideal, except for an early-season hail storm that reduced plant population. Yields were very good, and the use of strip tillage increased yields by 16 bu/a over yields of no-till corn. Soil temperature was consistently warmer in strip tillage than in no-till in both 2003 and 2004. A very hot, dry period occurred in late June and early July in 2005, but this period was followed by very favorable growing conditions, and yields were good. When averaged over fertility treatment, strip-tillage corn yielded 12 bu/a greater than no-till corn.

In all three years of the experiment, yield, early-season growth, and number of days from emergence to mid-silk were greatly improved in strip tillage, compared with no-till. Fall fertilization was as effective as spring fertilization. Strip tillage seems to be an attractive alternative to no-till for Great Plains producers.

Introduction

Production systems that limit tillage are being used by an increasing number of producers in the central Great Plains because of several inherent advantages. These include reduction of soil erosion losses, increased soil water-use efficiency, and improved soil quality. But early-season plant growth can be poorer in reduced-tillage systems than in conventional systems. The large amount of surface residue present in a no-till system can reduce seed-zone temperatures. Lower-than-optimum soil temperature can reduce the rate of root growth and nutrient uptake by plants. Soils can also be wetter in the early spring with no-till systems. Wet soils can delay planting. Early-season planting is done so that silking can occur when temperature and rainfall are more favorable. Strip tillage may provide an environment that preserves the soil- and nutrient-saving advantages of no-till, while establishing a seed bed that is similar to that of conventional tillage. The objectives of this experiment were to compare the effectiveness of strip tillage and no-till, and to assess the effects of fall, spring, or split applications of N-P-K-S fertilizer on growth, grain yield, and nutrient uptake of corn grown in strip-till or no-till systems.

Procedures

This experiment was conducted at the North Central Kansas Experiment Farm near Belleville on a Crete silt loam soil to compare strip-till and no-till systems for dryland corn production. Fertilizer treatments consisted of 40, 80, or 120 lb/a N with 30 lb/a P_2O_5, 5 lb/a K_2O, and 5 lb/a S. An unfertilized check plot also was included. In the strip-tillage system, fertilizer was either applied in the fall at the time of tilling or in the spring at planting. Fertilizer was applied in the spring at planting in the no-till system. Strip tillage was done in wheat stubble in early October in both years of the study. The zone receiving tillage was 5 to 6 inches wide. Fertilizer was placed 5 to 6 inches below the soil surface in the fall with the strip-tillage system. Spring-applied fertilizer was placed 2 inches to the side and 2 inches below the seed at planting. Nutrients were supplied as 28% UAN, ammonium polyphosphate (10-34-0), and potassium thiosulfate. Corn was planted in early April in all three years of the experiment. Soil test phosphorus, potassium, and sulfur were in the "high" category.

Results

Because the growing season was very dry in 2003, grain yields were very low, and response to applied N was variable. Strip tillage improved early-season growth, nutrient uptake, and grain yield of corn, compared with no-till (Table 2). When averaged over fertility treatments, strip-tilled plots reached mid-silk 7 days earlier than no-till plots did. The early-season growth advantage seen in the strip-tilled plots carried over all the way to harvest. Grain moisture in the strip-tilled plots was 2.8% less than in no-till plots. In this very dry year, the yield advantage may have been the result of the increased rate of development in the strip-tillage system. The corn plants reached the critical pollination period sooner in the strip-tilled plants, while some stored soil water was still available. The soil water reserve was depleted one week later when the plants in the no-till plots reached mid-silk. In 2004, rainfall was above normal in May, June, and July. A hail storm in early June did reduce plant population by an average of 12%, but surviving plants developed normally and grain yields were very good. When averaged over fertility treatments, strip-tilled plots yielded 16 bu/a more than no-till plots yielded (Table 3). As in 2003, early-season growth was increased, and days from emergence to mid-bloom were decreased, in the strip-tillage system. In 2005, weather was not as favorable during corn pollination as in 2004. Late June and early July were hot and dry, but this was followed by moderate temperatures and very favorable rainfall. Yields were still somewhat above average in 2005. Grain yields again were improved by the use of strip tillage (Table 4).

Soil temperature in the early growing season was warmer in the strip-tillage system than in the no-till system in both 2003 and 2004 (Figures 1 and 2). Soil temperature differences between the two tillage systems persisted into late May. Although final stand did not differ in the two tillage systems, plant emergence in the strip-tillage system reached 100% three days sooner than in the no-till system.

In all three years of the experiment, yields in the strip-tillage system were greater than yields in no-till at all rates of applied fertilizer (Tables 5, 6, and 7). Under Kansas conditions, fall-applied fertilizer was as effective as spring-applied fertilizer (Tables 8, 9, and 10). Splitting fertilizer application did not significantly improve yields over applying all in either the spring or the fall (Tables 11, 12, and 13).

Strip tillage proved to be an effective production practice in both low- and high-yielding environments. Strip tillage does provide a better early-season environment for plant growth and development, while still preserving a large amount of residue on the soil surface. This system may solve some of the major problems associated with conservation tillage, thus making it more acceptable to producers.

Table 2. Early-season growth, number of days from emergence to mid-silk, grain moisture at harvest, and yield of corn averaged over fertility treatments, Belleville, Kansas, 2003.

Treatment	V-6 Dry Weight	Emergence to Mid-silk	Harvest Moisture	Yield
	lb/a	days	%	bu/a
Strip Tillage	299	56	14.5	60
No Tillage	168	66	17.5	45
LSD (0.05)	20	3	1.2	7

Table 3. Early-season growth, number of days from emergence to mid-silk, grain moisture at harvest and yield of corn, averaged over fertility treatments, Belleville, Kansas, 2004.

Treatment	V-6 Dry Weight	Emergence to Mid-silk	Harvest Moisture	Yield
	lb/a	days	%	bu/a
Strip Tillage	421	55	13.8	160
No Tillage	259	66	16.2	144
LSD (0.05)	26	3	1.8	10

Table 4. Early-season growth, number of days from emergence to mid-silk, grain moisture at harvest and yield of corn, averaged over fertility treatments, Belleville, Kansas, 2005.

Treatment	V-6 Dry Weight	Emergence to Mid-silk	Harvest Moisture	Yield
	lb/a	days	%	bu/a
Strip Tillage	320	55	15.3	123
No Tillage	188	64	17.6	111
LSD (0.05)	21	2	1.9	9

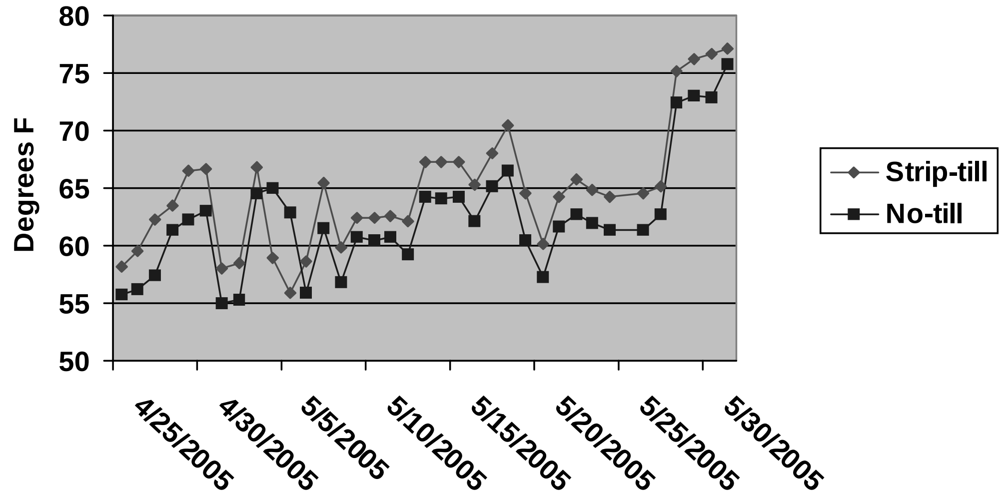

Figure 1. Soil temperature at planting depth, Belleville, Kansas, 2003.

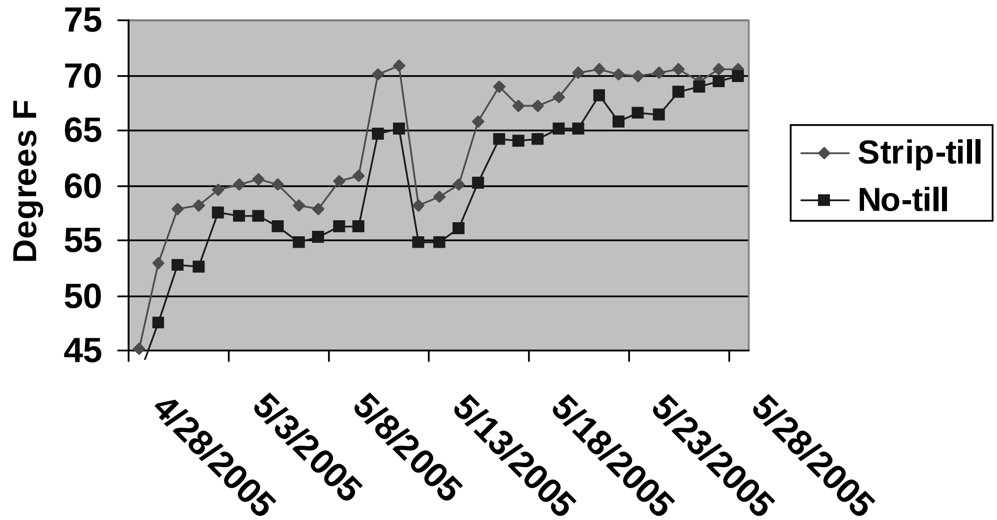

Figure 2. Soil temperature at planting depth, Belleville, Kansas, 2004.

Table 5. Corn grain yield as affected by tillage and spring-applied fertilizer, Belleville, Kansas, 2003.

Fertilizer	Grain Yield	
Treatment	Strip Till	No Till
lb/a	- - - - - - - - - - - bu/a - - - - - - - - - - -	
40-30-5-5	52	45
80-30-5-5	60	48
120-30-5-5	71	51
Average	61	48
LSD (0.05)	5	

Table 6. Corn grain yield as affected by tillage and spring-applied fertilizer, Belleville, Kansas, 2004.

Fertilizer	Grain Yield	
Treatment	Strip Till	No Till
lb/a	- - - - - - - - - - - bu/a - - - - - - - - - -	
40-30-5-5	161	146
80-30-5-5	174	159
120-30-5-5	186	165
Average	174	157
LSD (0.05)	8	

Table 7. Corn grain yield as affected by tillage and spring-applied fertilizer, Belleville, Kansas, 2005.

Fertilizer	Grain Yield	
Treatment	Strip Till	No Till
lb/a	- - - - - - - - - - - bu/a - - - - - - - - - - -	
40-30-5-5	120	108
80-30-5-5	126	114
120-30-5-5	128	115
Average	125	112
LSD (0.05)	6	

Table 8. Corn grain yield as affected by fall- or spring-applied fertilizer in the strip-tillage system, Belleville, Kansas, 2003.

	Grain Yield	
Fertilizer Treatment	Fall Fertilize Strip Till	Spring Fertilize Strip Till
lb/a	- - - - - - - - - - - bu/a - - - - - - - - - - -	
40-30-5-5	56	52
80-30-5-5	58	60
120-30-5-5	68	71
Average	61	61
LSD (0.05)	6	

Table 9. Corn grain yield as affected by fall- or spring-applied fertilizer in the strip-tillage system, Belleville, Kansas, 2004.

	Grain Yield	
Fertilizer Treatment	Fall Fertilize Strip Till	Spring Fertilize Strip Till
lb/a	- - - - - - - - - - - bu/a - - - - - - - - - - -	
40-30-5-5	161	161
80-30-5-5	174	174
120-30-5-5	185	186
Average	173	174
LSD (0.05)	10	

Table 10. Corn grain yield as affected by fall- or spring-applied fertilizer in the strip-tillage system, Belleville, Kansas, 2005.

	Grain Yield	
Fertilizer Treatment	Fall Fertilize Strip Till	Spring Fertilize Strip Till
lb/a	- - - - - - - - - - - bu/a - - - - - - - - - - -	
40-30-5-5	120	120
80-30-5-5	126	126
120-30-5-5	127	128
Average	124	125
LSD (0.05)	6	

Table 11. Corn grain yield as affected by timing of fertilizer application in the strip-tillage system, Belleville, Kansas, 2003.

Fertilizer Treatment	Yield
	bu/a
120-30-5-5 Fall	68
120-30-5-5 Spring	71
120-30-5-5 Split (2/3 fall, 1/3 spring)	75
LSD (0.05)	NS*

* Not significant

Table 12. Corn grain yield as affected by timing of fertilizer application in the strip-tillage system, Belleville, Kansas, 2004.

Fertilizer Treatment	Yield
	bu/a
120-30-5-5 Fall	185
120-30-5-5 Spring	186
120-30-5-5 Split (2/3 fall, 1/3 spring)	186
LSD (0.05)	NS*

* Not significant

Table 13. Corn grain yield as affected by timing of fertilizer application in the strip-tillage system, Belleville, Kansas, 2005.

Fertilizer Treatment	Yield
	bu/a
120-30-5-5 Fall	127
120-30-5-5 Spring	128
120-30-5-5 Split (2/3 fall, 1/3 spring)	125
LSD (0.05)	NS*

* Not significant

USE OF FOLIAR POTASSIUM FOR SOYBEAN PRODUCTION IN REDUCED-TILLAGE SYSTEMS

W.B. Gordon

Summary

Potassium (K) deficiency can be a problem on soils that have been managed with reduced-tillage practices. The large amount of residue left on the soil surface can depress soil temperature and interfere with plant growth, nutrient uptake, and, grain yield. Soil temperature influences both K uptake by root and K diffusion through the soil.

The appearance of K deficiency in fields managed with conservation-tillage systems has been reported with greater frequency in recent years and has become a concern for producers. In this experiment, preplant broadcast application of Trisert K+ (5-0-20-13) was compared with a planting-time starter application of Trisert-K+ and foliar application at three growth stages of soybean. The experimental area had been in a ridge-tillage production system since 1984. All treatments improved soybean seed yield over the untreated check plot. Yields were maximized with either planting-time application of Trisert K+ in combination with foliar application of Trisert-K+ at early pod stage or with two foliar applications of Trisert-K+, at early vegetative stage and again at early pod stage. Applying three foliar applications of Trisert K+ did not significantly improve yields over yields with two applications. All treatments increased whole-plant K content at the beginning of seed fill (R5) over the untreated check. Tissue K content was greatest in the treatment receiving three foliar applications of 2.5 gal/a Trisert K+.

Introduction

The use of conservation tillage has increased in recent years because of its effectiveness in conserving soil and water. Potassium (K) deficiency can be a problem on soils that have been managed with reduced-tillage practices. The large amount of residue left on the soil surface can depress soil temperature early in the growing season. Low soil temperature can interfere with plant root growth, nutrient availability in soil, and crop nutrient uptake. Soil temperature influences K uptake by roots and K diffusion through the soil. Limited soil water content or zones of soil compaction can reduce K availability.

In plant physiology, K is the most important cation, not only in its concentration in tissues, but also with respect to physiological functions. A deficiency in K affects such important physiological processes as respiration, photosynthesis, chlorophyll development, and regulation of stomatal activity. Plants suffering from a K deficiency show a decrease in turgor, making resistance to drought poor. The main function of K in biochemistry is in activating many different enzyme systems involved in plant growth and development. Potassium also influences crop maturity and plays a role in reducing disease. The appearance of K deficiency in fields managed with conservation tillage has been reported with greater frequency in recent years and has become a concern for producers. The objective of these studies was to determine if K applied as a starter at planting, alone or in combination with foliar applications of K, could improve K uptake and yield of soybean on soils that had been managed in a ridge-tillage production system.

Procedures

This field experiment was conducted in 2004 and 2005 on a Crete silt loam soil. The experimental area had been managed in a ridge-tillage system since 1984. Potassium deficiencies had been observed in this area before initiation of the study. Soil test results showed that initial pH was 6.5, organic matter was 2.5%, and Bray-1 P and exchangeable K in the top 6 inches of soil were 26 and 280 ppm, respectively. Treatments consisted of the liquid fertilizer Trisert-K+ applied at 2.5 gal/a at the V5 (early vegetative) or R3 (early pod) stage of growth; Trisert-K+ applied at 5 gal/a at R3; 2.5 gal/a of Trisert-K+ applied at both V5 and R3; starter-applied Trisert-K+; starter Trisert-K+ in combination with 2.5 gal/a Trisert-K+ applied at R3; 2.5 gal/a Trisert-K+ applied at V5, R3, and R4; and Trisert-K+ applied preplant broadcast. An untreated check plot also was included. Trisert-K+ is a chlorine-free, clear liquid solution containing 5% nitrogen (N), 20% K_2O, and 13% sulfur (S). Each gallon of Trisert-K+ contains 0.58 lb N, 2.34 lb K_2O, and 1.55 lb sulfur. Starter fertilizer was applied 2 inches to the side and 2 inches below the seed at planting. Foliar fertilizer was applied with a backpack sprayer at a total spray volume of 20 gal/a. Broadcast applications were made 5 days before planting. The experiment was furrow-irrigated. The Roundup Ready® soybean variety Asgrow 3303 was planted in early May each year at the rate of 12 seeds/ft. The V5 application was made on June 5 in 2004 and June 6 in 2005. The R3 application was on July 8 and July 12 in 2004 and 2005, respectively, and the R4 application was on August 17 in 2004 and on August 13 in 2005.

Results

All K fertilizer treatments improved soybean yields and whole-plant K concentration over the untreated check plot, except for the broadcast application (Table 14). Seed yields were maximized with either starter application of Trisert-K+ in combination with foliar application of either 2.5 gal/a or 5 gal/a of Trisert-K+ applied at R3, or with two foliar applications of Trisert-K+ at 5 gal/a applied at V5 and again at R3. Three foliar applications of Trisert-K+ did not improve yields over yields with two applications. Seed yield was 5 bu/a greater when starter fertilizer was combined with a single foliar application of Trisert-K+ at the R3 stage than when starter was applied alone. Broadcast application of fertilizer containing K was not as effective as starter plus foliar-applied fertilizer.

Table 14. Potassium fertilizer application effects on soybean yield, Scandia, Kansas, 2004-2005.

Treatment	Yield		Whole-plant K at Early Pod	
	2004	2005	2004	2005
	- - - - - bu/a - - - - -		- - - - - % - - - - -	
Trisert-K+ (2.5 gal/a at V5)	75.7	75.9	3.12	3.10
Trisert-K+ (5 gal/a at V5)	81.6	75.9	3.32	3.33
Trisert-K+ (2.5 gal/a at R3)	84.9	76.5	3.54	3.51
Trisert-K+ (5.0 gal/a at R3)	85.6	78.6	3.48	3.47
Trisert-K+ (2.5 gal/a at V5+R3)	89.3	86.2	3.57	3.51
Trisert-K+ (5gal/a at V5+R3)	91.8	90.1	3.66	3.68
Starter Trisert-K+ (5 gal/a)	85.3	78.0	3.20	3.15
Starter Trisert-K+ plus Trisert-K+ (2.5 gal/a at R3)	90.7	88.6	3.59	3.62
Starter Trisert-K+ plus TrisertK+ (5 gal/a at R3)	92.9	90.8	3.67	3.68
Preplant Broadcast KTS	83.1	74.2	3.08	3.00
Trisert-K+ (2.5 gal/a at V5+R3+R4)	91.5	87.6	3.72	3.77
Untreated check	69.5	70.1	2.82	2.67
LSD (0.05)	2.5	2.2	0.75	0.64

CONTROLLED-RELEASE UREA FOR IRRIGATED CORN PRODUCTION

W.B. Gordon

Summary

No-till production systems are being used by an increasing number of producers in the central Great Plains because of several advantages that include reduction of soil erosion, increased soil water-use efficiency, and improved soil quality. The large amount of residue left on the soil surface, however, can make nitrogen (N) management difficult.

Surface applications of urea-containing fertilizers are subject to volatilization losses. Leaching can also be a problem on coarse-textured soils when N is applied in one preplant application. Slow-release polymer-coated urea products are beginning to become available for agricultural use. The polymer coating allows the urea to be released at a slower rate than uncoated urea.

This experiment compares urea, a controlled-release polymer-coated urea (ESN), and ammonium nitrate at three nitrogen (N) rates (80, 160, and 240 lb/a). Split applications (1/2 preplant + 1/2 at V4 stage) at 160 lb/a N rate also were included for urea, ammonium nitrate, and ESN. The V4-stage application of all the materials was applied in a surface band. Only the preplant applications were broadcast. Other treatments included preplant applications of UAN broadcast and banded, and urea plus the urease inhibitor Agrotain®.

The study was conducted at the North Central Kansas Experiment Field on a Crete silt loam soil. The study was furrow-irrigated. The coated urea product, ESN, resulted in greater yield than urea did at all N rates. Ammonium nitrate and ESN resulted in essentially the same yields at all N rates. Grain yield was excellent in 2005. Yield increased with increasing N rate up to the 160 lb/a rate with ESN and ammonium nitrate, but continued to increase up to the 240 lb/a rate with uncoated urea. Applying 160 lb/a N in two split applications did not improve yields over applying all N preplant. Applying UAN broadcast was not effective as applying in a dribble band. Urea applied with the urease inhibitor was much more effective than urea alone. The polymer-coated urea product has the potential to make surface application of N in no-till systems more efficient.

Introduction

Conservation-tillage production systems are being used by an increasing number of producers in the Great Plains because of several inherent advantages. These advantages include reduction of soil erosion losses, increased soil water-use efficiency, and improved soil quality. The large amount of residue left on the soil surface in no-till systems can make N management difficult. Surface application of N fertilizers is a popular practice with producers. When urea-containing N fertilizers are placed on the soil surface, they are subject to volatilization losses. Nitrogen immobilization can also be a problem when N fertilizers are surface applied in high-residue production systems. Nitrogen leaching can be both an agronomic and environmental problem on coarse-textured soils. Polymer-coated urea has the potential to make N management more efficient when surface applied in no-till systems.

Procedures

This experiment was conducted at the North Central Kansas Experiment Field on a Crete silt loam soil. Soil pH was 6.5, organic matter was 2.15, Bray-1 P was 44 ppm, and exchangeable K was 325 ppm. The corn hybrid DeKalb DKC60-19 was planted without tillage into corn stubble on April 22, 2004, at the rate of 31,000 seeds/a. Nitrogen was applied on the soil surface immediately after planting. Split applications consisted of 1/2 of the N applied immediately after planting and 1/2 applied at the V4 stage. Preplant treatments were broadcast, and V4 treatments were banded. Treatments consisted of controlled-release polymer-coated urea (ESN), urea, or ammonium nitrate, applied at three rates (80, 160, and 240 lb/a). A no-N check plot also was included. Additional treatments were split applications of ESN, urea, ammonium nitrate, UAN (28% N) broadcast and applied in a dribble band, and urea plus the urease inhibitor, Agrotain®, at 160 lb/a N. The experimental area was adequately irrigated throughout the growing season. Plots were harvested on October 28, 2005.

Results

The ESN controlled-release urea product resulted in greater corn yield at all rates of N than application of urea did (Table 15). Yields achieved with ESN application were equal to those with ammonium nitrate. The lower yields with urea indicate that volatilization of N may have been a significant problem. Splitting applications of N did not improve corn yields with any of the materials. Weather conditions were good and yields were excellent. Yields increased with increasing N rate up to the 160 lb/a rate, except with urea, for which yields continued to increase with increasing N up to the 240 lb/a rate. Applying UAN in a dribble band was more effective than broadcasting, and applying urea with the urease inhibitor Agrotain® was more effective than urea alone.

Results of this study suggest that slow-release polymer-coated urea can improve N use efficiency, compared with urea and UAN, when surface applied in no-till conditions.

Table 15. Effects of nitrogen source and rate on corn grain yield and earleaf nitrogen, Scandia, Kansas, 2003 - 2005.

N	N	Yield		Earleaf N	
Source	Rate	2005	3-yr Avg	2005	2003-2005
	lb/a	- - - - - bu/a - - - - -		- - - - - - % - - - - -	
	0-N check	139	127	1.78	1.74
ESN	80	192	177	2.93	2.43
	160	215	199	3.08	2.63
	240	218	215	3.10	2.63
Urea	80	167	155	2.79	2.25
	160	183	171	2.90	2.36
	240	192	194	2.95	2.46
Am. nitrate	80	196	183	2.95	2.45
	160	219	202	3.10	2.56
	240	217	214	3.12	2.61
ESN	80+ 80 split	216	197	3.09	2.57
Urea	80+80 split	188	178	2.92	2.41
Am. nitrate	80+80 split	220	202	3.08	2.58
28% UAN broad	160	185	189*	2.97	---
28% UAN dribble	160	210	207*	3.02	---
Urea + Agrotain®	160	215	212*	3.10	---
LSD (0.05)		6		0.09	0.07

* 2-year averages (2004 and 2005).

MAXIMIZING IRRIGATED SOYBEAN YIELDS IN THE GREAT PLAINS

W.B. Gordon

Summary

In 2004, studies were initiated to seek ways to maximize soybean yield in the central Great Plains. Treatments included row spacing (30- and 7.5-inch rows), plant population (150,000 and 225,000 plants/a), and seven fertility treatments. Fertility treatments consisted of a low phosphorus (P) application (K-State soil test recommendation would consist of 30 lb/a P_2O_5 at this site), low P- low potassium (K), low P-high K, high P-high K, N-P-K, and an unfertilized check plot.

In 2005, a treatment consisting of 5 lb/a Mn in addition to N-P-K was added. Phosphorus application rates were 30 or 80 lb/a P_2O_5, and K treatments were 80 or 120 lb/a K_2O. The N-P-K treatment consisted of application of 20 lb/a N, 80 lb/a P_2O_5, and 120 lb/a K_2O. Fertilizer was broadcast in mid-March each year. Soybean was sprinkler irrigated. Planting dates were May 8, 2004, and May 10, 2005. Harvest dates were in mid-October each year.

In 2004, increasing plant populations did not increase grain yields, nor did reducing row spacing from 30 to 7.5 inches. Increasing plant population in narrow rows reduced yield. Soybean yields did respond to fertilizer application. Applying 80 lb P_2O_5 with 60 lb/a K_2O increased yield by 32 bu/a over yield in the unfertilized check plot. Applying additional K or adding N to the mix did not increase yields. Increasing plant population at lower fertility rates decreased yield.

In 2005, soybean yield was not affected by row spacing or plant population, nor was yield affected by any interaction of factors. Fertility treatments did have a dramatic effect on soybean yield. Applying 80 lb P_2O_5 with 60 lb/a K_2O increased yield by 33 bu/a over yield in the unfertilized check plot. Applying additional K or N did not result in any yield increase, but addition of Mn to the mix did significantly increase yield.

In high-yield environments, soybean yields can be greatly improved by direct fertilization.

Introduction

Analysis of corn yield data from hybrid performance tests in Kansas show that corn yields have increased by an average of 2.5 bu/a per year. Soybean yield trends in performance tests have also been on an upward trend, but average state-wide yields in Kansas have not increased. In a corn-soybean rotation, fertilizer typically is applied only during the corn phase of the rotation. On a per-bushel basis, soybean removes twice as much phosphorus and almost five times as much potassium as corn does. To capitalize on genetic improvements in yield, levels of plant nutrients must not be limiting. Other production practices, such as plant population and row spacing, may interact with fertility management to influence crop yields.

Procedures

The experiment was conducted on a Crete silt loam soil at the North Central Kansas Experiment Field and included soybean planted at two row spacings (30 and 15 inches) and two plant populations (150,000 and 225,000 plants/a). Fertility treatments consisted of a low-P application (K-State soil test recommendation would consist of 30 lb/a P_2O_5 at this site), low P- low K, low P-high K, high P-high K, N-P-K, N-P-K-Mn, and an unfertilized check plot. Phosphorus application rates were 30 or 80 lb/a P_2O_5, and K treatments were 80 or 120 lb/a K_2O. The N-P-K treatment consisted of application of 40 lb N, 80 lb P_2O_5 and 120 lb K_2O per acre. The N-P-K-Mn consisted of the same N-P-K treatment plus 5 lb/a of Mn. Soil test values were: pH, 6.9; Bray-1 P, 21 ppm; and exchangeable K, 210 ppm. Fertilizer was broadcast in mid-March. The soybean variety Asgrow 3305 was planted on May 8 in 2004 and on May 10 in 2005. Soybean was sprinkler irrigated.

Results

In neither year of the experiment did increasing plant populations or reducing row spacing result in any increase in yield (Tables 16 and 17).

In 2004, increasing plant population in narrow rows actually reduced yield. Soybean yields did respond to fertilizer application. Applying 80 lb/a P_2O_5 with 60 lb/a K_2O increased yield by 32 bu/a over yield of the unfertilized check plot (Table 18). Applying additional K or adding N to the mix did not increase yields. Increasing plant population at lower fertility rates decreased yield.

In 2005, soybean yield was not affected by row spacing or plant population, nor was yield affected by any interaction of factors. Fertility treatments did have a dramatic effect on soybean yield. Applying 80 lb/a P_2O_5 with 60 lb/a K_2O increased yield by 33 bu/a over the unfertilized check plot (Table 19). Applying additional K or N did not result in any yield increase, but addition of Mn to the mix did significantly increase yield.

Table 16. Soybean yield as affected by row spacing and plant population (average over fertility treatments), North Central Kansas Experiment Field, 2004.

	Yield	
Row Space	150,000 plants/a	255,000 plants/a
	- - - - - - - - - - bu/a - - - - - - - - - -	
30 inch	76	77
7.5 inch	77	73
LSD (0.05)	3	

Table 17. Soybean yield as affected by row spacing and plant population (average over fertility treatments), North Central Kansas Experiment Field, 2005.

	Yield	
Row Space	150,000 plants/a	255,000 plants/a
	- - - - - - - - - - - bu/a - - - - - - - - - - -	
30 inch	78	80
7.5 inch	80	78
LSD (0.05)	NS*	

*Not Significant

Table 18. Plant population and fertility effects on soybean yield (average over row spacing), North Central Kansas Experiment Field, 2004.

Treatments	Yield	
	150,000 plants/a	225,000 plants/a
	- - - - - - - - - - bu/a - - - - - - - - - -	
Check	53	43
Low P	61	53
Low P-Low K	73	69
Low P-High K	77	77
High P-Low K	85	85
High P-High K	85	84
N-P-K	86	85
LSD (0.05)	2	

Table 19. Fertility effects on soybean yield (average over row spacing and plant population), North Central Kansas Experiment Field, 2005.

Treatments	Yield
	bu/a
Check	55
Low P	63
Low P-Low K	76
Low P-High K	81
High P-Low K	88
High P-High K	89
N-P-K	88
N-P-K-Mn	93
LSD (0.05)	3

MANGANESE NUTRITION OF GLYPHOSATE-RESISTANT AND CONVENTIONAL SOYBEAN

W.B. Gordon

Summary

There is evidence to suggest that insertion of the gene that imparts glyphosate resistance in soybean may have altered physiological processes that affect manganese (Mn) uptake and metabolism. This study was conducted to determine if glyphosate-resistant soybean responds differently than conventional soybean to applied Mn. The glyphosate-resistant soybean variety KS 4202 RR and its conventional isoline were grown on a Crete silt loam soil with a pH of 6.9 at the North Central Kansas Experiment Field. Granular manganese sulfate was applied in late April to give rates of 2.5, 5, and 7.5 lb Mn/a. A no-Mn check plot also was included. Soybean was planted without tillage on May 10, 2005. The experiment was sprinkler irrigated.

Yield of the conventional soybean variety was 12 bu/a greater than its glyphosate-tolerant isoline. Addition of Mn improved yield of the glyphosate-resistant variety, but the yield of the conventional isoline decreased with increasing Mn rate. Foliar application of chelated Mn also was effective in improving yield of glyphosate-resistant soybean.

Introduction

There is evidence to suggest that yields of glyphosate-resistant soybean may still lag behind that of conventional soybean. Many farmers have noticed that soybean yields, even under optimal conditions, are not as high as expected. In Kansas, average yield seldom exceeds 60 to 65 bu/a, even when soybean is grown with adequate rainfall and/or supplemental irrigation water. The addition of the gene that imparts herbicide resistance may have altered other physiological processes. Some scientists suggest than soybean root exudates have been changed, and that plants no longer solubilize enough soil Mn. Application of glyphosate also may retard manganese metabolism in the plant. Addition of supplemental Mn at the proper time may correct deficiency symptoms and result in greater soybean yields.

In higher plants, photosynthesis in general, and photosynthetic O_2 evolution in Photosystem II (Hill Reaction) in particular, are the processes that respond most sensitively to Mn deficiency. Changes in O_2 evolution induced by Mn deficiency are correlated with changes in the ultrastructure of thylakoid membranes (internal chlorophyll-containing membranes of the chloroplast where light absorption and the chemical reactions of photosynthesis take place). When Mn deficiency becomes severe, the chlorophyll content decreases and the ultrastructure of the thylakoids is drastically changed. Manganese acts as a cofactor, activating about 35 different enzymes. Manganese activates several enzymes leading to the biosynthesis of aromatic amino acids, such as tyrosine, and secondary products, such as lignin and flavonoids. Flavonoids in root extracts of legumes stimulate *nod* (nodulation) gene expression. Lower concentrations of lignin and flavonoids in Mn-deficient tissue are also responsible for a decrease in disease resistance of Mn-deficient plants. In nodulated legumes, such as soybean, that transport nitrogen in the form of allantoin and allantoate to the shoot, the degradation of these ureides in the leaves and in the seed coat is catalyzed by an enzyme that has an absolute requirement of Mn. Ureides account for most of N transported in the xylem sap to the aerial portions of soybean. Tissue Mn deficiency and drought stress can increase shoot ureide concentration. In research done in Arkansas, it was found that foliar Mn applications reduced soybean shoot ureide concentrations and prolonged N_2 fixation. Information is needed to determine if field-grown glyphosate-resistant soybean responds to applied Mn in a different manner than conventional soybean does and, if so, what fertilization practices are best to correct the problem. There currently is little information on Mn fertilization of soybean in Kansas.

The objective of this research was to determine if glyphosate-resistant soybean responds differently to applied manganese than conventional soybean does and, if so, to develop fertilization strategies that will prevent or correct deficiencies, leading to improved yield for soybean producers.

Procedures

The glyphosate-resistant soybean variety KS 4202 RR and its conventional isoline were grown on a Crete silt loam soil with sprinkler irrigation. The soil pH in the top 6 inches of soil at the site was 6.9. Manganese fertilizer treatment was pre-plant banded soil applications of manganese sulfate at rates of 2.5, 5, and 7.5 lb/a. A no-Mn check treatment also was included. The experimental design was a randomized complete block with a split-plot arrangement. Whole plots were herbicide-resistant and conventional soybean varieties (isolines of KS 4202), and split plots were Mn rates and sources. An additional experiment evaluated liquid chelated Mn applied to soybean foliage at three growth stages (V4, V8, and R2). Manganese was applied to the glyphosate-resistant soybean variety KS 4202RR to give a rate of 0.3 lb/a Mn at each application.

Results

Yields were affected by an interaction between soybean variety and Mn rate (Figure 3). In the glyphosate-resistant variety KS 4202 RR, yields increased with addition of Mn up to the 5 lb/a rate. Yield of the conventional variety KS 4202 was 12 bu/a greater than its glyphosate-resistant isoline KS 4202RR when no Mn was added. Yield of the conventional variety declined with increasing Mn rate. Tissue Mn concentration (uppermost expanded trifoliate at full bloom) in the herbicide-resistant isoline was less than half that of the conventional variety when no Mn was applied (Figure 4). Foliar-applied liquid Mn chelate was effective in increasing yield of glyphosate-resistant soybean (Table 20).

Table 20. Foliar-applied manganese effects on soybean yield, 2005.

Stage of Growth	Yield
	bu/a
V4	62
V4+V8	69
V4+V8+R2	72
Untreated Check	80
LSD (0.05)	4

0.3 lb Mn/a was applied at each application.

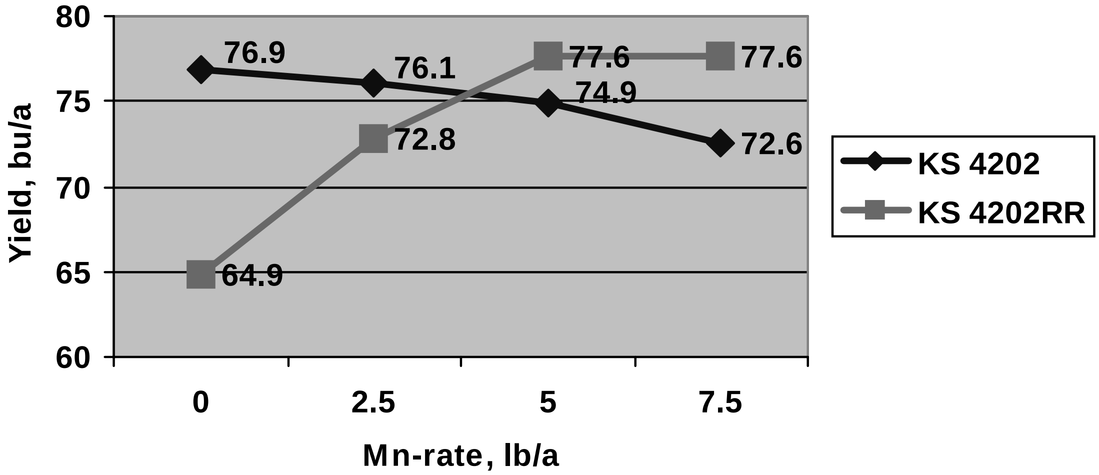

Figure 3. Soybean yield response to applied manganese.

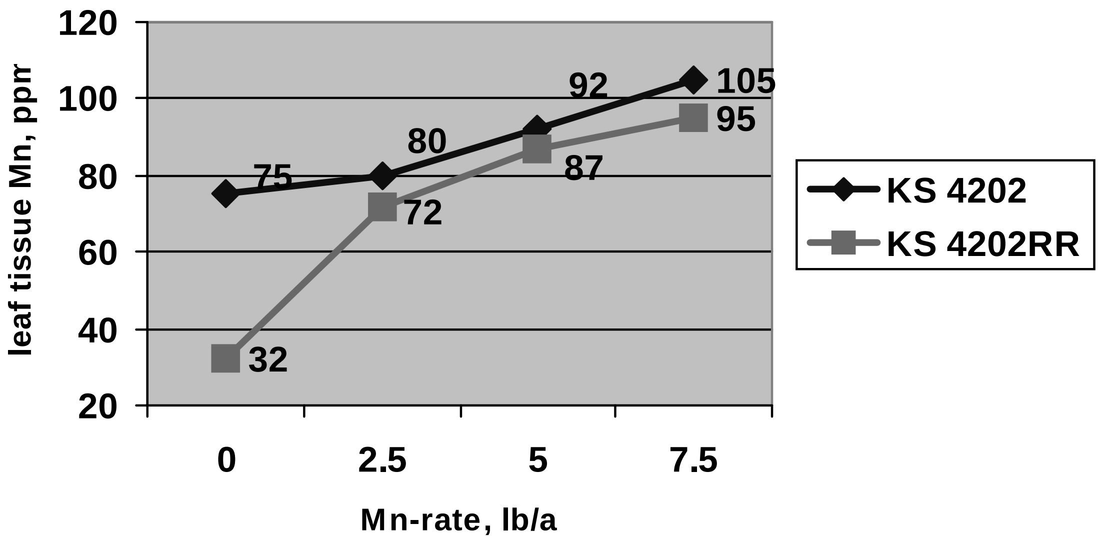

Figure 4. Soybean leaf tissue Mn concentration (uppermost expanded trifoliate at full bloom).

MANAGEMENT SYSTEMS FOR GRAIN SORGHUM PRODUCTION UNDER DRYLAND AND IRRIGATED CONDITIONS

W.B. Gordon

Summary

Experiments were conducted at the North Central Kansas Experiment Fields on a Crete silt loam soil to compare corn and sorghum in both dryland and irrigated environments. In the dryland experiment, when averaged over populations and hybrids, corn yield averaged 104 bu/a and grain sorghum yielded 137 bu/a.

With grain sorghum, the latest-maturing hybrid (DKS 53-11) yield was the greatest and the earliest (DKS 36-00) yield was the least. Longer-season sorghum develops more leaves than shorter-season sorghum does and, thus, has a greater potential for fixing carbon and increasing yield. In many years, however, the fuller-season hybrids run short of water in dryland environments, and the potential for greater yield is not realized.

Above-normal rainfall was received in August 2005, and distribution was ideal for grain sorghum production. In the irrigated experiment, when averaged over populations and hybrids, corn yielded 180.3 bu/a and grain sorghum yielded 183 bu/a. Grain sorghum demonstrated its ability to compete with corn in both dryland and limited-irrigation production systems.

Introduction

As competition for limited water supplies increases in arid and semi-arid regions, irrigation water is becoming increasingly scarce and expensive. Where water is a limiting resource, the objectives of irrigation management may shift from obtaining maximum yield to obtaining maximum economic production per unit of applied water. When the available water supply is limited, producers are faced with different planning decisions than historically were encountered. Deficit irrigation occurs when water supplies are limited to the extent that full replacement of evapotranspiration (ET) demand is no longer possible. With limited amounts of available water, choice of cropping system may change.

The slope of the yield ET relationship for corn is larger than for most other crops. The ET threshold for grain yield is also higher. With grain sorghum, it takes 6 inches of water to produce the first bushel of grain. Corn requires twice that amount to produce the first bushel of grain.

Sorghum originated in, is well adapted to, and is primarily grown in the semiarid regions of the world. It has long been recognized as being drought tolerant, compared with other major grain crops, and is therefore well suited to conditions characterized by: (1) insufficient water supply to meet evaporative demand, (2) uneven seasonal distribution of precipitation, and (3) high year-to-year variation in rainfall and surface water supplies. In dryland conditions or with limited amounts of irrigation water available, grain sorghum may become a viable alternative to corn production.

The objectives of this research would be to compare grain sorghum to corn production in dryland and limited irrigation cropping systems.

Procedures

In 2005, a dryland experiment was conducted at the North Central Kansas Experiment Field on a Crete silt loam soil to compare corn and grain sorghum production in the same environment. The experiment consisted of three corn hybrids (DeKalb DKC

50-20, DeKalb DKC 58-80, and DeKalb DKC 60-19) planted at three plant populations (16,000, 24,000, and 30,000 plants/a) and three grain sorghum hybrids (DeKalb DKS 36-00, DeKalb DKS 42-20, and DeKalb 53-11) planted at 28,000, 36,000 and 44,000 plants/a. Hybrids were selected to represent early-, medium-, and late-maturity groups. Corn and grain sorghum plots were overplanted and thinned to desired populations. Corn was planted on April 22, 2005, and grain sorghum was planted on May 18, 2005. Crops were planted without tillage into wheat stubble.

An irrigated experiment was conducted in 2005. Two corn hybrids (DKC 58-80 and DKC 60-19) and two grain sorghum hybrids (DKS 42-20 and DKS 53-11) were evaluated at three plant populations and two rates of irrigation.

Corn populations were 20,000, 26,000, and 32,000 plants/a. Grain sorghum populations were 50,000, 70,000, and 90,000 plants/a. Irrigation rates were 5 and 10 inches of applied water.

Water-use efficiency is defined as pounds of grain per inch of water. Total water use was calculated from soil water use, rainfall, and irrigation. Corn was planted on April 18, 2005, and grain sorghum was planted on May 12, 2005. Both crops were planted into soybean stubble without any additional tillage.

Results

In the dryland experiment, when averaged over populations and hybrids, corn yield averaged 103.7 bu/a and grain sorghum yielded 136.5 bu/a (Table 21).

In 2005, plant population did not have a great effect on yield of either crop. Yield of DKC 58-80 was significantly greater than yield of the other two corn hybrids. With grain sorghum, the latest-maturing hybrid (DKS 53-11) yield was the greatest and the earliest-maturing hybrid (DKS 36-00) had the least yield. Longer-season sorghum developed more leaves than shorter-season sorghum did, so it had a greater potential for fixing carbon and increasing yield. In many years, however, the fuller-season hybrids run short of water in dryland environments, and the potential for greater yield is not realized. Above-normal rainfall was received in August 2005, and distribution was ideal for grain sorghum production.

In the irrigated experiment, when averaged over populations and hybrids, corn yielded 180.3 bu/a and grain sorghum yielded 183 bu/a (Table 22). Corn yield was improved by 14 bu/a when irrigation water amount was increased. Grain sorghum yield was not improved by increasing the amount of applied water. Water-use efficiency (pounds of grain/inch of water) of grain sorghum was superior to that of corn under dryland and limited- irrigation conditions. When 10 inches of irrigation water was applied, there was no statistical difference in water-use efficiency between corn and sorghum. Grain sorghum has demonstrated its ability to compete with corn in both dryland and limited-irrigation production systems.

Table 21. Grain Sorghum and corn yield as affected by hybrid and plant population, North Central Kansas Experiment Field, 2005.

Crop	Hybrid	Population	Yield
			bu/a
Grain Sorghum	DKS 36-00	Low	117.3
		Medium	120.8
		High	121.5
Grain Sorghum	DKS 42-20	Low	133.9
		Medium	138.3
		High	138.5
Grain Sorghum	DKS 53-11	Low	152.4
		Medium	154.3
		High	152.0
Corn	DKC 50-20	Low	96.9
		Medium	104.2
		High	102.9
Corn	DKC 58-80	Low	103.9
		Medium	112.7
		High	110.8
Corn	DKC 60-19	Low	98.7
		Medium	102.2
		High	101.4
LSD (0.05)			4.2

Table 22. Irrigation effects on yield of grain sorghum and corn hybrids, North Central Kansas Experiment Field, 2005.

Crop	Hybrid	Irrigation, inches	Yield
			bu/a
Grain Sorghum	DKS 42-20	5	176.1
		10	176.0
	DKS 53-11	5	189.8
		10	190.0
Corn	DKC 58-80	5	170.6
		10	184.2
	DKC 60-19	5	175.5
		10	190.8
LSD (0.05)			6.1

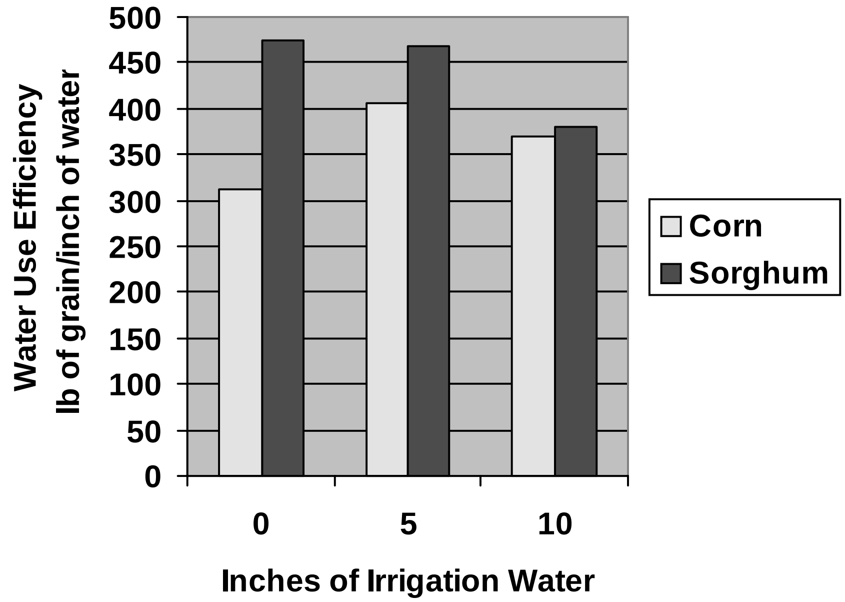

Figure 5. Water use efficiency of corn and grain sorghum.

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EXPERIMENT FIELD PERSONNEL

William F. Heer, Agronomist-in-Charge

SOUTH CENTRAL KANSAS EXPERIMENT FIELD

Hutchinson

Introduction

The South Central Kansas Experiment Field, Hutchinson, was established in 1951 on the U.S. Coast Guard Radio Receiving Station located southwest of Hutchinson. The first research data were collected with the harvest of 1952. Before 1952, data for the South Central area of Kansas were collected at three locations (Kingman, Wichita/Goddard, and Hutchinson). The current South Central Field location is approximately 3/4 miles south and east of the old Hutchinson location on the Walter Peirce farm.

Research at the South Central Kansas Experiment Field is designed to help the area's agriculture develop to its full agronomic potential using sound environmental practices. The principal objective is achieved through investigations of fertilizer use, weed and insect control, tillage methods, seeding techniques, cover crops and crop rotations, variety improvement, and selection of hybrids and varieties adapted to the area, as well as alternative crops that may be beneficial to the area's agriculture production.

Experiments deal with problems related to production of wheat, grain and forage sorghum, oat, alfalfa, corn, soybean, cotton, rapeseed/canola, sunflower, and soil tilth. Breeder and foundation seed of wheat, oat, and canola varieties/hybrids are produced to improve seed stocks available to farmers. A large portion of the research program at the field is currently dedicated to wheat and canola breeding and germplasm development.

In March of 2004, the Kansas State University Foundation took possession of approximately 300 acres of land southwest of Partridge, Kansas. This land was donated to the Foundation by George V. Redd and Mabel E. Bargdill for use in developing and improving plants and crops. The acreage is in two parcels. One parcel of approximately 140 acres lies south of Highway 61 and west of county road Centennial. It is currently in CRP and will remain there until the contract runs out. The second parcel, a full quarter, is currently in Foundation wheat, production wheat, and grain sorghum. Both quarters will be worked into the research activities of the South Central Experiment Field.

Soil Description

A new soil survey was completed for Reno County and has renamed some of the soils on the Field. The new survey overlooks some of the soil types present in the older survey and it is believed that the description of the soils on the Field as follows is more precise. The South Central Kansas Experiment Field has approximately 120 acres classified as nearly level to gently sloping Clark/Ost loams with calcareous subsoils. This soil requires adequate inputs of phosphate and nitrogen fertilizers for maximum crop production.

The Clark soils are well drained and have good water-holding capacity. They are more calcareous at the surface and less clayey in the subsurface than the Ost. The Ost soils are shallower than the Clark, having an average surface layer of only 9 inches. Both soils are excellent for wheat and grain sorghum production. Large areas of these soils are found in southwestern and southeastern Reno County and in western Kingman County. The Clark soils are associated with the Ladysmith and Kaski soils common in Harvey County but are less clayey and contain more calcium carbonate.

Approximately 30 acres of Ost Natrustolls Complex, with associated alkali slick spots, occur on the north edge of the Field. This soil requires special management and timely tillage, because it puddles when wet and forms a hard crust when dry. A 10-acre depression on the south edge of the Field is a Tabler-Natrustolls Complex (Tabler slick-spot complex). This area is unsuited for cultivated crop production and has been seeded to switchgrass. Small pockets of the Tabler-Natrustolls are found throughout the Field.

The soils on the Redd-Bargdill land are somewhat different from those on the current Field. The south quarter (CRP) has mostly Shellabarger fine sandy loams with 1 to 3% slopes. There are also some Farnums on this quarter. The new classification has these soils classified as Nalim loam. The north quarter was previously all classified as Tabler clay loam; the new survey has the soils classified as Funmar-Taver loams, Funmar loams, and Tever loams.

Weather Information

From 1997-2000 precipitation was above average. In 2001 and in 2003, below-normal precipitation was recorded at the Field. The precipitation for 2002 and 2004 was 0.946 and 3.14 inches above normal, respectively. The U.S. Department of Commerce National Oceanic and Atmospheric Administration National Weather Service rain gauge (Hutchinson 10 S.W. 14-3930-8) collected 32.09 inches of precipitation in 2005, 2.22 inches above the 30-year (most recent) average of 29.87 inches. It should be noted that the 30-year average has been increasing in the past few years. These figures are different from those available through the K-State automated weather station (http://www.oznet.k-state.edu/wdl/) because of the distance between the two. As with all years, distribution within the year and the rainfall intensity are the determining factors in the usefulness of the precipitation. In 2005, January, June, July, and August received above-normal precipitation, of 1.66, 4.57, 1.32, and 3.79 inches, respectively. The timing of the spring rains and cool temperatures allowed the winter wheat and other fall crops (canola) to do well. The excess summer rains were beneficial for the summer crops, as can be seen in the data tables, but the hail storm on July 3 had a major effect on yield, with the cotton plots being completely hailed out. Had it not been for the late freeze, the summer crops would not have yielded well.

A frost-free growing season of 177 days (April 30 - October 24, 2005) was recorded. This is six days less than the average frost-free season of 183 days (April 19 - October 17).

Table 1. Precipitation at South Central Kansas Experiment Field, Hutchinson, Kansas (10 S.W. 14-3930-8).

Month	Rainfall (inches)	30-yr Avg* (inches)	Month	Rainfall (inches)	30-yr Avg (inches)
2004			April	1.78	2.71
September	1.67	2.73	May	2.51	4.11
October	2.64	2.47	June	8.92	4.35
November	1.81	1.35	July	4.88	3.56
December	0.21	0.95	August	6.94	3.15
2005			September	0.47	2.73
January	2.35	0.69	October	1.02	2.49
February	1.75	1.10	November	0.19	1.38
March	1.07	2.70	December	0.31	0.90
			2005 Total	32.09	29.87

* Most recent 30 years.

CROP PERFORMANCE TESTS AT THE SOUTH CENTRAL FIELD

W.F. Heer and K.L. Roozeboom

Introduction

Performance tests for winter wheat, grain sorghum, alfalfa, canola, sunflower, oat, and spring wheat were conducted at the South Central Kansas Experiment Field. Off-site tests for irrigated corn, soybean, and grain sorghum also were conducted. Results of these tests can be found in this publication and in the following publications, which are available at the local county extension office or online at http://www.ksu.edu/kscpt.

2005 Kansas Performance Tests with Winter Wheat Varieties. KAES Report of Progress SRP 947.
2005 Great Plains Canola Research. KAES Report of Progress SRP 954.
2005 Kansas Performance Tests with Corn Hybrids. KAES Report of Progress SRP 949.
2005 Kansas Performance Tests with Grain Sorghum Hybrids. KAES Report of Progress SRP 950.
2005 Kansas Performance Tests with Sunflower Hybrids. KAES Report of Progress SRP 953.
2005 Kansas Performance Tests with Alfalfa Varieties. KAES Report of Progress SRP 952.
2005 Kansas Performance Tests with Summer Annual Forages. KAES Report of Progress SRP 955.
2005 Kansas Performance Tests with Soybean. KAES Report of Progress SRP 951.

EFFECTS OF NITROGEN RATE AND PREVIOUS CROP ON GRAIN YIELD IN CONTINUOUS WHEAT AND ALTERNATIVE CROPPING SYSTEMS IN SOUTH-CENTRAL KANSAS

W. F. Heer

Summary

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

Introduction

In South-Central Kansas, continuous hard red winter wheat and winter wheat - grain sorghum - fallow are the predominant dry-land cropping systems. The summer-fallow period following sorghum is required because the sorghum crop is harvested in late fall, after the optimum planting date for wheat in this region. Average annual rainfall is only 29 inch/yr, with 60 to 70% occurring between March and July. Therefore, soil moisture is often not sufficient for optimum wheat growth in the fall. No-tillage (NT) systems often increase soil moisture by increasing infiltration and decreasing evaporation. But higher grain yields associated with increased soil water in NT have not always been observed.

Cropping systems with winter wheat following several alternative crops would provide improved weed control, through additional herbicide options and reduced disease incidence by interrupting disease cycles, as well as allow producers several options under the 1995 Farm Bill. But the fertilizer nitrogen (N) requirement for many crops is often greater under NT than under CT. Increased immobilization and denitrification of inorganic soil N and decreased mineralization of organic soil N have been related to the increased N requirements under NT. Therefore, evaluation of N rates on hard red winter wheat in continuous wheat and in cropping systems involving "alternative" crops for the area have been evaluated at the South Central Field.

The continuous-winter-wheat study was established in 1979 and was restructured to include a tillage factor in 1987. The first of the alternative cropping systems, in which wheat follows short-season corn, was established in 1986 and modified in 1996 to a wheat-cover crop-grain sorghum rotation. The second cropping system (established in 1990) has winter wheat following soybean. Both cropping systems use NT seeding into the previous crop's residue. All three systems have the same N rate treatments.

Procedures

The research was conducted at the KSU South Central Experiment Field, Hutchinson. Soil is an Ost loam. The sites had been in wheat before the start of the cropping systems.

The research was replicated five times in a randomized block design with a split-plot arrangement. The main plot was crop and the subplot was six N rates (0, 25, 50, 75, 100, and 125 lb/a). Nitrogen treatments were broadcast applied as NH_4NO_3 before planting. Phosphate was applied in the row at planting. All crops were produced each year of the study. Crops were planted at the normal time for the area. Plots were harvested at maturity to determine grain yield, moisture, and test weight.

Continuous Wheat

These plots were established in 1979. The conventional tillage treatments are plowed immediately after harvest then worked with a disk as necessary to control weed growth. The fertilizer is applied with a Barber metered screw spreader before the last tillage (field cultivation) on the CT and before seeding of the NT plots. The plots are cross-seeded in mid-October to winter wheat. Because of an infestation of cheat in the 1993 crop, the plots were planted to oat in the spring of 1994. The fertility rates were maintained, and the oat was harvested in July. Winter wheat has been planted in mid-October each year since the fall of 1994. New herbicides have aided in the control of cheat in the NT treatments. In the fall of 2005, these plots were seeded to canola. The nitrogen rates and tillage treatments were retained. It is hoped that doing this will give us some field data on the effects of canola on wheat yields in a continuous-wheat cropping system.

Wheat after Corn/Grain Sorghum Fallow

In this cropping system, winter wheat was planted after short-season corn had been harvested in late August to early September. This early harvest of short-season corn allows the soil-profile water to be recharged (by normal late-summer and early-fall rains) before planting of winter wheat in mid-October. Fertilizer rates were applied with the Barber metered screw spreader in the same manner as for the continuous wheat. In 1996, the corn crop in this rotation was dropped, and three legumes (winter peas, hairy vetch, and yellow sweet clover) were added as winter cover crops. Thus, the rotation became a wheat-cover crop-grain sorghum-fallow rotation. The cover crops replaced the 25, 75, and 125 N treatments in the grain sorghum portion of the rotation. Yield data can be found in Field Research 2000, KAES Report of Progress SRP 854.

Wheat after Soybean

Winter wheat is planted after the soybean has been harvested in early- to mid-September in this cropping system. As with the continuous-wheat plots, these plots are planted to winter wheat in mid October. Fertilizer rates are applied with the Barber metered screw spreader in the same manner as for the continuous wheat. Since 1999, a group III soybean has been used. This delays harvest from late August to early October. In some years, this effectively eliminates the potential recharge time before wheat planting.

Wheat after Grain Sorghum in Cover Crop/Fallow - Grain Sorghum - Wheat

Winter wheat is planted into grain sorghum stubble harvested the previous fall. Thus, the soil-profile water has had 11 months to be recharged before planting of winter wheat in mid-October. Nitrogen fertilizer is applied at a uniform rate of 75 lb/a with the Barber metered screw spreader in the same manner as for the continuous wheat. This rotation will be terminated after the harvest of each crop in 2006. For the 2007 harvest year, canola will be introduced into this rotation where the cover crops had been.

Winter wheat is also planted after canola and sunflower to evaluate the effects of these two crops on the yield of winter wheat. Uniform nitrogen fertility is used; therefore, the data is not presented. The yields for wheat after these two crops are comparable to wheat after soybean.

Results

Continuous Wheat

Grain yield data from plots in continuous winter wheat are summarized by tillage and N rate in Table 3. Data for years before 1996 can be found in Field Research 2000, KAES Report of Progress SRP 854. Conditions in 1996 and 1997 proved to be excellent for winter wheat production, in spite of the dry fall of 1995 and the late-spring freezes in both years. Excellent moisture and temperatures during the grain- filling period resulted in decreased grain-yield differences between the conventional and no-till treatments within N rates. Conditions in the springs of 1998 and 1999 were excellent for grain filling in wheat. However, the differences in yield between conventional and no-till wheat still expressed themselves (Table 3). In 2000, the differences were wider, up to the 100 lb/a N rate. At that point, the differences were similar to those of previous years. The wet winter and late spring of the 2003-2004 harvest year allowed for excellent tillering and grain fill and yields (Table 2). In 2005, the dry period in April and May seemed to affect the yields in the plots with 0 and 25 lb/a N rates.

Wheat after Soybean

Wheat yields after soybean also reflect the differences in N rate. When comparing the wheat yields from this cropping system with those where wheat followed corn, however, the effects of residual N from soybean production in the previous year can be seen. This is especially true for N rates between 0 and 75 lb in 1993 and between 0 and 125 lb in 1994 (Table 3). Yields in 1995 reflect the added N from the previous soybean crop with yield-by-N-rate increases similar to those of 1994. The 1996 yields for spring wheat reflect the lack of response to nitrogen fertilizer for the spring wheat. Yields for 1997 and 1998 both show the leveling off after the first four increments of N. As with the wheat in the other rotations in 1999, the ideal moisture and temperature conditions allowed the wheat yields after soybean to express the differences in N rate up to 100 lb N/a. In the past, those differences stopped at the 75 lb N/a treatment. When compared with the yields in the continuous wheat, the yield of rotational wheat is starting to reflect the presence of the third crop (grain sorghum) in the rotation. Wheat yields were lower in 2000 than in 1999. This is attributed to the lack of timely moisture in April and May and the hot days at the end of May. This heat caused the plants to mature early, and also caused low test weights. In 2004, there was not as much cheat as in 2003; thus, the yields were much improved (Table 3). Yields in 2004 indicate that the wheat is showing a 50- to 75-lb N credit from the soybean and rotational effects. As with the continuous wheat cropping system, the yields in plots with the 0 and 25 lb/a N rate were less than in 2004. As the rotation continues to cycle, the differences at each N rate will probably stabilize after four to five cycles, with a potential to reduce fertilizer N applications by 25 to 50 lb/a where wheat follows soybean.

Wheat after Grain Sorghum/Cover Crop

The first year that wheat was harvested after a cover-crop grain sorghum planting was 1997. Data for the 1997-2005 wheat yields are in Table 4. Over these nine years, there does not seem to be a definite effect of the cover crop (CC) on yield. This is most likely due to the variance in CC growth within a given year. In years like 1998 and 1999, in which sufficient moisture and warm winter temperatures produced good CC growth, the additional N from the CC seems to carry through to the wheat yields. With the fallow period after the sorghum in this rotation, the wheat crop has a moisture advantage over the wheat after soybean. Cheat was the limiting factor in this rotation in 2003. A more aggressive herbicide control of cheat in the cover crops was started, and the 2004 yields reflect the control of cheat. Management of the grasses in the cover-crop portion of this rotation seems to be the key factor in controlling the cheat grass and increasing yields. This can be seen in the yields for 2005, when compared with the wheat yields, either continuous wheat or in rotation with soybean.

Other Observations

Nitrogen application significantly increased grain N contents in all crops. Grain phosphate content did not seem to be affected by increased N rate.

Loss of the wheat crop after corn can occur in years when fall and winter moisture is limited. This loss has not occurred in continuous winter wheat, regardless of tillage, or in the wheat after soybean. Corn will have the potential to produce grain in favorable years (cool and moist) and silage in nonfavorable (hot and dry) years. In extremely dry summers, extremely low grain sorghum and soybean yields can occur. The major weed-control problem in the wheat-after-corn system is with the grasses. This was expected, and work is being done to determine the best herbicides and time of application to control grasses.

Soybean and Grain Sorghum in Rotations

Soybean was added to intensify the cropping system in the South-Central area of Kansas. Soybean also has the ability, being a legume, to add nitrogen to the soil system. For this reason, nitrogen is not applied during the time when soybean are planted in the plots for the rotation. This gives the following crops the opportunity to use the added N and allows checking the yields against the yields for the crop in other production systems. Yield data for soybean following grain sorghum in the rotation are given in Table 5. Soybean yields are affected more by the weather for the given year than by the previous crop. In three out of the nine years, there was no effect of the N rates applied to the wheat and grain sorghum crops in the rotation. In the two years that N application rate did affect yield, it was only at the lesser N rates. This is a similar effect that is seen in a given crop. The yield data for the grain sorghum after wheat in the soybean-wheat-grain sorghum rotation are in Table 6. As with the soybean, weather is the main factor affecting yield. The addition of a cash crop (soybean), thus intensifying the rotation (cropping system), will reduce the yield of grain sorghum in the rotation; compare soybean-wheat-grain sorghum vs. wheat-cover crop-grain sorghum in Tables 6 and 7. More uniform yields are obtained in the soybean-wheat-grain sorghum rotation (Table 6) than in the wheat-cover crop-grain sorghum rotation (Table 7).

Other systems studies at the Field are a wheat-cover crop (winter pea)-grain sorghum rotation with N rates, and a date of planting, date of termination cover-crop rotation with small grains (oat) and grain sorghum.

Table 2. Wheat yields by tillage and nitrogen rate in a continuous-wheat cropping system, Hutchinson, Kansas.

N	Yield (bu/a)																			
Rate[1]	1996		1997		1998		1999		2000		2001		2002		2003		2004		2005	
	CT[2]	NT	CT	NT	CT	NT	CT	NT	CT	NT	CT	NT	CT	NT	CT	NT	CT	NT	CT	NT
0	46	23	47	27	52	19	49	36	34	15	50	11	26	8	54	9	66	27	47	26
25	49	27	56	45	61	37	67	51	46	28	53	26	34	9	56	9	68	41	63	36
50	49	29	53	49	61	46	76	61	52	28	54	35	32	8	57	22	65	40	68	38
75	49	29	50	46	64	53	69	64	50	34	58	36	34	7	57	42	63	37	73	43
100	46	28	51	44	55	52	66	61	35	33	54	34	35	5	56	35	64	43	73	40
125	45	25	48	42	56	50	64	58	31	32	56	36	32	5	57	38	63	31	69	35
LSD (0.01)*	NS	NS	8	8	5	5	13	13	14	14	10	10	6	NS	NS	18	NS	9	14	14

* Unless two yields in the same column differ by at least the least significant difference (LSD), there can be little confidence in one being greater than the other.

[1] Nitrogen rate in lb/a.

[2] CT conventional NT no-tillage.

Table 3. Wheat yields after soybeans in a soybean-wheat-grain sorghum rotation with nitrogen rates, Hutchinson, Kansas.

N	Yield (bu/a)														
Rate[1]	1991	1992	1993	1994	1995	1996[2]	1997	1998	1999	2000	2001	2002[3]	2003	2004	2005
0	51	31	24	23	19	35	13	21	31	26	12	9	31	40	30
25	55	36	34	37	26	36	29	34	46	37	16	10	48	46	43
50	55	37	41	47	34	36	40	46	59	46	17	9	59	48	49
75	52	37	46	49	37	36	44	54	66	54	17	7	65	46	52
100	51	35	45	50	39	36	45	55	69	55	20	8	67	43	50
125	54	36	46	52	37	36	47	57	68	50	21	8	66	40	48
LSD (0.01)*	NS	4	6	2	1	1	4	3	7	5	7	4	3	5	5
CV (%)	7	6	9	5	7	2	9	4	5	7	23	24	4	6	6

* Unless two yields in the same column differ by at least the least significant difference (LSD), there can be little confidence in one being greater than the other.

[1] Nitrogen rate in lb/a.

[2] Spring wheat yields.

[3] Yields severely reduced by hail.

Table 4. Wheat yields after grain sorghum in a wheat-cover crop-grain sorghum rotation with nitrogen rates, Hutchinson, Kansas.

N	Yield (bu/a)								
Rate[1]	1997	1998	1999	2000	2001	2002[3]	2003	2004	2005
0	17	25	26	4	45	10	9	47	59
HV[2]	43	50	39	16	45	10	5	36	63
50	59	52	50	21	41	8	4	35	56
WP[2]	43	51	66	21	41	9	8	37	60
100	52	56	69	26	39	5	5	32	55
SC[2]	53	54	70	22	42	6	6	36	55
LSD (0.01)*	21	12	5	5	5	3	NS	8	6
CV (%)	26	14	6	16	6	20	70	12	6

* Unless two yields in the same column differ by at least the least significant difference (LSD), there can be little confidence in one being greater than the other.

[1] Nitrogen rate in lb/a.

[2] HV hairy vetch, WP winter pea, SC sweet clover.

[3] Yields severely reduced by hail.

Table 5. Soybean yields after grain sorghum in soybean-wheat-grain sorghum rotation with nitrogen rates, Hutchinson, Kansas.

N	Yield (bu/a)									
Rate[1]	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
0	16	26	22	33	25	7	22	5	53	20
25	17	29	23	35	21	8	22	6	50	19
50	18	30	23	36	23	9	22	6	50	18
75	20	29	24	36	24	8	21	7	51	18
100	22	31	25	37	21	9	21	7	51	19
125	20	25	24	34	22	8	22	7	49	19
LSD (0.01)*	3	7	NS	NS	NS	NS	ns	1.4	5	NS
CV (%)	10	12	6	12	15	13	7	17	6	11

* Unless two yields in the same column differ by at least the least significant difference (LSD), there can be little confidence in one being greater than the other.

[1] N rate in lb/a; N rates are not applied to the soybean plots in the rotation.

Table 6. Grain sorghum yields after wheat in a soybean-wheat-grain sorghum rotation with nitrogen rates, Hutchinson, Kansas.

N	Yield (bu/a)									
Rate[1]	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
0	32	13	57	52	55	15	34	10	86	86
25	76	29	63	67	56	15	41	10	112	90
50	93	40	61	82	54	13	43	9	129	97
75	107	41	60	84	49	9	43	8	136	95
100	106	65	55	77	50	7	46	8	141	101
125	101	54	55	82	49	7	47	9	142	95
LSD (0.01)*	8	13	NS	13	NS	NS	8	NS	9	12
CV (%)	5	18	10	9	10	58	11	24	4	7

* Unless two yields in the same column differ by at least the least significant difference (LSD), there can be little confidence in one being greater than the other.

[1] Nitrogen rate in lb/a.

Table 7. Grain sorghum yields after cover crop in cover crop-grain sorghum-wheat rotation with nitrogen rates, Hutchinson, Kansas.

N	Yield (bu/a)									
Rate[1]	1996	1997	1998	1999	2000	2001	2002[3]	2003	2004	2005
0	73	26	69	81	68	17	22	21	92	84
HV[2]	99	36	70	106	54	17	21	16	138	93
50	111	52	73	109	66	13	25	15	135	90
WP[2]	93	35	72	95	51	19	23	17	138	101
100	109	54	67	103	45	12	25	14	136	89
SC[2]	94	21	72	92	51	19	19	19	94	80
LSD (0.01)*	13	14	NS	21	16	6	NS	5	19	16
CV (%)	8	22	13	12	16	21	20	22	9	10

* Unless two yields in the same column differ by at least the least significant difference (LSD), there can be little confidence in one being greater than the other.
[1] Nitrogen rate in lb/a.
[2] HV hairy vetch, WP winter pea, SC sweet clover.
[3] Yields affected by hot dry conditions in July and bird damage.

EFFECTS OF TERMINATION DATE OF AUSTRIAN WINTER PEA WINTER COVER CROP AND NITROGEN RATES ON GRAIN SORGHUM AND WHEAT YIELDS

W.F. Heer

Summary

The effects of the cover crop most likely were not expressed in the first-year (1996) grain sorghum harvest (Table 8). Limited growth of the cover crop (winter peas), due to weather conditions, produced limited amounts of organic nitrogen (N). Therefore, the effects of the cover crop were limited and varied, compared with those of fertilizer N. The wheat crop for 1998 was harvested in June. The winter pea plots were then planted, and were terminated the following spring, before 1999 grain sorghum plots were planted. The N rate treatments were applied and grain sorghum was planted on June 11, 1999. Winter wheat was again planted on the plots in October 2000 and harvested in June 2001. Winter peas were planted in September 2001 and terminated in April and May 2002. Grain sorghum was planted in June and harvested in October.

During 2003, this area was in sorghum fallow, and the plots were fertilized and planted to wheat in October 2003 for harvest in 2004. The winter pea cover crop was planted into the wheat stubble in the fall of 2004. These plots were terminated as indicated in Table 8, and were planted to grain sorghum in June 2005.

Introduction

There has been a renewed interest in the use of winter cover crops as a means of soil and water conservation, as a substitute for commercial fertilizer, and for the maintenance of soil quality. One of the winter cover crops that may be a good candidate is winter pea. Winter pea is established in the fall, overwinters, produces sufficient spring foliage, and is returned to the soil before planting of a summer annual. Because it is a legume, there is a potential for adding nitrogen to the soil system. With this in mind, research projects were established at the South Central Experiment Field to evaluate the effect of winter pea and its ability to supply N to the succeeding grain sorghum crop, compared with commercial fertilizer N, in a winter wheat-winter pea-grain sorghum rotation.

Procedures

The research is being conducted at the KSU Research and Extension South Central Experiment Field, Hutchinson. The soil in the experimental area is an Ost loam. The site had been in wheat before starting the cover-crop cropping system. The research used a randomized block design and was replicated four times. Cover-crop treatments consist of fall-planted winter peas with projected termination dates in April and May, and no cover crop (fallow). The winter peas are planted into wheat stubble in early September at a rate of 35 lb/a in 10-inch rows with a double disk opener grain drill. Before termination of the cover crop, above-ground biomass samples are taken from a one-square-meter area. These samples are used to determine forage yield (winter pea and other), and forage nitrogen and phosphate content for the winter pea portion. Fertilizer treatments consist of four fertilizer N rates (0, 30, 60, and 90 lb/a N). Nitrogen treatments are broadcast applied as NH_4NO_3 (34-0-0) before planting of grain sorghum. Phosphate is applied at a rate of 40 lb P_2O_5 in the row at planting. Grain sorghum plots are harvested to determine grain yield, moisture, test weight, and grain nitrogen and phosphate content. The sorghum plots are fallowed until the plot area is planted to wheat in the fall of the following year. The fertilizer treatments are also applied before planting wheat.

Results

Winter Pea/Grain Sorghum

Results for winter pea cover crop and grain sorghum were summarized in the Field Research 2000 Report of Progress SRP 854 pages 139-142. The grain sorghum yields by N rate (Table 8) were similar to the wheat yields in the long-term N-rate study. The first increment of N resulted in the greatest change in yield, and the yields tended to peak at the 60-lb N rate treatment, regardless of the presence or lack of winter pea.

Winter Wheat

The fall of 2000 was wet, after a very hot, dry August and September. Thus, the planting of wheat was delayed. Fall temperatures were warm, allowing the wheat to tiller into late December. January and February both had above-normal precipitation. April, May, and June were slightly below normal in both precipitation and temperature. Wheat yields reflected the presence of the winter pea treatments, as well as the reduced yields in the grain sorghum for the no-pea treatment plots. Test weight of the grain was not affected by pea or fertilizer treatment, but was affected by the rainfall at harvest time. This was also true for the percentage of nitrogen in the seed at harvest. A concern with the rotation is weed pressure. The treatment with April-termination pea plus 90 lb/a N had significantly more weeds in it than any of the other treatments. Except for this treatment, there were no differences noted for weed pressure. Grain yield data are presented in Table 9. With the earlier planting for the 2004 crop, the wheat should have had a better chance to tiller, but the fall was wet and cold, limiting fall growth.

As this rotation continues and the soil system adjusts, it will reveal the true effects of the winter cover crop in the rotation. It is important to remember that in the dry (normal) years, the soil water (precipitation) during the growing season most likely will not be as favorable as it was in 1999, and the water use by the cover crop will be the main influence on the yield of succeeding crop.

Table 8. Grain sorghum yield as affected by nitrogen rate, winter pea cover crop, and termination date in a winter wheat-winter pea cover crop-grain sorghum rotation, KSU South Central Field, Hutchinson, Kansas.

		Flag Leaf		Grain												
		1996		1996			1999			2002			2005			
Date	N Rate[1]	N	P	N	P	Yield	N	P	Yield	N	P	Yield	N	P	Yield
	lb/a	%				bu/a	%		bu/a	%		bu/a	%		bu/a
April[2] No/pea	0	2.5	0.38	1.6	0.26	86.5	1.1	0.32	72.6	1.5	0.38	78.4	1.0	0.31	54
	30	2.7	0.44	1.6	0.27	93.9	1.2	0.29	90.9	1.6	0.40	87.5	1.1	0.29	76
	60	2.8	0.43	1.7	0.27	82.6	1.5	0.32	106.4	1.8	0.40	82.8	1.4	0.31	94
	90	2.8	0.44	1.7	0.25	90.4	1.7	0.34	101.8	1.8	0.35	92.5	1.5	0.31	96
April[2] /pea	0	2.4	0.40	1.5	0.29	80.2	1.3	0.31	93.5	1.6	0.37	79.9	1.4	0.29	102
	30	2.7	0.39	1.6	0.26	85.7	1.3	0.32	97.4	1.7	0.38	91.1	1.4	0.31	107
	60	2.7	0.38	1.7	0.27	90.0	1.5	0.33	105.1	1.8	0.40	87.5	1.5	0.31	107
	90	2.9	0.41	1.8	0.23	83.8	1.8	0.32	97.9	2.0	0.37	77.2	1.6	0.32	98
May[3]	0	2.1	0.39	1.4	0.30	81.4	1.1	0.34	40.5	1.6	0.41	56.4	1.1	0.31	67
	30	2.4	0.39	1.5	0.28	88.1	1.1	0.32	66.6	1.7	0.40	71.6	1.1	0.30	92
	60	2.6	0.40	1.6	0.27	90.7	1.2	0.30	93.3	1.8	0.40	71.4	1.2	0.31	95
	90	2.6	0.40	1.6	0.26	89.6	1.4	0.31	105.9	1.9	0.40	82.6	1.4	0.33	95
May[3] /pea	0	2.3	0.40	1.4	0.29	85.0	1.2	0.31	92.4	1.7	0.39	74.8	1.4	0.31	95
	30	2.5	0.40	1.5	0.31	92.4	1.3	0.31	97.7	1.8	0.38	81.5	1.5	0.30	98
	60	2.6	0.38	1.6	0.26	92.9	1.5	0.30	112.3	1.9	0.36	86.8	1.6	0.30	91
	90	2.7	0.41	1.6	0.25	90.5	1.5	0.32	108.7	1.8	0.39	90.3	1.6	0.31	98
LSD (P=0.05)		0.2	0.02	0.1	NS	8.9	0.2	0.04	16.0	0.14	0.05	14.0	0.11	0.02	15

[1] Nitrogen applied after winter pea termination, before planting grain sorghum.
[2] Early April termination. Actual termination May 16, 1996, April 21, 1999, April 13, 2002, and April 27, 2005.
[3] Early May termination. Actual termination June 4, 1996, May 19, 1999, May 25, 2002, and May 18, 2005.

Table 9. Winter wheat yield after grain sorghum as affected by nitrogen rate, winter pea cover crop, and termination date in a winter wheat-winter pea cover crop-grain sorghum rotation, KSU South Central Field, Hutchinson, Kansas.

Termination Date	N Rate[1]	Grain Yield 2001	Grain Yield 2004	Grain N 2001	Grain N 2004	Grain P 2001	Grain P 2004	Plant Height 2001	Plant Height 2004	Lodging 2004	Weeds 2001
	lb/a	bu/a		%				inch		%	rating[2]
April[3] N/pea	0	37	58	2.32	1.73	0.38	0.38	26	31	0	3
	30	40	56	2.43	1.94	0.36	0.36	28	29	3.8	5
	60	39	51	2.30	2.23	0.38	0.34	30	30	17.5	4
	90	37	44	2.24	2.27	0.38	0.35	30	29	35.0	7
April[3] /pea	0	39	58	2.38	1.89	0.35	0.38	26	29	3.8	3
	30	42	55	2.33	1.97	0.37	0.34	27	32	8.8	4
	60	36	50	2.22	2.23	0.40	0.33	29	31	37.5	7
	90	37	47	2.18	2.46	0.37	0.32	28	30	60.0	10
May[4] N/pea	0	38	57	2.30	1.79	0.37	0.36	26	30	1.3	3
	30	38	53	2.32	2.13	0.37	0.34	26	30	32.5	5
	60	34	46	2.42	2.30	0.35	0.35	30	30	46.3	7
	90	38	44	2.24	2.37	0.35	0.35	30	30	50.0	8
May[4] /pea	0	42	60	2.37	1.91	0.40	0.36	26	30	3.8	4
	30	37	50	2.38	2.19	0.38	0.35	28	30	27.5	6
	60	35	45	2.38	2.33	0.37	0.33	29	30	42.5	9
	90	37	45	2.34	2.42	0.38	0.34	28	30	42.5	10
LSD (P=0.05)		5	6	0.18	0.12	0.03	0.03	2	1	24	3

[1] Nitrogen applied as 34-0-0 before planting winter wheat.
[2] Visual rating 1= few to 10=most. Insufficient weeds were present in 2004 to rate.
[3] Early April termination.
[4] Early May termination. There was minimal lodging in 2001.

EVALUATION OF SPRING SMALL GRAINS FOR THE PRODUCTION OF GRAIN AND FORAGE

V. L. Martin and W.F. Heer

Summary

Hard red winter wheat is the predominant small grain cereal in Kansas, with climatic requirements typical of conditions in the state in May and June. Spring cereals (oat, wheat, and triticale) mature later than winter wheat, and this often results in reduced grain yields and test weights. But spring cereals are an excellent potential source of forage as pasture, hay, or silage, and are an important niche forage for producers during the spring. In addition, the grain, although not possessing a significant market, is well-suited as feed on a local basis.

The purpose of this study is to evaluate the forage and grain yield potential of spring oat, wheat, and triticale, particularly new varieties, in South-Central Kansas. This test also provides information for producers interested in spring wheat as a potential substitute for winter wheat. Conditions for growth and development in 2005 were cooler and wetter than normal. These conditions resulted in excellent forage yields for most varieties, despite delayed planting due to wet conditions. Oat grain yield and test weight were acceptable for the area. Spring triticale and wheat matured significantly later than oat, and a severe storm lodged and shattered the triticale and wheat grain before harvest.

Introduction

Spring cereal grains, predominantly oat, originally were planted in Kansas as feed for livestock, especially horses. But hot, dry conditions common in late May and June typically reduce yields and test weights significantly. Therefore, as on-farm livestock disappeared, so did spring cereal acreage. Although conditions are not conducive for grain production, spring weather often is favorable for the production of forage. With the development of new, hardier spring oat, triticale, and wheat varieties, the potential exists for grain production suitable for off-farm marketing.

These spring cereals can provide a valuable bridge forage for livestock producers during a time of year when perennial pastures are often not ready for livestock, hay and silage are scarce, or forage is expensive. The grain also provides suitable livestock feed.

Procedures

Research was conducted at the South Central Experiment Field, Hutchinson, on an Ost loam. The site was fallowed during 2004 with the following tillage operations: moldboard plow - August 9, 2004, tandem disk - September 7, 2004, pre-plant field cultivation - March 9, 2005. Fertilizer was applied as follows: 75 lb/a N as urea (46-0-0) broadcast on October 2, 2004, and 50 lb/a N as urea broadcast on March 7, 2005. No post-emergence herbicides were applied.

Spring cereals were divided into two tests, spring oat varieties and spring wheat plus spring triticale varieties. Plots were planted in a randomized complete-block design, with four replications. Each test was planted twice, with one set of plots for forage harvest and one for grain. Eighteen oat, three triticale, and seven hard red spring wheat varieties were planted. Jagger winter wheat was used for comparison in the spring wheat/triticale test.

Each plot was 35 ft X 5 ft, consisting of six rows, eight inches apart and planted with a plot drill. Seeding rate was two bu/a. All plots were planted on March 9. Planting was delayed due to wet soil conditions. Forage was harvested with a Carter plot forage harvester and a harvest area of 15 ft X 3 ft. Total wet weight was determined and a sub-sample was taken to determine forage moisture. Forage yields were determined on a dry- weight basis. Forage yields were determined on June 2, 2005.

Oat grain yields were determined with a Gleaner E plot combine and a harvest area of 30 X 5ft. Sub-samples were taken to determine grain moisture, and yields were adjusted to 12.5% moisture. Grain harvest was June 28, 2005. A severe storm prevented harvest of triticale and spring wheat.

Results

Winter and spring conditions during 2005 were much wetter than normal and quite mild. Although this resulted in delayed planting, it also provided excellent conditions for crop development. A late-April freeze severely damaged the oat variety CHD-2301-SO and resulted in moderate leaf damage on most other oat varieties. Triticale and wheat varieties suffered little visual damage. Above-normal precipitation in May and early June delayed grain maturity and forage harvest.

Oat forage yields averaged more than four tons per acre (Table 10), with a range of 5696 to 9672 lb/a. Typical recommendations for Kansas indicate that oat varieties with the highest grain yield produce the most forage. In 2005, however, this was not true. This may be partly a result of the abnormally mild, wet conditions. Another factor is the introduction of oat varieties developed specifically for forage production and specifically bred for later maturity to maximize forage production. Forage Plus from Wisconsin and Reeves are examples of this. Grain yields were quite good considering the late planting, and averaged 51 bu/a (Table 10). Two varieties, Forage Plus and CHD-2301-SO had grain yields that were only 20% of the test average. Both are later-maturing, forage-type oat that were more severely affected by the late freeze.

Spring wheat and triticale dry matter yields averaged approximately 2,400 lb/a less than yields of spring oat (Table 11). Triticale forage yields were superior to those of spring wheat. Jagger forage accumulation was essentially zero due to severe plant-disease pressure. Spring wheat exhibited symptoms of rust and other disease pressure, whereas the three triticale varieties were unaffected. The spring-planted winter triticale (EH-DP-WT) was second in overall dry matter production. As stated earlier, a severe storm destroyed the grain plots before harvest. These two trials are continuing in 2006.

Table 10. Spring oat dry matter (forage) and grain yield and test weights, 2005, Hutchinson, Kansas.

Variety	Dry Matter Yield	Grain Yield	Test Weight
	lb/a	bu/a	lb/bu
Bates	7713	51.6	28.6
Blaze	9672	52.4	29.5
Chaps	7640	64.0	28.7
CHD-2301-SO	5696	10.2	18.2
Dane	7387	57.6	26.8
Don	6769	57.0	30.6
Esker	9206	57.5	27.2
Forage Plus	8451	12.3	17.8
Gem	9395	49.1	27.4
INO9201	8964	58.6	28.7
Jay	7726	55.1	30.2
Jerry	8368	52.5	28.1
Jim	8407	60.1	29.9
Moraine	8134	58.2	28.1
Ogle	8013	56.7	28.0
Reeves	8145	46.4	28.6
Richard	9227	45.5	24.4
Spurs	7917	66.6	29.4
Mean	8124	50.6	27.3
LSD (.05)*	1577	11.9	2.66

*Unless two values within a column differ by more than the least significant difference (LSD), there can be little confidence in one being greater than the other.

Table 11. Spring wheat and triticale dry matter (forage), 2005, Hutchinson, Kansas.

Variety	Grain[1]	Dry Matter Yield
		lb/a
Jagger	HRWW	0
Briggs	HRSW	6612
Forge	HRSW	6230
Granger	HRSW	6043
Ingot	HRSW	5675
Oxen	HRSW	5868
Russ	HRSW	6242
Walworth	HRSW	5882
EH-DP-WT	WT	6793
CHD-400	ST	6364
EH-P-ST	ST	7027
Mean		5703
LSD (.05)*		978

[1] HRWW (Hard Red Winter Wheat); HRSW (Hard Red Spring Wheat); WT (Winter Triticale); ST (Spring Triticale).
*Unless two values within a column differ by more than the least significant difference (LSD), there can be little confidence in one being greater than the other.

EFFECTS OF ROW SPACING AND SEEDING RATE ON SUMMER ANNUAL FORAGE DRY MATTER YIELD

V.L. Martin and W.F. Heer

Summary

Although traditional summer annual forages have long been a crop produced in Kansas, relatively little work has been done to optimize total production and feed quality. Typical growing-season conditions allow for adequate production of vegetation but often negatively impact grain production without irrigation. Summer annual forages (e.g., forage sorghum, sudan grass, pearl millet, and sorghum X sudan hybrids) are an underutilized source of feed for both beef and dairy production.

The objective of this research is to determine the effect of cultural practices on the forage yield and quality of traditional summer annual forages produced in Kansas. The effects of seeding rate and row spacing were examined for six common summer annual forages. Headless and fertile forage sorghum dry matter yields were highest, whereas those of the sorghum sudan grass were significantly lower. A seeding rate of eighteen lb/a resulted in the highest average dry matter yields. Individual forage response to seeding rate varied. Even with less-than-optimal conditions and delayed planting, dry matter yields averaged more than 5 tons per acre.

Introduction

Summer annual forages occupy a small but important niche for producers in Kansas, especially for beef production. These forages are fed as hay and silage, and are grazed, with haying being the most common. They typically are stockpiled for periods when pasture is limiting or weather is severe. Grain production is not the primary goal with these crops, so weather conditions normally allow for adequate production of dry matter. Within the last few years, the development of Brown Mid Rib (BMR) forages has improved the quality and palatability of the forages.

With the price of fuel and fertilizer increasing, evaluating Best Management Practices (BMP) for traditional summer annual forages will provide information to optimize dry matter production and forage quality. Once determined, these BMP can be adopted across the range of summer annual forages, allowing for significant improvements in rate of gain and time to finish.

Procedures

Research was conducted at the South Central Experiment Field, Hutchinson, on an Ost loam. The site was in sunflower production during 2004, with the following tillage operations before planting: tandem disk - April 15, 2005, field cultivation - April 19, 2005. Fertilizer was applied as follows: 100 lb/a N as urea (46-0-0) broadcast on July 22, 2005. Buctril (1.5 pt/a) was applied for puncture vine control July 23, 2005.

Excessive precipitation in May and June caused the abandonment of the planting-date study and a delay in planting the other three studies until late June/early July. The other three studies each consisted of a randomized complete-block design with four replications, planted using forages as listed in Table 12.

Each plot was 35ft X 5 ft, consisting of six rows, eight inches apart and planted with a plot drill, with the exception of the nitrogen-rate study, which was planted with a Marliss no-till drill with 10-inch centers and plot dimensions of 10 ft X 30 ft. Forages were harvested with a Carter forage harvester and a harvest area of 10 ft X 3 ft. Total wet weight was determined and a sub-sample was taken to determine forage moisture. Non-replicated sub-samples were analyzed to determine potential nitrate toxicity and relative feed value. Forage yields were determined on a dry-weight basis. Forage yields were determined on September 29 and 30.

Nitrogen Rate Study: N rates applied were 0, 50, 100, and 150 lb/a N as urea. Pearl millet (10 lb/a), sterile sorgo X Sudan grass hybrid (18 lb/a), and fertile forage sorghum (18 lb/a) were planted on July 1 and harvested October 20.

Seeding Rate Study: Forages were planted on July 8 at 6, 12, 18, and 24 lb/a seed, and were harvested on September 29.

Row Spacing Study: Forages were planted in 8- and 16-inch rows on July 8 and were harvested on September 29.

Results

Spring/early summer conditions were much wetter than normal and resulted in significantly delayed planting. A severe storm two days after planting significantly decreased emergence of forages planted for the N-rate study, and caused abandonment of the pearl millet plots. Nitrogen rate had no effect on forage dry matter accumulation (Table 13); there was a slight increase in nitrate levels in the forage as the N rate increased. This is probably due to uneven stands, weed pressure, and significant rainfall shortly after nitrogen application.

Forage yields were significantly affected by seeding rate (Table 14 and 15). The only forage unaffected by seeding rate was pearl millet; this is not unusual, with its growth habit and ability to tiller. The two forage-type sorghums responded positively to increased seeding rate, but not as strongly as sorghum sudan grass and the two hybrids. Overall, except for the pearl millet, the optimal seeding rate in 2005 for later planting was approximately 18 lb/a. Overall, forage yields were not significantly different among the forages, with the exception of the sorghum sudan grass. This is not unusual, based on the growth habit of this forage and the fact that it is a BMR type, which tend to yield less than conventional types, but are of much better quality. Yields for both the pearl millet and sorghum sudan grass would likely have increased with earlier planting and multiple cuttings.

Row spacing had no significant effect on dry matter accumulation (Table 16). Overall, increasing row spacing slightly decreased forage yield. Forage sorghums typically are planted in 30-inch rows, but these studies indicate that decreasing row spacing does not negatively affect yield. Narrow row spacing would help control weed pressure often common in forage sorghums and also would decrease stalk diameter.

These studies, in addition to several others, are continuing to help determine BMP for summer annual forage production.

Table 12. Summer annual forage research entries, 2005, Hutchinson, Kansas.

Name	Description	Seeds/lb
Pro-Mil	Hybrid Pearl Millet	79,000
BMR44S	Brown Midrib Sorghum Sudan Grass	14,500
Sweetleaf II	Sterile Sorgo/Sudan Grass Hybrid	21,000
800HS	Headless Forage Sorghum	21,300
Nutri-Cane II	Sterile Sorgo X Sorgo Forage Hybrid	23,900
Nutri-Ton II	Fertile Forage Sorghum	17,600

Table 13. Summer annual forage dry matter yield as affected by nitrogen fertilizer rate, 2005, Hutchinson, Kansas.

Forage	Nitrogen Fertilizer Rate	Dry Matter Yield
	lb/a	t/a
Sorgo/Sudan Grass Hybrid	0	3.9
	50	4.2
	100	4.6
	150	4.1
Sorgo X Sorgo Forage Hybrid	0	5.2
	50	4.5
	100	4.1
	150	4.5
Mean		4.4
LSD (.05)*		NS
Nitrogen rate across forage		
0		4.6
50		4.3
100		4.4
150		4.3
LSD (.05)*		NS

*Unless two values within a column differ by more than the least significant difference (LSD), there can be little confidence in one being greater than the other. NS - Not Significant at the 5% level.

Table 14. Summer annual forage dry matter yields as affected by forage type X seeding rate, 2005, Hutchinson, Kansas.

Forage	Seeding Rate	Dry Matter Yield
	lb/a	t/a
Pearl Millet	6	5.60
Pearl Millet	12	5.45
Pearl Millet	18	5.76
Pearl Millet	24	5.52
Sorghum Sudan Grass	6	3.38
Sorghum Sudan Grass	12	3.75
Sorghum Sudan Grass	18	4.26
Sorghum Sudan Grass	24	4.83
Sorgo/Sudan Grass Hybrid	6	4.75
Sorgo/Sudan Grass Hybrid	12	5.73
Sorgo/Sudan Grass Hybrid	18	5.38
Sorgo/Sudan Grass Hybrid	24	6.04
Headless Forage Sorghum	6	5.75
Headless Forage Sorghum	12	5.96
Headless Forage Sorghum	18	6.28
Headless Forage Sorghum	24	6.28
Sorgo X Sorgo Forage Hybrid	6	4.41
Sorgo X Sorgo Forage Hybrid	12	5.94
Sorgo X Sorgo Forage Hybrid	18	6.38
Sorgo X Sorgo Forage Hybrid	24	5.10
Fertile Forage Sorghum	6	5.34
Fertile Forage Sorghum	12	5.34
Fertile Forage Sorghum	18	6.11
Fertile Forage Sorghum	24	6.07
Mean		5.39
LSD (.05)*		1.22

*Unless two values within a column differ by more than the least significant difference (LSD), there can be little confidence in one being greater than the other.

Table 15. Summer annual forage dry matter yield, 2005, Hutchinson, Kansas.

Factor	Dry Matter Yield
	t/a
Forage	
Pearl Millet	5.58
Sorghum Sudan Grass	4.05
Sorgo/Sudan Grass Hybrid	5.47
Headless Forage Sorghum	6.07
Sorgo X Sorgo Forage Hybrid	5.46
Fertile Forage Sorghum	5.72
LSD (.05)*	0.75
Seeding Rate (lb/a)	
6	4.87
12	5.36
18	5.70
24	5.64
LSD (.05)*	0.45

*Unless two values within a column differ by more than the least significant difference (LSD), there can be little confidence in one being greater than the other.

Table 16. Summer annual forage dry matter yields as affected by forage type X row spacing, 2005, Hutchinson, Kansas.

Forage	Row Spacing	Dry Matter Yield
	inches	t/a
Pearl Millet	8	4.08
Pearl Millet	16	4.24
Sorghum Sudan Grass	8	4.90
Sorghum Sudan Grass	16	4.02
Sorgo/Sudan Grass Hybrid	8	5.38
Sorgo/Sudan Grass Hybrid	16	4.80
Headless Forage Sorghum	8	5.57
Headless Forage Sorghum	16	5.07
Sorgo X Sorgo Forage Hybrid	8	4.18
Sorgo X Sorgo Forage Hybrid	16	4.20
Fertile Forage Sorghum	8	4.70
Fertile Forage Sorghum	16	4.78
Mean		4.66
LSD (.05)*		1.09

*Unless two values within a column differ by more than the least significant difference (LSD), there can be little confidence in one being greater than the other.

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NORTHWEST KANSAS RESEARCH - EXTENSION

COUNTY COMPARISONS OF NO-TILL TO TILLED WHEAT IN NORTHWEST KANSAS

B.L.S. Olson and J.S. Falk

Summary

Many farmers in western Kansas are evaluating whether to move their farming operation completely to a no-till system. These farmers are asking many questions. Is there a yield drag from no-till? Are wheat varieties impacted adversely when grown in a different tillage system? A multi-site side-by-side comparison study of tilled to no-till wheat was setup across Northwest Kansas to address these questions. No-till wheat yields were 7 bu/a higher than those from wheat planted into tilled fields. In addition, wheat varieties were not impacted differently across tillage systems which is good news for farmers when they go to choose a variety. Therefore, farmers can assess yield from performance tests and disease ratings and not worry whether the wheat variety will be adversely affected by the tillage system.

Introduction

Many farmers in western Kansas who are already using no-till production practices for their summer crops are evaluating whether to move their farming operation to a no-till system. This move would involve planting winter wheat into no-till fields. Concerns over a possible reduction in yield or possible differences in how wheat varieties may be affected by a different tillage system are all factors farmers are considering. However, as wheat drills need to be replaced, input costs such as diesel continue to rise, and glyphosate continues to decrease in price, more farmers are willing to change their production system.

Therefore, the objectives of this study were to evaluate wheat yield from multiple on-farm side-by-side comparisons assessing wheat planted no-till to wheat planted on tilled ground under various environments across Northwest Kansas, and to evaluate any difference in wheat varietal response to the two tillage systems.

Procedures

Multiple on-farm comparisons sites were located across Northwest Kansas. At each site, a 150 ft wide by 250 ft long section was marked for the no-till plot. After all tillage operations were completed a second 150 ft by 250 ft long section was marked for the tilled plot. Crop rotations varied across county sites with the following rotations recorded: wheat/corn/fallow - Wallace, Thomas, Decatur; wheat/grain sorghum/fallow - Phillips, Ellis, Sheridan, Gove, Trego; wheat/wheat - Rooks, Mitchell; wheat/fallow - Cheyenne, Sherman, Rawlins; wheat/soybean/wheat/fallow - Smith. Weed control on the no-till plots at each site was either applied by K-State faculty, the farmer cooperator, or elevator agronomists with glyphosate with or without 2,4-D or dicamba as the standard herbicide treatment. In tilled plots, the ground was typically worked with a field cultivator two to three times and a disc once before planting. Any fertilizer was applied according to wheat needs at each location and was applied at the same rate across tillage systems. For the no-till plots, fertilizer was injected across a majority of the sites, while on the tilled plots, the fertilizer was either injected or broadcast applied.

Six varieties were planted in both tillage systems across all sites. These varieties were Jagger, 2137, Jagalene, Cutter, T-81, and Stanton. A 6 ft Great Plains no-till drill seeded the wheat in both tillage systems at a rate of

85 lbs/a. Two passes were used for each variety, so each varietal plot within each tillage system was 12 ft by 250 ft. At four of the locations (Decatur, Sheridan, Gove, and Trego), an additional eight varieties and one blend were added: TAM 111, NuHills, Wesley, Overley, Dominator, Millennium, Thunderbolt, Trego, and a blend of Jagger/2137/T-81.

In March, soil moisture and temperature data loggers were placed at four locations (Decatur, Sheridan, Thomas, and Gove) to record soil moisture at the 6 and 18 inches along with soil temperature at 1 and 12 inches. Soil moisture in centibars and temperature in degrees Celsius was collected until mid-June. Data was downloaded and graphed. At harvest, plots were harvested with the assistance of the local cooperator, weighed with a weigh wagon, and subsamples were collected for test weight and moisture. All data was analyzed using SAS with each location representing a replication. Five sites were eliminated from the analysis due to the following reasons: Sherman and Smith had crop failures, Ellis and Rooks had management problems with fertilizer application, and Cheyenne had low and highly variable wheat yields.

Results

Results from the nine county sites are in Table 1. Variability across the sites is evident with wheat yields ranging from the mid-30's to low-70's in bu/a. When evaluating the average wheat yield across the six varieties, no-till yielded more at seven locations and tilled wheat yielded more at one site with the two systems yielding the same at the last site. When analyzing across variety, tillage system, and location, no-till yielded 58 bu/a and tilled wheat yielded 51 bu/a with an LSD (0.05) at 4.6 bu/a.

A reason for the increased yield in no-till may be related to the higher soil moisture content that was observed at the four locations that had the soil moisture and temperature sensors. Even though no difference were observed for soil moisture at 6 inches or soil temperature and 1 and 12 inches, soil moisture was greater at 18 inches in the no-till systems compared with the tilled system. The composite average for soil moisture from each tillage system is displayed in Fig. 1. Greater soil moisture at the 18 inch depth likely allowed for increased number of spikelets to survive and produce grain, thus increasing yield.

When evaluating differences in varietal response to the two tillage systems, no yield difference was observed for the fourteen varieties and one blend planted at four sites across tillage systems (Table 2), or the six varieties planted at nine locations across tillage systems (Table 3).

In conclusion, no-till wheat yields from the various side-by-side comparison across Northwest Kansas were higher than those from wheat planted into tilled fields. In addition, wheat varieties were not impacted differently across tillage systems which is good news for farmers when they go to choose a variety. Therefore, farmers can assess yield from performance tests and disease ratings and not worry whether the wheat variety will be adversely affected by the tillage system.

Acknowledgments

The assistance and cooperation from all the area farmers where these on-farm sites were located to the many county agents that assisted with these comparisons to the financial support provided by the Kansas Wheat Commission allowed for this study to be completed is acknowledged and appreciated.

Table 1. County wheat yields, Northwest Kansas.

Variety	Tillage	Lincoln	Trego	Sheridan	Rawlins	Wallace	Decatur	Gove	Thomas	Phillips
		---bu/a--								
Jagger	NT	43	63	68	47	62	62	73	75	65
Jagalene	NT	41	64	77	47	57	63	81	67	72
Cutter	NT	46	52	72	41	62	64	71	67	65
2137	NT	45	52	51	31	41	55	66	69	50
Stanton	NT	37	38	60	39	52	60	65	65	58
T-81	NT	41	56	76	51	54	59	72	69	62
	AVG	42	54	67	43	55	60	71	69	62
Jagger	CT	40	63	57	48	63	58	63	45	55
Jagalene	CT	40	52	68	48	58	63	68	36	67
Cutter	CT	36	45	68	51	76	60	64	19	60
2137	CT	40	51	40	37	40	54	54	30	52
Stanton	CT	26	36	46	43	41	57	57	28	54
T-81	CT	30	49	75	46	54	55	70	42	67
	AVG	**35**	**50**	**59**	**46**	**55**	**58**	**63**	**33**	**59**

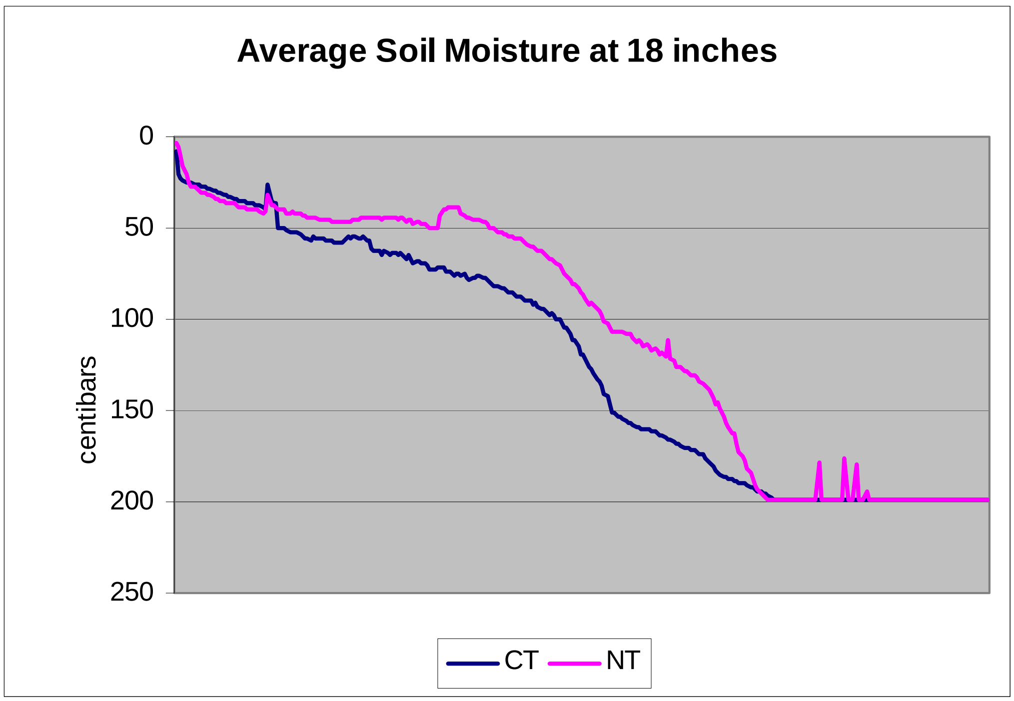


Figure 1. Soil moisture at 18 inches across four locations in Northwest Kansas.

Table 2. No variety response by tillage system was evident at the four locations the 14 varieties and one blend were planted in Northwest Kansas.

Variety	bu/a
TAM 111	73
Jagalene	67
NuHills	66
T-81	64
Jagger	64
Wesley	62
Overley	62
Cutter	62
Dominator	60
Jagger/2137/T-81	58
Millennium	58
Thunderbolt	56
2137	53
Stanton	52
Trego	51
LSD (0.05)	9.5

Table 3. No variety response by tillage system was evident at the nine locations the 6 varieties were planted in Northwest Kansas.

Variety	bu/a
Jagalene	60
T-81	58
Jagger	57
Cutter	57
Stanton	48
2137	48
LSD (0.05)	7.5

DRYLAND STRIP-TILL IN WESTERN KANSAS

B.L.S. Olson and R. Aiken

Summary

Interest in strip-till has risen over the past few years. Questions about whether strip-till is beneficial on dryland fields is a major concern for producers in western Kansas evaluating this process. To provide answers to some of these questions, a farmer assisted field study was initiated in the fall of 2003. The objectives of this research were to compare no-till to strip-till fertilizer treatments applied at various timings. No response to strip-till was observed with grain sorghum in 2004 and 2005. Grain sorghum root development was more likely influenced by soil moisture than tillage system. For sunflower, a spring applied liquid strip-till and winter applied anhydrous ammonia strip-till yielded more than no-till over both years. Sunflower root development was probably more influenced by tillage than by soil moisture.

Introduction

Strip-till is a tillage process by which a six- to ten-inch strip of ground is tilled. The basic configuration consists of a coulter, disks, and a sub-surface knife for injecting fertilizer. Questions from farmers about whether dryland strip-till is a viable production option in Northwest Kansas have arisen over the past few years. Some of the benefits to strip-till may include warming of the ground in the spring which provides an ideal environment for seedling crops and destruction of compaction zones which are prevalent in western Kansas fields. By working the ground, however, moisture loss could negate any benefit strip-till could provide on dryland fields. Therefore, the objectives of this research were to compare no-till to strip-till fertilizer treatments applied at various timings.

Procedures

A two year farmer assisted field research study was conducted on fields of wheat stubble ½ mile east of Quinter, KS. In 2004, previous cropping history indicated the field had been no-till for the previous five years, whereas, for the 2005 site, the previous cropping history indicated the field had been no-till for the previous four years. Treatment 1 consisted of a fall applied strip-till treatment of 50 lb/a of nitrogen (N) applied as 28% UAN which was strip-tilled on December 1, 2003 and December 13, 2004. Treatment 2 consisted of anhydrous ammonia strip-tilled on January 23, 2004 and December 13, 2004 at 50 lb/a of N. For Treatment 3, 50 lb/a of N applied as 32% UAN was strip-tilled on April 19, 2004 and April 27, 2005. At planting, an additional 25 lb/a of N was applied as urea in a 2x2 (two inches over from the planted row and two inches in the soil) for all strip-till treatments. For Treatment 4 (the no-till treatment), 75 lb/a of N was applied as urea in a 2x2 at planting. All treatments had a total of 75 lb/a of N applied. Plot size was 8- to 30-inch rows wide by 600 feet long. Treatments were randomized across three replications for each crop. DeKalb DKF 3880 CL (sunflower) was planted on May 28, 2004 at 17,300 seeds/a and May 20, 2005 at 18,900 seeds/a. Appropriate pest management measures were taken to control weeds and head moth in the sunflower. Grain sorghum (NC+ 5B89) was planted on May 28, 2004 at 51,800 seeds/a and May 20, 2005 at 55,000 seeds/a. Plots were harvested on October 9, 2004 and October 7, 2005.

In 2004, the site had higher than normal average rainfall for the period of April to September (2004 - 20.51 inches, Average - 17.79 inches). The higher than average rainfall along with cooler than normal temperatures for June and July allowed for adequate moisture to be available to meet the needs of the crops even though the crops were planted on eighteen inches of subsoil containing available moisture.

In 2005, rainfall was near normal for the growing season with adequate subsoil moisture available at planting.

Root measurements were taken on five randomly selected plants from each plot after grain harvest. Roots were extracted carefully from the soil for Treatment 2 and 4 for grain sorghum and Treatment 3 and 4 for sunflower. Roots were then washed, tagged, and air dried.

Root scores were obtained by evaluating all of the roots from the plot. For sunflower, taproot mass was assessed on a scale of 1 to 5 with 1 equal to greatest taproot mass and 5 equal to least taproot mass. Straightness of taproot was gauged on a scale of 1 to 5 with 1 equal to very straight while 5 equals significant turning. For grain sorghum, root mass was assessed on a scale of 1 to 5 with 1 equal to greatest root mass and 5 equal to least root mass. Straightness of root mass was gauged on a scale of 1 to 5 with 1 equal to very straight while 5 equals significant turning. Lateral roots were scored on a scale of 1 to 5 with 1 equal to abundant lateral roots and 5 equal to sparse lateral roots, while secondary roots were evaluated on a scale of 1 to 5 with 1 equal to abundant and 5 equal to sparse.

Results

Results from 2004 and 2005 suggest a benefit to strip-tilled sunflower compared to no-tilled sunflower, while there were no differences observed for grain sorghum. With sunflower, two of the three strip-till treatments yielded more than no-till when results were combined across years (Table 4). The number of plants per acre were higher in these treatments compared to no-till in 2004 while the difference in population between strip-till treatments compared with no-till is not as dramatic in 2005. Higher numbers of seedling survival may be one reason why strip-till yielded more.

Another reason for the higher yields for the strip-till treatments could be better root development (Table 5). Roots examined from the strip-till treatment had straighter roots with more lateral and secondary root growth than those extracted from the no-till treatment. Although the field had been in no-till prior to the study for four to five years, root growth was still impeded which in turn likely affected yield.

For grain sorghum, there was no difference in grain yield (Table 6). Root measurements in 2004 indicated root mass and straightness of the root mass was higher in the strip-till treatment, whereas there was no difference in root development for straightness, mass, laterals, and secondary roots in 2005 (Table 7). The difference in development between the two years possibly could be explained by the difference in soil conditions at planting. The increased straightness of root mass with more root mass in the 2004 strip-till treatment was probably due to the grain sorghum root more easily exploring the loosened soil in the strip-till treatment versus the no-till treatment. In 2005, however, soil moisture was prevalent the first few weeks after planting which probably allowed for roots in both treatments to adequately develop.

In summary, there was a positive response to strip-tilling sunflower with Treatment 2 and 3 yielding more than Treatment 4 (no-till) over both years. Sunflower root development was more likely influenced by tillage than by soil moisture. For grain sorghum, no response to strip-till was observed in either 2004 or 2005. Grain sorghum root development was probably more influenced by soil moisture than tillage system.

Table 4. Sunflower yield, Quinter, Kansas, 2004 and 2005.

Trts.	Tillage	Test weight	Population (plts/a) 2004	2005	lbs/a adj. 10.0% moisture
2	Strip-till	29.6	12900	18000	2225
3	Strip-till	28.9	15700	17500	2218
4	No-till	29.8	11200	16500	2008
1	Strip-till	29.4	13600	16800	1984
	LSD (0.05)	NS	1084		167

Table 5. Sunflower root scores , Quinter, Kansas, 2004 and 2005.

Trts	Tillage	Root Mass	Tap Root Straightness	Lateral Roots	Secondary Roots
3	Strip-till	2.9	1.9	2.1	2.4
4	No-till	2.9	3.1	3.0	3.3
	LSD (0.05)	NS	0.77	0.48	0.55

Table 6. Grain sorghum yield, Quinter, Kansas, 2004 and 2005.

Trts	Tillage	Test weight	bu/a adj. 14.0% moisture
1	Strip-till	56.7	114
4	No-till	56.4	113
2	Strip-till	56.2	113
3	Strip-till	55.7	111
	LSD (0.05)	NS	NS

Table 7. Grain sorghum root scores, Quinter, Kansas, 2004 and 2005.

Trts	Tillage	Root Mass		Root Mass Straightness		Lateral Roots		Secondary Roots	
		2004	2005	2004	2005	2004	2005	2004	2005
2	Strip-till	1.3	3.3	1.3	3.1	1.3	3.0	1.3	3.1
4	No-till	4.0	3.0	3.0	2.6	2	2.7	2	2.7
	LSD (0.05)	1.85	NS	0.93	NS	NS	NS	NS	NS

PMDI FIELD TEST RESULTS FROM SHERIDAN COUNTY

B.L.S. Olson and D. Rogers

Introduction

Precision mobile drip irrigation is an irrigation system where drip hoses are attached to a center pivot sprinkler and drug on top of the ground. The placement of water by the hoses on the ground could potentially increase irrigation efficiency over a standard drop nozzle system. In addition, problems associated with wet wheel tracks should be reduced. Drag hoses lying on the ground, however, could cause more management concerns for farmers. One example would be animal damage to the drip hoses which disrupts uniform water distribution.

The objectives of this study were to compare yield from corn irrigated using precision mobile drip irrigation (PMDI) to sprinkler irrigation with drops (drop nozzle). The second objective was to discern if the emitters have a reduction in water flow over the season due to clogging. Figure 2 is a sprinkler with the drag hoses attached.

Procedures

The study was initiated on a center pivot sprinkler located seven miles north and three miles west of Hoxie, KS. Cooperation from DLS Farms was very important to evaluating these two application methods. Three spans, spans 4, 5, and 7, of an eight span center pivot sprinkler were divided into two sections. Each section had either the PMDI system installed or the standard drop nozzle system. With this configuration, three replications of each method were achieved for a total of six plots. The center pivot sprinkler is nozzled to apply 300 gpm. Drag hose spacing on the PMDI system was 60 inches, whereas the spacing on the drop nozzle system was 120 inches. The entire flow to the center pivot was screen filtered to 50 mesh.

For the 2004 growing season, the farmer strip-tilled the field the previous fall and applied 75 lb/a of nitrogen (N) as anhydrous ammonia and 7-25-0 lb/a as 10-34-0. The field was planted on May 2, 2004 in circular rows with Mycogen 2E685 treated with Cruiser at 26,000 seeds/a with 50 lb/a of N as 32% UAN applied in a 2x2. Appropriate pest management measures were taken to control weeds and insects.

For the 2005 growing season, manure was applied to the field, and then the field was strip-tilled in the fall. On April 28, 2005 Mycogen 2E762 treated with Cruiser was seeded in straight noncircular rows at 26,000 seeds/a with 50 lb/a N as 32% UAN applied in a 2x2. Appropriate pest management measures were taken to control weeds and insects.

Emitter water flow at the end emitter and then the 5, 10, and 15 emitter from the end of two drag hoses from each plot were captured for one minute on May 26, August 4, and September 13 in 2004 and May 27, July 29, and September 8 in 2005. Water flow for the entire drag hose was collected for the two drag hoses along with the water flow from two drop nozzles on the same span.

Corn yield was collected in two ways. First, samples were hand harvested from forty feet of each plot. Samples were then dried, threshed, weighed, and yield was calculated on a bu/a basis. Yield was also collected at harvesting using a Green Star yield monitoring system for the entire field.

Results

Weather conditions over the summer brought supplemental rainfall which allowed for respectable yields to be achieved at the site for both years. When comparing hand harvest yields, there was no significant difference between the PMDI treatment and the drop nozzle treatment in either year or when combined across years (Table 8). When looking at the 2004 field map (Fig. 3) or the

2005 field map (Fig. 4) generated by a yield monitor, no discernable pattern was evident between the two systems.

In 2004, the average emitter output over the summer declined from 214 ml/min. on May 24 to 209 ml/min on August 4 to 180 ml/min on September 13. Output from the emitters decreased by an average of 16% through the summer (Fig. 6). Output from the nozzles from span 4, 5, and 7 also decreased from an average of 2.51 gpm on May 26 to 2.48 gpm on August 4 to 2.28 gpm on September 13 (Fig. 5). The average reduction in flow was 9%. The 9% reduction in flow indicates that the overall pumping capacity of the well was reduced. However, the additional 7% reduction in flow rate from the emitters is likely due to emitter clogging.

In 2005, the average emitter output over the summer declined from 180 ml/min. on May 27 to 168 ml/min on July 29 to 158 ml/min on September 8. Output from the emitters decreased by an average of 14% through the summer (Fig. 6). Output from the nozzles from span 4, 5, and 7 actually increased from an average of 2.13 gpm on May 27 to 2.17 gpm on July 29 to 2.49 gpm on September 8. The average increase in flow was 17%. Why there was an increase in flow over this time is difficult to explain, but it may be related to a difference in field evaluation for the locations where the sampling was conducted. There was a greater difference in 2005, however, compared with 2004 in the flow between the average output of the emitters and the average output of the nozzles which implies increased clogging of the emitters.

Summary

In conclusion, as with any field evaluation, variability is inherently higher due to factors outside of the parameters that can be controlled by the investigators. There was no positive or negative impact on yield from those plots that were irrigated with the PMDI system versus a standard drop nozzle system. Emitter flow was decreased in both years when compared with nozzle flow which was likely due to emitter clogging. Clogging of the emitters over the life of the system along with puncturing of the hoses from wildlife appear to be two negatives of the system. One benefit of the system was the reduced wheel pivot tracks when the PMDI system is used to water crops near the pivot wheel. The authors of this paper would again like to thank DLS farms for their cooperation on this project.

Table 8. Yield as influenced by irrigation treatment (data from hand harvest), Sheridan County, Kansas.

Treatment	2004	2005	Combined Results
	- - - - - - - -	bu/a	- - - - - - - -
PMDI	233	239	236
Drop Nozzle	236	236	236
LSD (0.05)	NS	NS	NS

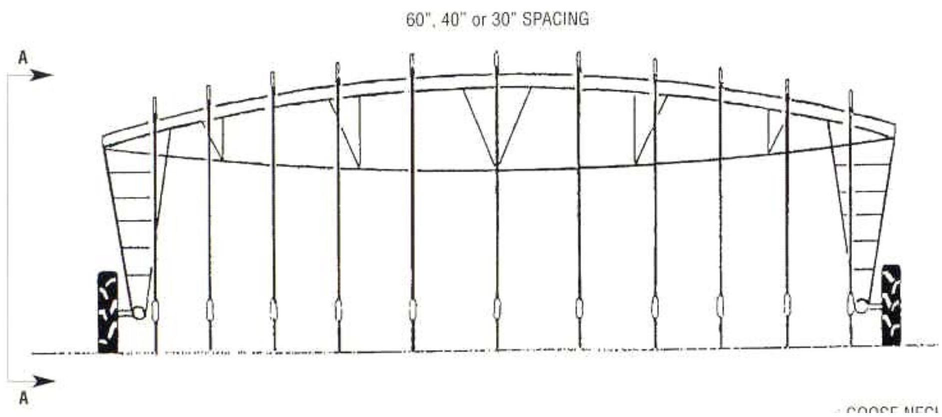


Figure 2. Sprinkler with drag hoses attached.

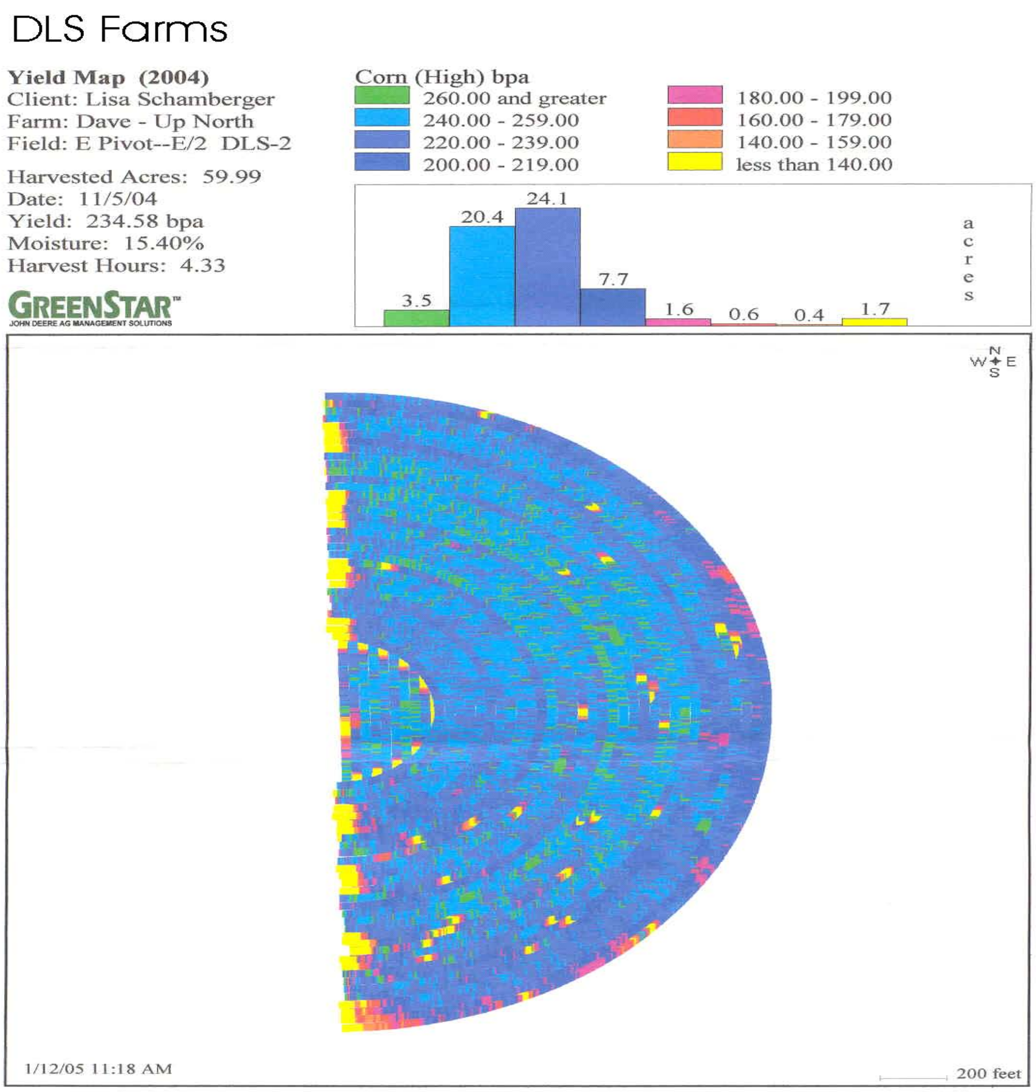


Figure 3. 2004 Field Map

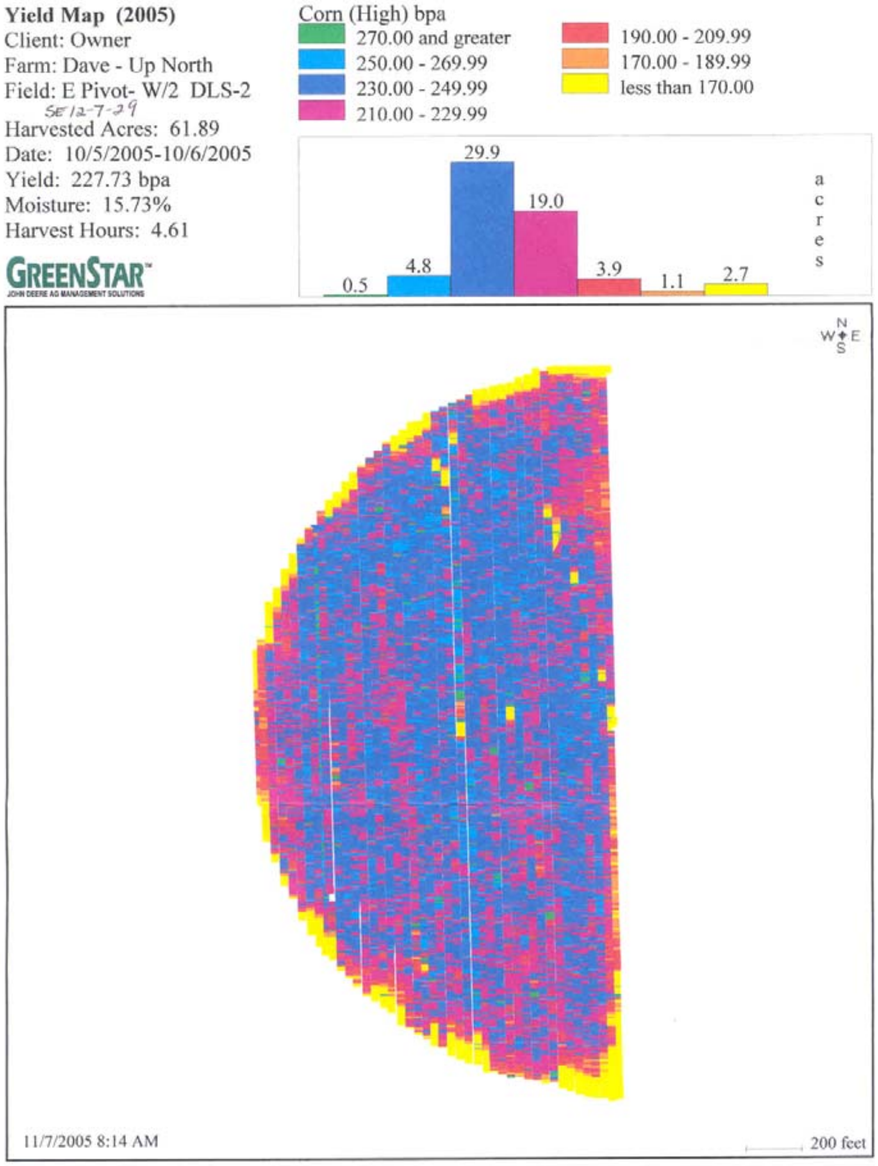
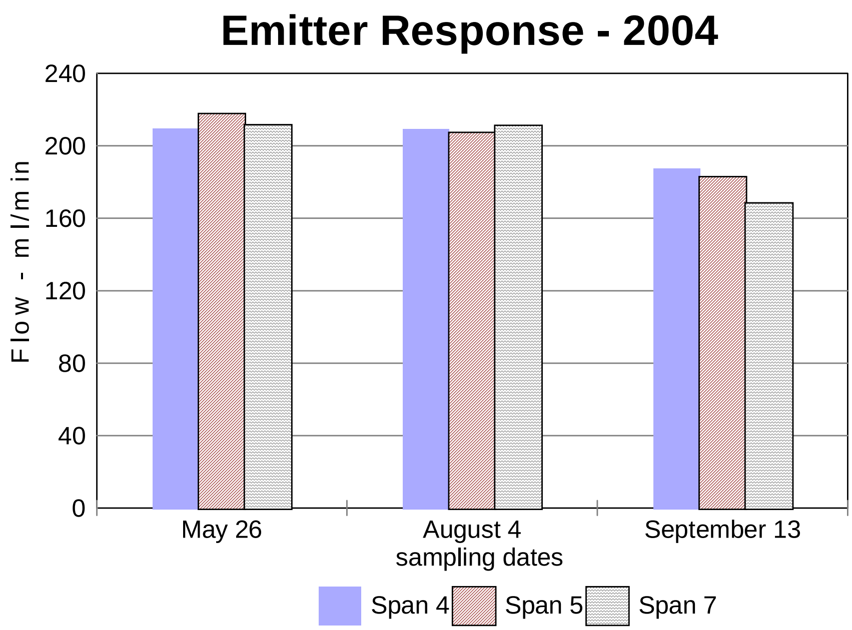


Figure 4. 2005 Field Map.



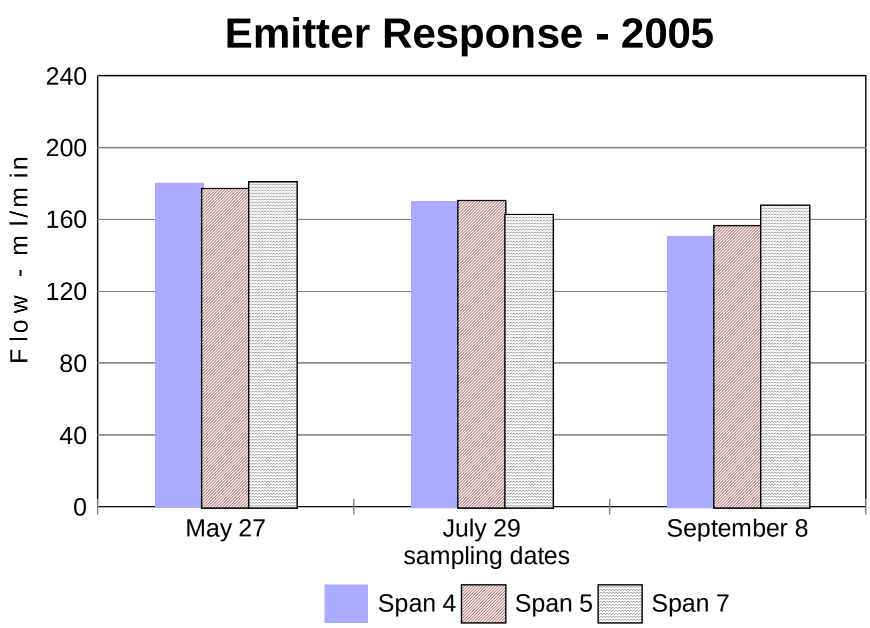
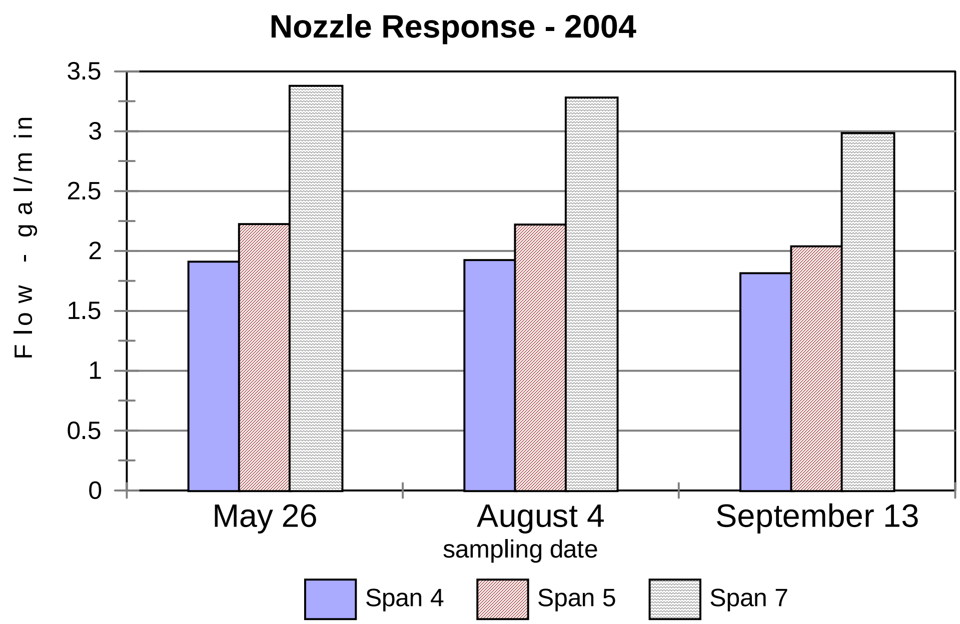


Figure 5. Emitter response from 2004 and 2005.



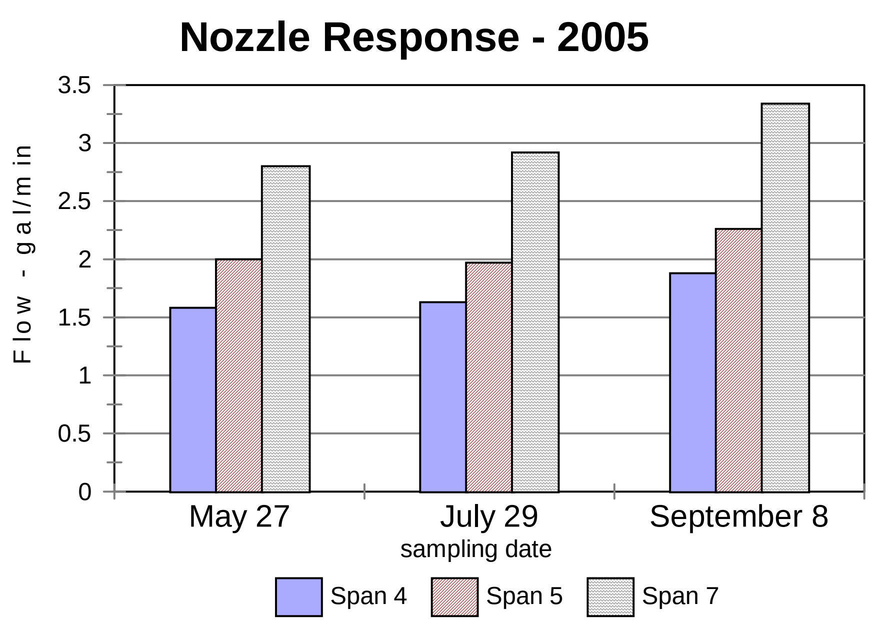


Figure 6. Nozzle response from 2004 and 2005.

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