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Kansas State University
Agricultural Experiment Station and
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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 determine 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 and application methods for crop efficiency and environmental effects.

Soil Description

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

2006 Weather Information

Precipitation during 2006 totaled 31.73 inches, which was 5.05 inches below the 35-year average (Table 1). Rainfall during May and June was 5.38 inches below average, which affected corn yields. Rainfall during August - the critical month for soybean - was 4.76 inches above average. The coldest daily temperatures during 2006 occurred in February and December, with eight days in single digits. The overall coldest day was 4.8°F on February 18.

On 56 days during the summer of 2006, temperatures exceeded 90°F. The hottest day was July 20, with a temperature of 105°F. The hottest seven-day periods were July 14 through 20 and July 28 through August 2, when daily temperatures averaged 97.7°F and 97.5°F, respectively. The last freeze in the spring was April 9 (average, April 18) and the first killing frost in the fall was October 13 (average, October 21). The number of frost-free days was 186, compared with the long-term average of 185.

Table 1. Precipitation (inches) at the East Central Experiment Field, Ottawa, KS.

Month	2006	35-yr. avg.	Month	2006	35-yr. avg.
January	0.71	1.03	July	3.35	3.37
February	0.00	1.32	August	8.35	3.59
March	2.00	2.49	September	2.11	3.83
April	3.33	3.50	October	3.11	3.43
May	3.77	5.23	November	1.60	2.32
June	1.29	5.21	December	2.11	1.45
Annual Total				31.73	36.78

EVALUATION OF NITROGEN RATES AND STARTER-FERTILIZER PLACEMENT METHODS FOR STRIP-TILL CORN IN EASTERN KANSAS

Keith A. Janssen

Summary

Nitrogen rates and starter-fertilizer placement methods were evaluated for strip-till corn on a Woodson soil at the East Central Experiment Field in 2006. The 80 lb/a nitrogen rate for corn following soybeans maximized corn grain yields under fairly dry growing conditions. The placement of the phosphorus-potassium-nitrogen (P-K-N) starter-fertilizer beside the seed row at planting increased early-season corn growth 64 percent compared to the application of all the P-K-N starter in the strip-till zone. Increased early-season growth with planter-banded fertilizer, however, did not increase yields. Highest grain yields were produced when all of the P-K-N starter fertilizer was included in the strip-till zone.

Introduction

Corn growers in eastern Kansas might benefit if they can reduce traditional nitrogen rates when using an under-the-row strip-till banded fertilization system. Nitrogen's high cost demands prudent use. Research also considered whether there is a yield advantage from applying P-K-N starter-fertilizers beside the seed row at planting in a strip-till system. Depending on the outcome, growers may be able to adjust nitrogen rates. If there is little or no yield advantage from starter-fertilizers banded at planting versus all under-the-row, producers could avoid buying costly planter fertilizer banding equipment and not have to apply fertilizers at planting time.

Procedures

This was the first year for this study. Six nitrogen rates and three P-K-N starter-fertilizer placement methods were evaluated for corn on a Woodson silt loam soil at the East Central Kansas Experiment Field near Ottawa. Nitrogen rates compared in 2006 were 60, 80, 100, 120, 140 and 160 lb/a, including a check. The P-K-N starter-fertilizer placement methods evaluated were all applied 5 inches below the row during the strip-till operation, placed 2.5 x 2.5 inches from the seed row at planting, and a combination of half in the strip-till zone and half at planting. In all cases 30 lb/a N was applied, along with the P-K starter-fertilizers. Past research has shown that for best P response, a 1:1 N-P ratio mix should be used.

The experiment design was a randomized complete block with four replications. The previous crop was soybean. For pre-plant weed control, 1 qt/a atrazine 4L plus 0.66 pt/a 2,4-D LVE plus 1 qt/a COC were applied. Pioneer 35P17 corn was planted April 6, 2006. The P-K-N starter-fertilizers were applied 2.5 x 2.5 inches from the seed row at planting. Seed-drop was 24,500 seeds/a. Pre-emergence herbicides containing 0.5 qt/a atrazine 4L plus 1.33 pt/a Dual II Magnum were applied the day after planting. The effects of treatments on plant establishment were measured by counting all plants in the center two rows of each plot. Whole above-ground plant tissue samples (six randomly selected corn plants from non-harvest rows in each plot) were collected at the 6-leaf growth stage to measure treatment effects on early-season corn growth. Grain yields were measured by machine-harvesting the center two rows of each 10-ft-wide x 40-ft-long plot. Test plots were harvested September 1, 2006.

Results

The 2006 corn growing season was hotter and drier than normal. Under these conditions and with corn following soybeans, the 80 lb/a N rate maximized corn grain yields (Table 2). The location of starter-fertilizer significantly affected early-season corn growth (Figure 1). The application of P-K-N starter fertilizer 2.5 inches beside and 2.5 inches below the seed row at planting increased early-season corn growth by 64 percent compared to the application of all of the P-K-N starter in the strip-till zone. The combination starter applications (half at planting and half in the strip-till zone) produced intermediate early-season growth effects. The increased early-season growth with the P-K-N fertilizer banded at planting, however, did not improve grain yields (Figure 2). Highest corn grain yields were produced when all of the P-K-N starter fertilizer was applied in the strip-till zone. More years of testing are needed to determine whether this is an actual representation of how the strip-till tillage fertilization system really works or just a reflection of the growth response of corn to this particular year's moisture pattern.

Plant populations were not affected by the application of starter-fertilizers or the rates of nitrogen (Table 2).

Table 2. Effects of nitrogen rates and P-K-N starter fertilizer placement methods on plant population, V6 plant dry weight, and grain yield of strip-till corn, East Central Kansas Experiment Field, Ottawa, KS, 2006.

Fertilizer Treatments		Plant Population	V6 Dry Weight	Grain Yield
Strip-till	Planter 2.5"x2.5"			
--------------- N-P-K, lb/a ---------------		x 1000	grams/plant	bu/a
Check 0-0-0		24.3	2.1	47
60-40-20		24.3	5.5	101
80-40-20		24.8	4.2	109
50	30-40-20	24.8	6.6	103
50-20-10	30-20-10	24.6	6.4	101
100-40-20		24.3	4.4	103
120-40-20		24.9	4.3	108
90	30-40-20	24.8	7.6	102
90-20-10	30-20-10	24.2	6.2	105
140-40-20		24.1	3.9	109
160-40-20		24.1	4.0	108
130	30-40-20	24.3	6.8	100
130-20-10	30-20-10	24.0	5.3	106
LSD* 0.05		NS	1.0	6

*LSD: Least significant difference.

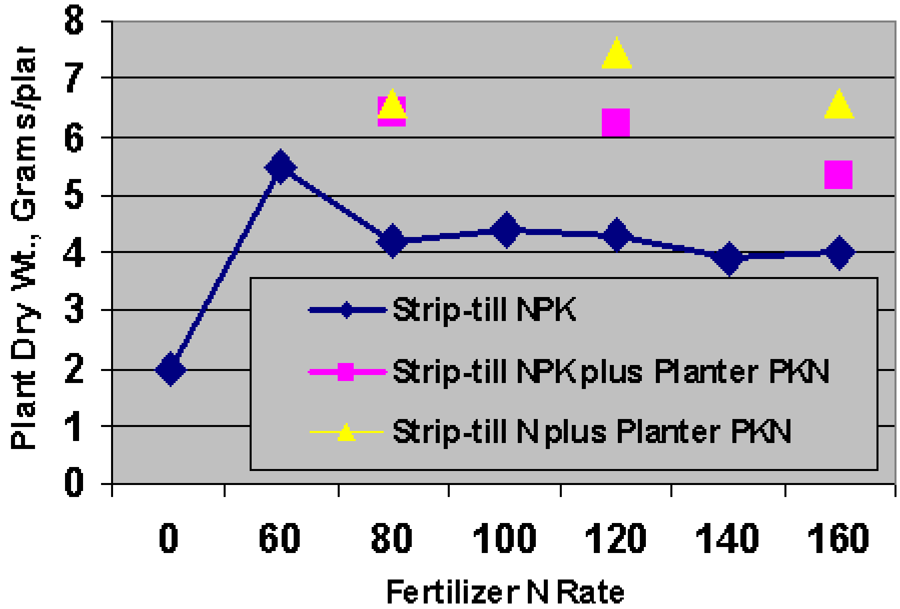

Figure 1. N rates and P-K-N fertilizer placement effects on 6-leaf growth of strip-till corn.

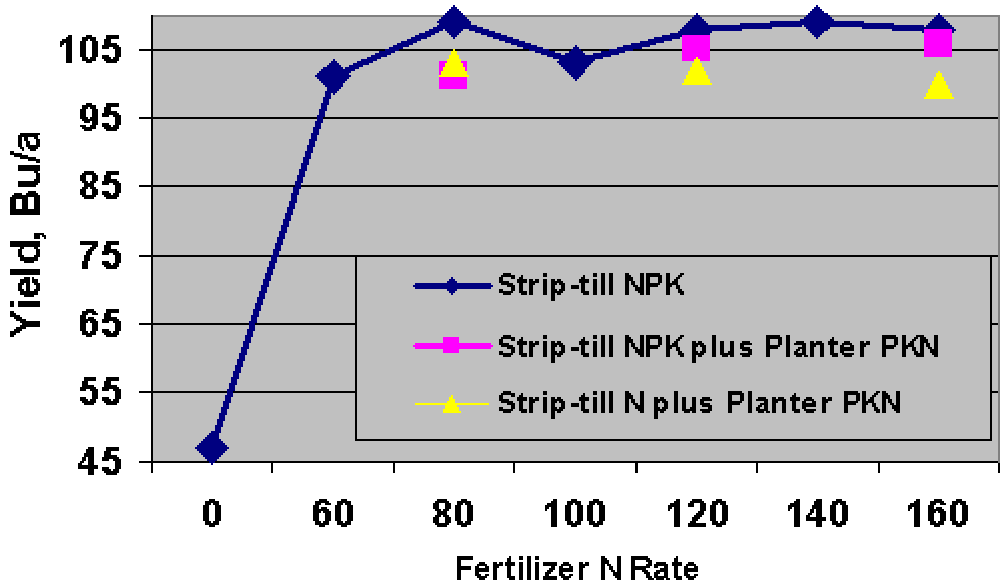

Figure 2. N rates and P-K-N fertilizer placement effects on yield of strip-till corn.

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, using Roundup Ready soybean technology for weed control, has proven to be successful for growing double-cropped soybeans in eastern Kansas. Generally, the key to successful double-crop soybeans is to plant as quickly as possible after harvesting wheat and to plant soybean varieties that will fully utilize the 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 Roundup Ready soybean varieties were planted no-till in 2003, six in 2004, four in 2005, and seven in 2006. Seeding was with a no-till planter at approximately 160,000 seeds/a in 30-inch rows (9 seeds per foot of row, which is slightly more than for a full-season planting). No fertilizer was applied, but phosphorus (P) and potassium (K) soil test levels were good, and the previous wheat crops had all received P and K fertilizers. Roundup Weather Max at 22 oz/a was sprayed one or two times all years, to control weeds and volunteer wheat. Soybean planting and harvest dates, plant and pod heights, and dates when the varieties matured (pods were dry) are shown in data tables.

Results

Yields for individual varieties ranged from 17.2 to 44.4 bu/a during the four-year period (Tables 3, 4, 5, 6). Moisture was the predominant factor limiting double-crop-soybean yields in 2003, wet soil and delayed planting was a problem in 2004, near ideal growing conditions occurred in 2005, and growing conditions in 2006 were generally good. The varieties that performed best overall tended to be the longer-season varieties.

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

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.

*LSD: Least significant difference.

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

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 Weight	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.

Table 6. Double-crop soybean variety performance test, 2006, Ottawa, KS.

Variety	Yield	Maturity	Test Weight	Plant Height	Pod Height
	bu/a @ 13%	month/day	lb/bu	inch	inch
Midland 4806 NRS	37.8	10-16	54.9	30.0	5.9
Pioneer 94B73	36.9	10-11	55.9	28.8	5.4
AgVenture AV 38T8NRRSTS	34.2	10-10	54.1	25.0	5.5
Midland 4367 NRR	34.1	10-12	55.1	29.2	5.4
Pioneer 94M30	34.0	10-16	55.2	27.8	5.9
Pioneer 93M95	33.2	10-8	54.6	28.5	5.8
AgVenture AV 46J5NRR	31.8	10-13	55.0	25.8	5.4
LSD 0.05	4.6	-1	0.5	1.6	NS

Planting date: June 16, 2006; harvest date: November 1, 2006.

*LSD: Least significant difference.

EVALUATION OF STRIP-TILL AND NO-TILL TILLAGE/FERTILIZATION SYSTEMS FOR GROWING GRAIN SORGHUM IN KANSAS

Keith A. Janssen and Gary L. Kilgore

Summary

Field studies were conducted at the East Central Kansas (ECK) Experiment Field at Ottawa and at an on-farm location in south-central Kansas to evaluate how strip-till will perform compared to no-till when growing grain sorghum in Kansas. Treatments at the ECK Experiment Field evaluated strip-till and no-till tillage/fertilization systems using early and traditional grain sorghum planting dates, with 0 to 150 lb/a N and selected strip-till and planter-banded starter phosphorus-potassium -nitrogen (P-K-N) fertilizer applications.

Treatments at the south-central Kansas location compared strip-till, no-till, and conventional-till tillage/fertilization systems using large replicated field plots, all at the same rate of fertilizer application. Neither location showed evidence that strip-till improved plant stands compared to no-till.

Application of fertilizer at the ECK field had a significant positive effect on early-season grain sorghum growth in both tillage systems at both planting dates. Early-season grain sorghum growth at the Sumner County location and at the ECK field were unaffected by tillage. No statistical difference in grain yields was observed because of tillage at either location. Both studies showed a clear advantage for strip-till or no-till. More years of testing are needed to fully evaluate these tillage/fertilization planting options.

Introduction

The objective of this study was to evaluate strip-till and no-till tillage/fertilization systems for grain sorghum when planted early and at regular planting dates using nitrogen rates ranging from 0 to 150 lb/a with different P-K-N starter-fertilizer application methods.

Strip-till is a conservation tillage system in which a narrow-tilled zone is produced for planting with under-the-row banded fertilizers. The study is based on the hypothesis that if grain sorghum is planted early, strip-tillage with residues moved aside and fertilizer banded under the row might benefit early-season grain sorghum growth and stand establishment. This is expected because of the warmer, loosened seed bed and a readily available source of nutrients under the row. For grain sorghum planted at the normal planting time (late May to early June), when soil temperatures are typically warmer and nutrients in the soil are generally more useable, strip-tillage in the row may not be as advantageous, and might result in reduced yields because of potentially increased moisture loss compared to no-till.

Procedures

Two studies were established in 2006: one at the ECK Experiment Field at Ottawa and one in Sumner County in south-central Kansas. The crop preceding the grain sorghum experiment at the ECK Experiment Field was no-till soybeans, and the crop preceding the grain sorghum crop at the Sumner County location was no-till grain sorghum. For pre-plant weed control at the ECK field, 1qt/a atrazine 4L plus 0.66 pt/a 2,4-D LVE plus 1 qt/a COC were applied. At the Sumner County location, 24 oz of Touchdown CF plus 17 lbs AMS and 16 oz of 2,4-D LV6 was applied for burn-down. Pioneer 84G62 grain sorghum was planted April 14 (early-planting date) and May 24 (normal time of planting) at the ECK field, and Pioneer 8500 grain sorghum was planted at the Sumner County location on May 17. Seed-drop was 52,000 seeds/a at the Sumner County location and 69,000 seed/ a at the ECK field. Preemergence herbicides containing 0.5 qt/a atrazine 4L plus 1.33 pt/a Dual II Magnum were applied at the ECK field, and 1.0 qt/a atrazine 4L plus 1.33 pt/a Dual II Magnum were applied at the Sumner county location for additional weed control.

The effects of the tillage and fertilization treatments on plant establishment were evaluated by counting or visually observing plant stands. Whole above-ground plant tissue samples (six randomly selected plants from each plot) were collected at the 6-leaf growth stage at both locations to measure treatment effects on early-season grain sorghum growth. Grain yields were measured by machine harvesting the center two rows of each 10-ft-wide by 40-ft-long plot at the ECK field and by harvesting the grain from the entire 40-ft-wide by 400-ft-long plots at the Sumner County location. Harvest was on September 5 at the Sumner County location and on September 19 at the ECK field.

Results

Moisture was limiting at both locations, but was especially short in Sumner County. At both locations and both planting dates at the ECK field there was no evidence of improved plant stands with strip-till compared to no-till (visual observation at the ECK field and plant stand counts at the Sumner County location, Table 8). Air and soil temperatures at the ECK field were unusually warm (80ºF to 90ºF air temperatures and 60ºF to 70ºF 4-inch-depth soil temperatures) during the early planting period, which could have aided plant establishment in no-till. Early season grain sorghum growth was generally unaffected by the tillage methods at either location (Tables 7 and 8). Again, this could be a reflection of unusually warm growing conditions.

Fertilizer application had a significant positive effect on early-season grain sorghum growth at both planting dates at the ECK field. On average, fertilizer increased early-season grain sorghum growth approximately 30 percent. Days to half-bloom at the ECK field ranged from 87 to 94 days after planting (July 10 through 17) for the early planted sorghum: not early enough to totally miss the main hot and dry period of the summer. Consequently, a shorter season hybrid (shorter than the 115- to 119-day hybrid that was planted) would have been more appropriate for planting early. The half-bloom dates for the later-planted sorghum occurred about 10 to 12 days after the early planted sorghum (July 22 through 28). For this later planting date, the longer season hybrid that was used was likely a good choice.

Tillage had no significant effect on days to half-boom at either location. Yields also were statistically not affected by tillage. Sixty to 90 pounds of nitrogen maximized grain sorghum yields under these fairly dry growing conditions. Split applications of starter-fertilizer, with part applied at planting and part in the strip-till zone, did not increase yields compared to all of the P-K-N starter placed below the row during the strip-till operation. Neither study showed a significant advantage for strip-till or no-till when fertilizers were banded under the row in strip-till and beside the seed row in no-till. Additional years of testing are needed to better evaluate these tillage/fertilization planting options.

Acknowledgments

We gratefully acknowledge the Kansas Grain Sorghum Commission for providing financial support for this research.

Table 7. Effects of tillage, nitrogen rates, and starter fertilizer placement on early growth, one-half bloom dates, and yield of early- and normal time-planted Pioneer 84G62 grain sorghum, ECK Experiment Field, Ottawa, KS.

Treatment		Early Planting April 14			Normal Planting May 24		
Tillage	Fertilizer Rate and Placement	6-leaf Dry-wt	½ Bloom date	Yield	6-leaf Dry-wt	½ Bloom date	Yield
		gm	July	bu/a	gm	July	bu/a
No-till	0-0-0	5.4	14	74	6.4	28	48
No-till	60-30-10, 2.5"x2.5" at planting	6.8	11	106	8.8	24	95
No-till	90-30-10, 2.5"x2.5" at planting	6.6	11	92	8.6	24	101
No-till	120-30-10, 2.5"x2.5" at planting	5.5	14	94	8.4	24	84
No-till	150-30-10, 2.5"x2.5" at planting	6.5	13	96	8.0	25	93
Mean		**6.2**	**13**	**92**	**8.0**	**25**	**84**
Strip-till	0-0-0	4.3	17	73	7.3	26	85
Strip-till	60-30-10, 5" below the row	6.0	10	93	9.4	22	107
Strip-till	90-30-10, 5" below the row	7.0	12	101	8.7	23	115
Strip-till	120-30-10, 5" below the row	6.4	11	95	8.9	22	101
Strip-till	150-30-10, 5" below the row	6.7	12	84	8.2	23	108
Mean		**6.1**	**12**	**89**	**8.5**	**23**	**103**
Strip-till	90-30-10, 5" below the row	7.0	12	101	8.7	23	115
Strip-till	60-15-5 strip-till and 30-15-5 at planting	6.6	12	83	9.2	22	107
Strip-till	120-30-10, 5" below the row	6.4	11	95	8.9	22	101
Strip-till	90-15-5 strip-till and 30-15-5 at planting	6.8	11	94	9.0	22	100
LSD* 0.05		1.1	NS	15	1.4	2	22

*LSD: Least significant difference.

Table 8. On-farm evaluation of strip-till, no-till, and conventional tillage/fertilization systems for grain sorghum in Sumner County, KS.

Treatment	Plant Population	6-leaf Plant Dry Weight	Grain Moisture	Test Weight	Yield
	x 1000	grams	%	lbs/bu	bu/a
No-till, with all of the fertilizer banded 2.5"x2.5" from the seed row at planting	28.6	4.6	13.5	56.8	41.4
Strip-till, with all of the fertilizer knifed 5" below the row	28.8	4.8	13.5	56.9	38.5
Strip-till, with 2/3 of the fertilizer knifed below the row and 1/3 fertilizer 2.5"x2.5" at planting	28.4	4.8	14.1	56.8	39.9
Conventional tillage, with all of the fertilizer knifed and then mixed with the soil by tillage	27.0	5.5	13.6	56.5	36.5
LSD. 0.05	NS	NS	NS	NS	NS

*LSD: Least significant difference.

EFFECTS OF PLANTING DATE, HYBRID MATURITY, AND PLANT POPULATION ON CORN

Larry D. Maddux

Summary

Three planting dates (March 14, March 29, and April 13), three corn hybrid maturities (98-, 106-, 112-day) and three plant populations (18,000, 22,000, 26,000 plants/a) were evaluated in 2005 near Ottawa, KS. Silking dates were the same for the first two planting dates and about 8 days later for the third. The 106- and 112-day hybrids silked 3 and 5 days after the 98-day hybrid. Grain test weight decreased slightly with the third planting date and also as hybrid maturity increased. Grain yields were not significantly different at the 5 percent level of probability, but the highest yield was obtained with the 106-day hybrid planted March 29. No significant differences with plant populations were observed.

Introduction

During the past few years corn acreage has increased in east-central Kansas. This study was designed to evaluate three planting dates, three plant populations, and three corn hybrids of varying maturities.

Procedures

Three Pioneer brand corn hybrids of different maturities were planted in 2005 on a Woodson silt loam on the East Central Experiment Field, Ottawa, KS: PI 38H66 (98-day); PI 35P80 (106-day); and PI 33B49 (112-day). The three hybrids were planted March 13, March 29, and April 13 at seeding rates of 19,800, 24,200, and 28,600 in an effort to obtain plant populations of 18,000, 22,000, and 26,000 plants/a. Fertilizer (120-30-30) was applied with a strip-till applicator before planting. Recommended herbicides were applied for weed control. Plots were harvested with a John Deere 3300 plot combine.

Results

The plant populations obtained were close to the desired populations (data not shown). Emergence of the March 14 planting date was only 3 days before that of March 29 and they reached 50 percent silking at approximately the same dates (Table 9). The third date of planting reached 50 percent silking about 8 days later. PI 35P80 silked 3 days later than PI 38H66, and PI 33B49 reached silking 2 days after that. The test weight of the April 13 planting was lower than the other two planting dates. Test weight also tended to decrease as the hybrid maturity increased. Grain yields were not significantly different at the 5 percent level of probability, although the March 29 planting date did have the highest yield, and the April 13 date had the lowest yield. No significant differences in yields between hybrids or between plant populations were observed. However, plant populations of 22,000 and 26,000 tended to yield higher at the early planting date, while the 18,000 plants/a tended to yield higher at the April 13 planting date.

Table 9. Planting date, hybrid maturity, and plant population effects on corn, Ottawa, KS, 2005.

Planting Date	Hybrid	Population	50% Silking	Test Wt.	Yield
		Plant/a	Days after June 1	lb/bu	bu/a
March 13	PI 38H66	18,000	19	58.0	92
		22,000	19	58.6	106
		26,000	19	58.2	107
March 13	PI 35P80	18,000	21	56.8	95
		22,000	21	57.2	96
		26,000	22	56.8	93
March 13	PI 33B49	18,000	23	56.7	93
		22,000	23	57.1	100
		26,000	24	57.2	103
March 29	PI 38H66	18,000	19	58.0	103
		22,000	20	58.4	110
		26,000	20	58.4	108
March 29	PI 35P80	18,000	21	57.1	104
		22,000	22	57.9	108
		26,000	22	57.5	100
March 29	PI 33B49	18,000	23	57.4	103
		22,000	23	57.2	100
		26,000	24	57.4	102
April 13	PI 38H66	18,000	27	55.5	88
		22,000	25	55.5	89
		26,000	25	55.8	91
April 13	PI 35P80	18,000	27	55.5	100
		22,000	28	55.6	93
		26,000	29	55.4	95
April 13	PI 33B49	18,000	32	55.2	92
		22,000	32	54.4	89
		26,000	33	54.7	93
Planting Date Means:					
March 14			21	57.4	98
March 29			21	57.7	104
April 13			29	55.3	92
	Hybrid Means:				
	PI 38H66		21	57.4	99
	PI 35P80		24	56.6	98
	PI 33B49		26	56.4	97
		Pop. Means:			
		18,000	24	56.7	97
		22,000	24	56.9	99
		26,000	24	56.8	99

KANSAS RIVER VALLEY EXPERIMENT FIELD

Introduction

The Kansas River Valley Experiment Field was established to study effective management and use of irrigation resources for crop production in the Kansas River Valley. The Paramore Unit consists of 80 acres 3.5 miles east of Silver Lake on US 24, then 1 mile south of Kiro, and 1.5 miles east on 17th street. The Rossville Unit consists of 80 acres located 1 mile east of Rossville or 4 miles west of Silver Lake on US 24.

Soils Description

Soils on the two fields are predominantly 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.

2006 Weather Information

The frost-free season was 189 days at both the Paramore and Rossville units (173 days average). The last spring freeze was on April 4 at both fields (average, April 21) and the first fall freeze was October 12 (average, October 11). There were 58 days above 90ºF. Precipitation was 8 to 9 inches below normal for the growing season (Table 1). Precipitation was below average in May and June and irrigation was started in mid-June. Severe hail lowered corn yields at Rossville. Very little sudden death syndrome was observed in soybeans. Soybean yields were lower than normal at both fields, possibly because of the extended hot weather from June through early August.

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

Month	Rossville Unit		Paramore Unit	
	2005-2006	30-Yr. Avg.	2005-2006	30-Yr. Avg.
Oct.	2.37	0.95	3.98	0.95
Nov.	0.74	0.89	0.83	1.04
Dec.	0.71	2.42	0.86	2.46
Jan.	0.48	3.18	0.25	3.08
Feb.	0.00	4.88	0.00	4.45
Mar.	3.07	5.46	2.32	5.54
Apr.	3.51	3.67	3.39	3.59
May	1.39	3.44	2.53	3.89
June	1.41	4.64	1.21	3.81
July	3.56	2.97	2.40	3.06
Aug.	7.11	1.90	6.89	1.93
Sep.	2.34	1.24	2.54	1.43
Total	26.68	35.64	27.20	35.23

CORN HERBICIDE PERFORMANCE TEST

Larry Maddux

Summary

The study conducted at the Rossville Unit compared preemergence and two-pass herbicide applications. Excellent control of Palmer amaranth and common sunflower resulted, and only one treatment resulted in less than 90 percent control. Control of large crabgrass and ivyleaf morning glory was generally better with the two-pass applications than with a preemergence application alone. No significant difference in yield was observed between treatments.

Introduction

Chemical weed control and cultivation have been used in row crops to reduce weed competition, which can reduce yields. Timeliness of application is a major factor in determining effective weed control. Eleven herbicide treatments, including preemergence, preemergence plus postemergence, and glyphosate herbicide treatments were compared. Weeds evaluated in this test were large crabgrass (lacg), Palmer amaranth (paam), common sunflower (cosf), and ivyleaf morning glory (ilmg)

Procedures

The test was conducted at the Rossville Unit on a Eudora silt loam soil previously cropped to soybeans. It included five preemergence (PRE) treatments, six preemergence plus early or late postemergent (EP or LP), and one untreated check. One of the PRE plus EP treatments included an experimental herbicide and is not reported. The test site had a pH of 6.9 and an organic matter content of 1.1 percent. DeKalb DKC63-81RR hybrid corn was planted on April 26 at 29,600 seeds/a in 30-inch rows. Anhydrous ammonia at 150 lb/a N was applied preplant, and 120 lb/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. Experimental design was a randomized complete block with three replications per treatment. PRE applications were made on April 26. EP treatments were applied on June 1 to 6-leaf corn, seedling to 1-4" large crabgrass, 4-12" Palmer amaranth, 4-12" common sunflower and 1-3" ivyleaf morning glory. LP treatments were applied on June 7 to 1-3" large crabgrass, 1-5" Palmer amaranth, 3-6" common sunflower, and 1-4" ivyleaf morning glory. Populations of all four weed species were moderate to heavy, but were generally fairly light at postemergence time in plots receiving a preemergence treatment. Plots were not cultivated. Weed control ratings reported were made on July 14. The first significant rainfall after PRE herbicide application was on April 28 (1.47 inches). Plots were irrigated as needed. Harvest was on September 19 using a John Deere 3300 plot combine.

Results

Rainfall of 1.47 inches occurred four days after planting. No crop injury was observed. Excellent control of Palmer amaranth and common sunflower was obtained with all treatments (Table 2). The Hornet + Balance Pro + Surpass treatment was the only one that gave less than 90 percent control of the two. Control of large crabgrass ranged from 73 to 92 percent and control of ivyleaf morning glory ranged from 72 to 95 percent. The two-pass application treatments generally resulted in better control than the PRE only treatments. Little grain was produced on the untreated check. No significant difference in grain yield was observed among herbicide treatments.

Table 2. Effects of pre- and post-emergence herbicides on weed control and grain yield of corn, Kansas River Valley Experiment Field, Rossville, KS, 2006.

Treatment[1]	Rate, product/a	Appl Time[2]	Percent Weed Control, July 14 [3]				Grain Yield, bu/a
			lacg	paam	cosf	ilmg	
Untreated check		---	0	0	0	0	32
SureStart[4] *fb*	1.75 pt/a	PRE	88	96	100	88	144
Glyphomax XRT +	24 oz/a	LP					
AMS	2.5 lb/a	LP					
Keystone *fb*	1.4 qt/a	PRE	92	94	100	85	149
Glyphomax XRT +	24 oz/a	LP					
AMS	2.5 lb/a	LP					
Keystone +	2.8 qt/a	PRE	77	100	93	72	162
Hornet	3.5 oz/a	PRE					
Lumax	3.0 qt/a	PRE	88	96	93	72	158
Hornet +	2.0 oz/a	PRE	75	88	85	73	145
Balance Pro+	0.5 oz/a	PRE					
Surpass	2.5 pt/a	PRE					
Surpass *fb*	2.5 pt/a	PRE	88	100	100	95	164
Hornet +	3.0 oz/a	EP					
Callisto +	0.75 oz/a	EP					
AAtrex Nine-O +	0.28 lb/a	EP					
COC + AMS	1% v/v + 2.5 lb/a	EP					
Keystone *fb*	2.8 qt/a	PRE	87	100	100	95	171
Hornet +	3.0 oz/a	EP					
Callisto +	0.75 oz/a	EP					
AAtrex Nine-O +	0.28 lb/a	EP					
MSO + AMS	1% v/v + 2.5 lb/a	EP					
Keystone *fb*	2.8 qt/a	PRE	90	100	100	93	147
Hornet +	3.0 oz/a	EP					
Impact +	0.19 oz/a	EP					
AAtrex Nine-O +	0.28 lb/a	EP					
MSO + AMS	1% v/v + 2.5 lb/a	EP					
Guardsman Max	2.0 qt/a	PRE	73	100	100	87	158
Distinct	4 oz/a	EP					
Bicep II Magnum	2.1qt/a	PRE	93	100	87	75	159
LSD (0.05)			10	6	10	16	29

[2] Postemergence treatments had surfactants added 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 morning glory.
[4] SureStart is currently not labeled for use on corn. Commercial use is expected for the 2008 season.

EFFECTS OF PREEMERGENCE HERBICIDES FOLLOWED BY GLYPHOSATE IN SOYBEANS

Larry Maddux

Summary

A study at the Rossville Unit compared preemergence herbicide treatments followed by glyphosate. Most treatments gave good to excellent control of large crabgrass, Palmer amaranth, and common sunflower. Only two treatments resulted in better than fair control of ivyleaf morning glory. There were no significant yield differences among treatments.

Introduction

Chemical weed control and cultivation have been used in row crops to reduce weed competition, which can reduce yields. Treatments in this test included an untreated check, ten preemergence applications followed by glyphosate, and one treatment of two glyphosate applications. The weeds evaluated in this test were large crabgrass (lacg), Palmer amaranth (paam), common sunflower (cosf), and ivyleaf morning glory (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 organic matter content of 1.1 percent. Corn stubble had been disked in the fall. No additional tillage was done before planting. A burn-down of glyphosate, 0.75 lb ae/a plus 2,4-D ester, 0.5 pt/a, was applied on May 12. There was no rainfall before planting Stine 4102-4 soybean on May 22 at 139,000 seeds/a in 30-inch rows with10-34-0 fertilizer banded at 120 lb/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 22. Mid-postemergence (MP) treatments were applied June 20 to 1-4" large crabgrass; 2 - 12" Palmer amaranth; 3 - 12" common sunflower; and 1- 4" ivyleaf morning glory. Late postemergence (LP) treatments were applied June 27. Weed sizes were: large crabgrass, 1-5"; Palmer amaranth, 1-14"; common sunflower, 1-14"; and ivyleaf morning glory, 1-6". All weed populations were moderate to heavy. Plots were not cultivated. Severe hail on June 28 defoliated approximately 60 percent of the soybeans and brought a new flush of weeds. Glyphosate, 0.75 lb ae/a + AMS was applied on July 25. No injury was observed. Weed control ratings were reported July 11. Plots were irrigated as needed and were harvested October 9 using a John Deere 3300 plot combine.

Results

Because no rainfall had been received since May 8, 0.50 inch was applied by sprinkler irrigation May 27. PRE herbicides were activated 5 days after application.

No significant crop injury was observed. All herbicide treatments gave 100 percent control of common sunflower. A contributing factor was the blanket preplant application of 2,4-D ester. Control of Palmer amaranth was very good, ranging from 83 to 95 percent. Control of large crabgrass ranged from 77 to 93 percent. The low rate of python fb Glyphomax XRT control, at 77 percent, was significantly lower than most treatments. Boundary fb Touchdown Total had the second lowest large crabrass control (82 percent). Ivyleaf morning glory control was relatively poor, ranging from 53 to 85 percent. Valor and FirstRate fb glyphosate had the best ivyleaf morning glory control (82 and 85 percent). No significant differences in soybean yield were observed.

Table 3. Effects of herbicide application on weed control and grain yield of soybean, Kansas River Valley Experiment Field, Rossville, KS, 2006.

Treatment[1]	Rate, product/a	Appl Time[2]	Percent Weed Control, July 11[3]				Grain Yield, bu/a
			lacg	paam	cosf	ilmg	
Untreated check		---	0	0	0	0	16.0
Python *fb*	0.5 oz/a	PRE	77	88	100	78	48.5
Glyphomax XRT	24.0 oz/a	MP					
Python *fb*	0.8 oz/a	PRE	87	87	100	67	46.4
Glyphomax XRT	24.0 oz/a	MP					
GF-1280 *fb*	24.0 oz/a	EP	92	90	100	53	45.7
GF-1280	24.0 oz/a	LP					
FirstRate *fb*	0.3 oz/a	PRE	85	83	100	82	46.0
Glyphomax XRT	24.0 oz/a	MP					
Boundary *fb*	1.5 pt/a	PRE	82	92	100	57	47.3
Touchdown Total	24.0 oz/a	MP					
Intrro + Valor *fb*	2.0 qt/a + 1.5 oz/a	PRE	88	95	100	67	49.6
Roundup WeatherMax	22.0 oz/a	MP					
Prowl H2O + Valor *fb*	1.0 qt/a + 1.5 oz/a	PRE	90	93	100	67	46.0
Roundup WeatherMax	22.0 oz/a	MP					
Prowl H2O + Valor *fb*	1.0 qt/a + 2.0 oz/a	PRE	88	93	100	67	45.7
Roundup WeatherMax	22.0 oz/a	MP					
Prowl H2O + Valor *fb*	1.0 qt/a + 3.0 oz/a	PRE	90	93	100	78	43.9
Roundup WeatherMax	22.0 oz.a	MP					
Valor *fb*	2.5 oz/a	PRE	93	94	100	85	50.1
Roundup WeatherMax	22.0 oz/a	MP					
Dual II Magnum *fb*	1.3 pt/a	PRE	90	95	100	63	44.7
Touchdown Total	24.0 oz/a	MP					
LSD (0.05)			6	9	--	20	6.9

[1] Postemergence treatments of glyphosate had AMS added at 2.5 lb/a.
[2] PRE = preemergence (5/22); MP = Mid-postemergence (6/20); LP = Late postemergence (6/27).
[3] lacg = large crabgrass; paam = palmer amaranth; cosf = common sunflower; ilmg = ivyleaf morning glory.

FUNGICIDES ON SOYBEANS

Larry D. Maddux

Summary

Fungicides were applied to soybeans at the R3 growth stage in 2005 and 2006 at the Kansas River Valley Experiment Field. No significant yield responses were obtained in 2005. In 2006, five of the nine fungicide treatments resulted in more than 3.0 bu/a soybean yield increase over that of the untreated check.

Introduction

Fungicides have been shown to increase grain yield of soybeans when foliar diseases are present. Sometimes increased yields have been noted even when diseases were not obvious. This research was conducted to evaluate the application of several fungicides on soybeans to evaluate their effect on grain yield.

Procedures

This test was conducted on a Eudora silt loam soil previously cropped to corn. The test site had a pH of 7.1 and an organic matter content of 2.1 percent. Corn stubble was disked and chiseled in the fall, then field-cultivated in the spring. Stine 4102-4 soybeans were planted May 24, 2005, and on May 22, 2006, at 139,000 seeds/a in 30-inch rows with 10-34-0 fertilizer banded at 120 lb/a. A randomized complete block design with four replications was used. Fungicides were applied July 25, 2005, and July 29, 2006, at 20 gal/a. Plots were sprinkler-irrigated as needed. Harvest was October, 14, 2005, and October 12, 2006, with a John Deere 3300 plot combine.

Results

Results are shown in Table 4. In 2005, no significant differences were observed among any of the treatments or the check. In 2006, the fungicide treatments of Headline, Domark, Stratego, Quadris, and Headline plus Caramba increased soybean yield by 3 bu/a or more over yield of the check. But there were no significant differences in yield among fungicides. The application of Folicure, Quilt, or Laredo did not result in a significant yield increase over that of the check. The Headline plus Folicure treatment yielded 2.8 bu/a more than the check, which was not significantly greater than that of the check at the 95 percent probability level, but would have been at the 90 percent probability level.

Table 4. Effect of fungicides applied at R3 on soybean yields, Paramore Unit, Kansas River Valley Experiment Field, 2005 and 2006.

Fungicide	Rate	Yield, 2005	Yield, 2006
	0z/a	-------------------------bu/a-------------------------	
Check		68.4	44.6
Headline	6.0	66.9	48.5
Folicure	4.0	63.7	46.4
Domark	5.0	64.7	48.7
Stratego	7.0	67.8	47.9
Quilt	14.0	65.9	45.8
Laredo	7.0	68.5	45.3
Quadris	6.2	---	48.0
Headline + Folicure	4.7 + 3.1	68.7	47.4
Headline + Caramba	4.4 + 7.7	67.5	49.6
LSD* (0.05)		NS	2.9

*LSD: Least significant difference.

EFFECTS OF TILLAGE IN CORN-SOYBEAN CROPPING SEQUENCES

Larry D. Maddux

Summary

Three tillage systems (conventional till, strip-till, and no-till) were evaluated for three years under continuous corn and soybeans and a corn-soybean rotation. The data indicated that corn and soybean yields equivalent to those obtained with conventional tillage can be obtained with strip-till and no-till tillage systems as long as weed control is maintained. One of the advantages of the corn-soybean rotation appears to be the ability to control weeds better than in the monocultures.

Introduction

Decreasing tillage can improve timeliness of operations and lower production costs, especially when considering the increasing price of fuel and equipment. Strip-till has occasionally been shown to have an advantage over no-till because of the placement of fertilizer under the row and also from soil temperatures being a little warmer in the strip-tilled area at planting time. The soil also tends to dry quicker in the strip tilled area than in no-till, allowing more timely planting. The objective of this study was to evaluate conventional till, strip-till, and no-till in a continuous monoculture of corn and soybeans and in a corn-soybean rotation.

Procedures

This test was originally established in 1983 with the tillage treatments of conventional till (fall disk and chisel, spring field cultivate); reduced till (fall or spring disk); and no-till (no tillage before planting), but was cultivated and furrowed for irrigation. In the fall of 2003, the entire plot area was disked and the reduced till was changed to a spring strip-till treatment (started in spring of 2004).

Anhydrous ammonia was used as a nitrogen (N) source for all treatments. It was knifed on 30-inch centers (between where the rows would be for no-till and conventional till and the rows would be for strip-till). The N rate used was 150 lb/a N for corn following soybeans and 175 lb/a N for continuous corn. A 2x2 starter of 10 gal/a 10-34-0 was applied at planting in addition to the anhydrous ammonia. Corn hybrids planted were: April 15, 2004 - Dekalb DKC 60-19 RRBT; April 18, 2005 - Dekalb DKC 63-81 RRYG; and April 12, 2006 - Dekalb DKC 61-72 RR2. Planting rate was 29,600 seeds/a. A full rate of preemergence herbicide was used each year. In 2005, one post application of glyphosate was applied.

Soybean varieties planted were: May 7, 2004 - Croplan 3939 RR; May 6, 2005 - Stine 4102-4; and May 22, 2007 - Stine 4102-4. Planting rate was 139,000 seeds/a. As with corn, a 2x2 starter of 10 gal/a 10-34-0 was used. A preemergence herbicide was used as well as a postemergence application of glyphosate.

Plots were irrigated as needed and harvested with a John Deere 3300 plot combine.

Results

In 2004, the strip-till - and especially the no-till plots in the continuous corn plots - lacked weed control from preemergence herbicides and did not receive the needed postemergence herbicide application. Resulting grain yields were considerably lower than in the conventional tillage plots. No significant differences in grain yields of corn following soybeans was observed, although the no-till treatment was 20 bu/a lower than the conventional and strip-till.

In 2005, a post-herbicide application provided acceptable weed control, and no significant difference was observed in corn yield due to tillage treatment. The no-till continuous corn yielded lower than the other two treatments in 2006. Corn following soybeans yielded higher than continuous corn all three years, although the difference in 2005 was not significant at the 5 percent level of probability.

Soybean yields were lower in continuous soybeans than in the corn/soybean rotation all three years, although that difference was significant at only the 10% level of probability. No significant differences between tillage systems were observed.

The data from this study would indicate that corn and soybean yields equivalent to those obtained with conventional tillage can be reached with strip-till and no-till tillage systems as long as weed control is maintained. One of the advantages of the corn-soybean rotation is the ability to control weeds better than in the monocultures.

Table 5. Effect of tillage on corn and soybeans, Kansas River Valley Experiment Field, 2004 - 2006.

Cropping		Corn, bu/a			Soybeans, bu/a		
Sequence	Tillage	2004	2005	2006	2004	2005	2006
Cont.	Conv.	231	224	195	50.1	49.7	41.4
Cont.	Strip-Till	180	216	190	42.0	48.4	35.4
Cont.	NoTill	137	216	167	49.3	54.3	34.6
Corn/SB	Conv.	226	208	203	64.4	48.9	43.7
Corn/SB	Strip-Till	228	227	242	64.9	63.8	46.7
Corn/SB	NoTill	206	233	225	67.4	60.7	44.7
LSD (0.05) (Interaction)		33	20	12	9.2	NS*	3.5
Cropping Sequence							
Cont.		183	219	185	47.1	50.8	37.2
Corn/SB		220	223	223	65.5	57.8	45.1
LSD (0.05)		10	NS	15	NS	NS*	NS*
Tillage							
Conv.		228	216	199	57.2	49.3	42.6
Strip-Till		204	222	216	53.4	56.1	41.1
No-Till		172	225	197	58.4	57.5	39.7
LSD (0.05)		23	14	21	NS	NS	3.8

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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
Pioneer
Sorghum Partners, Inc.
Triumph Seed Co.
Syngenta

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. It is designed to directly benefit the agricultural industry of the area. The focus is primarily on wheat, grain sorghum, and soybeans, but research is also conducted on alternative crops such as corn and sunflowers. 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 Street, is all Ladysmith silty clay loam with 0-1% slope. The South Unit, located four miles south and two 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 a 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.

2005-2006 Weather Information

The three-week period before most of the earliest wheat plantings on the station was dry, except for several small rainfall events averaging less than 0.1 inch. Two rains about one week apart occurred in mid-October, bringing a total of about 0.6 to 0.7 inches which proved to be important in establishment of good stands in all experiments with wheat. The remainder of October brought less than a quarter of an inch of rain. November and December were very dry.

Wheat emerged in 8 to 10 days after planting. Fall wheat development was good, but tempered by dry conditions.

Winter drought continued through January and February. Precipitation in March returned to near normal. January was unusually warm, with an average temperature 12 ^{o}F above normal. February was nearly 2 ^{o}F below normal, and March was about 1 ^{o}F above normal. The coldest temperatures of the winter occurred in mid-February, when temperatures of 2 to 9 ^{o}F occurred on several days. Wheat survival was good.

As in March, rainfall in April was near normal, but May rains totaled less than half of the long-term average. The first and third weeks of June brought significant moisture, impacting sorghum and soybean planting schedules. Monthly totals for June were about 85 to 94% of normal at the two locations. Mean air temperatures were 4^{o}F above normal in April and only sightly above normal in May and June.

As a whole, the wheat growing season was the second driest on record. Wheat reached the heading stage 10 to 14 days earlier than usual, and most leaves had dried up by the end of May or early June. Wheat diseases generally were minimal. Low levels of powdery mildew were noted in April and a trace of leaf rust observed in May. Most wheat was harvested without weather interference.

Weather and soil conditions permitted timely corn planting, with meaningful rains within 7 to 10 days afterward. No freezing temperatures occurred after April 8, when corn emerged from the earliest March planting. Corn reached the early-silking stage in late June and early July. Hot and dry conditions prevailed during this period. The months of June, July and August had a total of 35 days with temperatures of 95 ^{o}F or higher, and 14 days with temperatures of 100 to 108 ^{o}F. Mean temperatures in September and October were 5.4 and 2.6 ^{o}F below normal. July was dryer than usual. Rains in August arrived too late to be of much benefit to corn, but above-normal August rainfall, coupled with more moderate temperatures during the second half of the month, greatly benefitted the sorghum and soybean crops. September rainfall was 1.8 inches below the long-term average, and October also was dryer than usual.

Woolybear caterpillar posed a significant threat in late August and early September for both sunflowers and soybeans. Insecticide application provided effective control. Neck rot occurred in some grain sorghum plots, but lodging was generally negligible. First freezing temperatures of the fall arrived on October 18, followed by several days with minimum temperatures below 32 ^{o}F. The advent of cold temperatures did not affect sorghum yield, but the latest maturing soybean varieties were affected to some extent. The frost-free season, which began on March 29, extended for a period of 203 days, about 35 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
	2005				2006		
October	0.99	1.15	2.95	March	2.66	2.82	2.71
November	0.32	0.25	1.68	April	2.77	3.14	2.84
December	0.26	0.25	1.01	May	2.17	2.22	4.83
				June	4.43	4.04	4.72
	2006			July	4.45	3.05	3.59
January	0.08	0.12	0.79	August	5.04	5.12	3.88
February	0.00	0.00	1.08	September	1.13	1.17	2.99
Twelve-month total					24.30	23.33	33.07
Departure from 30-year normal at N. Unit							

[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 in a No-till Wheat-Grain Sorghum Rotation; Fungicide Effect on Soybeans*; and *Herbicides for Weed Control in Corn*. All other experiments in this report were conducted at the North Unit.

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

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 tenth consecutive year. Tillage in alternate years generally did not affect no-till wheat after row crops. In 2006, no-till wheat following grain sorghum with V-blade tillage yielded 9.2 bu/a more than in a complete no-till system. Crop rotation effects on wheat yield were not significant. Wheat in rotation with soybeans, corn, and grain sorghum averaged 63.6, 63.5, and 58.4 bu/a, whereas continuous wheat averaged 62.5 bu/a over all tillage systems. Continuous wheat with no-till yielded 65.6 bu/a versus 59.7 and 62.1 bu/a for chisel and burn systems, respectively. Usual wheat yield enhancement from crop rotation was overshadowed by a very dry wheat growing season. Corn averaged 66.2 bu/a and declined 7.9 bu/a with no-till versus V-blade tillage. Soybeans, on the other hand, averaged 35.7 bu/a and increased 6.4 bu/a with no-till. No-till May-planted grain sorghum following wheat as well as no-till June-planted continuous grain sorghum averaged 7 to 8 bu/a more than with tillage. Continuous May-planted grain sorghum with chisel tillage produced 5.2 bu/a more than no-till. Crop rotation and planting date had a significant influence on sorghum yields. Sorghum after wheat averaged 70.4 bu/a, 8.3 bu/a more than continuous sorghum. June planting produced 18 bu/a more than May 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 soybeans also are viable candidates for crop rotations in central Kansas dryland systems that conserve soil moisture. Because of their ability to germinate and grow under cooler conditions, corn and soybeans can be planted earlier in the spring and harvested earlier in the fall than sorghum, 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, soybeans, and grain sorghum) in annual rotation with wheat, and two for continuous grain sorghum. Each system, except no-till, included secondary tillage as needed for weed control and seedbed preparation. Wheat in rotations was planted after each row-crop harvest without prior tillage. The following procedures were used.

Wheat after Corn
- 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 Soybeans
WS-NTV = No-till after V-blade (V-blade, sweep-treader, mulch treader) for soybeans
WS-NTNT = No-till after No-till soybeans

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

Soybeans 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 22 oz/a Roundup Original Max + 8 oz/a Select + 3 oz/a Clarity + 2.55 lb/a ammonium sulfate (AMSU) + 0.5% v/v crop oil concentrate (COC) on July 21. Additional fallow application of Roundup Original Max + AMSU at 22 oz + 02.55 lb/a was made on September 20. For wheat after row crops, late-season weeds and volunteer growth were sprayed in late September or early October with 22 oz/a Roundup Original Max + 2.55 lb/a AMSU, with or without 2.67 oz/a of 2,4-D_{LVE} 6 EC.

Variety Overley was planted on October 15, 2005, in 7.5-inch rows at 90 lb/a with a John Deere 1590 no-till drill. 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. No herbicides were used on wheat in rotations. Continuous wheat was treated with 0.6 oz/a Olympus 70 WG + 0.5% nonionic surfactant (NIS) in mid-November. Wheat was harvested on June 15, 2006.

No-till corn after wheat plots received the same fallow herbicide treatments as WW-NT during the summer. Roundup Ultra Max II at 22 oz/a + 3 oz/a Clarity + 2.55 lb/a AMSU were applied on April 4. Weeds and volunteer wheat were controlled with three tillage operations in CW-V plots between wheat harvest and corn planting the next spring. Corn was fertilized with 110 lb/a N as ammonium nitrate broadcast before planting. An additional 14 lb/a N and 37 lb/a P_2O_5 were banded 2 inches from the row at planting. A White no-till planter with double-disk openers on 30-inch centers was used to plant Poncho 250-treated Pioneer 35P80 RR at approximately 18,700 seeds/a on April 5, 2006. CW-NT and 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 7.

No-till sorghum after wheat plots received the same fallow (July through early April) herbicide treatments as no-till corn. All GW-NT and GG-NT plots were sprayed with Roundup Ultra Max II plus a very low rate of 2,4-D $_{LVE}$ in mid-May. GW-V plots required four tillage operations between wheat harvest and sorghum planting. GG-C treatments involved fall chiseling and two (May planting) or three (June planting) spring sweep-treader operations. Preemergence herbicides for grain sorghum consisted of Dual II Magnum + AAtrex 4L at 1.33 pt/a + 1.5 qt/a for continuous sorghum and 1.33 pt/a + 0.75 qt/a for sorghum in rotation with wheat.

Sorghum was fertilized like corn, but with a total of 115 lb N/a. Pioneer 8500 treated with Concep safener and Cruiser insecticide was planted at 42,000 seeds/a in 30-inch rows on May 19, 2006. A second set of continuous sorghum plots was planted on June 30. Sorghum was not row cultivated. May- and June-planted sorghum crops were harvested on September 15 and November 3, respectively.

Fallow weed control procedures through early April for no-till soybeans 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 3302 RR soybeans were planted at 7 seeds/ft in 30-inch rows on May 18. Weeds were controlled in the crop with a preemergence application of Dual II Magnum shortly after planting, and a single postemergence application of Roundup Ultra Max II in late June. Soybeans were harvested on September 25, 2006.

Results

Wheat

Crop residue cover in wheat after corn, sorghum, and soybeans averaged 81, 85, and 58%, respectively (Table 2). WW-B, WW-C, and WW-NT averaged 4, 19, and 92% residue cover after planting. Most wheat emerged 10-13 days after planting. Wheat stands were excellent in all tillage systems and crop rotations.

Cheat control was excellent with all treatments. Plant N concentration in wheat at late boot-early heading stage was highest in WW-B, WW-C, WC-V and WS-V. Plant N was lowest in wheat after grain sorghum and in WW-NT. Heading date occurred one to two days earlier in wheat after soybeans and in WW-B than in the other systems, with the largest delay in no-till.

Yields reflected little or no advantage for wheat rotations with row crops. Wheat after soybeans, corn, and sorghum, averaging 63.6, 63.5 and 58.4 bu/a. In no-till wheat after corn and soybeans, tillage for the preceding row crop did not affect wheat yield in 2006. WG-NT yielded 9.2 bu/a less than WG-V. No-till continuous wheat produced a competitive yield of 65.6 bu/a, presumably on the strength of better soil moisture in a very dry wheat year. WW-NT yields were comparable to those of WW-B, and 5.9 bu/a greater than WW-C. Wheat test weight was not affected by tillage system or crop rotation.

Despite variations in treatment effects on wheat production from year to year, tillage systems had little effect on 10-year average wheat yields, regardless of crop rotation. Crop sequence, however, had a significant effect, with wheat following soybeans and corn having a 10.2 and 8.9 bu/a advantage over wheat after grain sorghum. Wheat after grain sorghum and continuous wheat produced comparable yields over the long run.

Row Crops

Corn, sorghum, and soybeans following wheat had long-term, respective averages of 40, 35, and 29% 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 79 to 84%. Over the years, the respective averages for GG-C $_{May}$ and GW-V ground cover were 37 and 35%, whereas GG-C $_{June}$ averaged 25% ground cover. NT sorghum after wheat averaged 11% more ground cover than May-planted NT continuous sorghum, and 22% more ground cover than June planted NT continuous sorghum.

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

In sorghum after wheat and in June-planted continuous sorghum, tillage system had no significant effect on stand, leaf N, days to half-bloom, or grain test weight, but no-till increased grain yield by 7.2 and 8 bu/a, respectively. In May-planted continuous sorghum, the chisel system versus no-till increased stands by 3,300 plants/a, decreased the time to reach half-bloom by four days, and tended to increase yield, although not at $p = 0.05$ or 0.10.

Crop rotation and planting date both had large effects on grain sorghum. June-planted versus May-planted sorghum had somewhat fewer plants/a, the highest leaf N level, the shortest time to reach half-bloom, and the highest average yield of 80.1 bu/a. Sorghum after wheat had slightly more heads/plant and produced 70.4 bu/a, 8.3 bu/a more than continuous sorghum planted on the same date.

No-till soybeans averaged 38.9 bu/a, 6.4 bu/a more than SW-V. Ten-year mean soybean yields were identical for SW-NT and SW-V.

Table 2. Effects of row crop rotation and tillage on wheat, Harvey County Experiment Field, Hesston, Kansas, 2006.

Crop Sequence[1]	Tillage System	Crop Residue Cover [2]	Yield[3] 2006	Yield[3] 10-Yr	Test Wt	Stand[4]	Heading[5]	Plant N[6]	Cheat Control[7]
		%	bu/a		lb/bu	%	date	%	----%----
Wheat-corn (No-till)	V-blade	73	65.4	57.5	62.0	100	23	1.97	100
	No-till	89	61.4	57.9	61.9	100	24	1.88	100
Wheat-sorghum (No-till)	V-blade	81	63.0	49.4	61.8	100	23	1.62	100
	No-till	89	53.8	48.2	61.6	99	24	1.67	100
Wheat-soybeans (No-till)	V-blade	49	63.1	57.8	61.5	100	22	1.95	100
	No-till	67	64.2	60.2	61.6	100	22	1.89	100
Continuous wheat	Burn	4	62.1	48.8	61.7	99	22	2.14	100
	Chisel	19	59.7	46.5	61.4	100	23	2.08	100
	No-till	92	65.6	49.7	61.7	100	24	1.69	99
LSD .05		8	NS	8.1	NS	NS	0.8	0.21	NS
LSD .10		7	5.8	6.8	NS	NS	0.6	0.17	NS
Main effect means:									
Crop Sequence									
Wheat-corn		81	63.5	57.7	61.9	100	23	1.93	100
Wheat-sorghum		85	58.4	48.8	61.7	100	23	1.65	100
Wheat-soybeans		58	63.6	59.0	61.5	100	22	1.92	100
Continuous wheat		55	62.7	48.1	61.6	100	23	1.89	99
LSD .05		6	NS	8.0	NS	NS	0.6	0.16	NS
Rotation Tillage system									
No-till/V-blade		67	63.8	54.9	61.8	100	23	1.85	100
No-till/no-till		82	59.8	55.4	61.7	100	23	1.81	100
LSD .05		6	NS	NS	NS	NS	NS	NS	NS

[1] All wheat planted no-till after row crops. 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 May 2.

[5] Date in April 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 soybeans, Harvey County Experiment Field, Hesston, Kansas, 2006.

Crop Sequence	Tillage System	Crop Residue Cover [1]	Yield[2] 2006	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	40	70.1	73.8	53.3	16.2	77	1.01	2.94
	No-till	84	62.2	67.9	53.4	15.2	81	0.99	2.98
LSD .05		8	NS	NS	NS	NS	1.5	NS	NS
Sorghum-wheat	V-blade	35	66.8	88.5	57.4	33.0	64	1.08	2.20
	No-till	81	74.0	90.6	57.7	33.4	64	1.12	2.19
Continuous sorghum (May)	Chisel	37	64.7	73.1	58.5	35.8	62	0.97	2.14
	No-till	70	59.5	73.2	57.5	32.5	66	1.05	2.02
Continuous sorghum (June)	Chisel	25	76.1	64.7	57.5	29.7	61	1.28	2.61
	No-till	59	84.1	68.3	57.7	30.6	60	1.34	2.51
LSD .05[5]		8	8.4	14.1	NS	1.9	1.2	0.13	0.23
Soybeans-wheat	V-blade	29	32.5	28.6	---	---	123	---	---
	No-till	79	38.9	28.6	---	---	122	---	---
LSD .05		7	5.2	NS	---	---	NS	---	---
Main effect means for sorghum:									
Crop sequence									
Sorghum-wheat		58	70.4	89.6	57.5	33.2	64	1.10	2.20
Contin. sorghum (May)		53	62.1	73.1	58.0	34.2	64	1.01	2.08
Contin. sorghum (June)		42	80.1	66.5	57.6	30.1	60	1.31	2.56
LSD .05		5	5.9	10.0	NS	1.31	0.9	0.09	0.16
Tillage system									
V-blade/chisel		32	69.2	75.4	57.8	32.8	62	1.11	2.32
No-till/no-till		70	72.6	77.3	57.6	32.2	63	1.17	2.24
LSD .05		4	NS	NS	NS	NS	0.7	NS	NS

[1] Crop residue cover estimated by line transect after planting. Multi-year averages.
[2] Means of four replications adjusted to 15.5% moisture (corn), 12.5% moisture (sorghum) or 13% moisture (soybeans).
Multiple-year averages based on 9 years(1997-1999, 2001-2006) for corn and 10 years (1997-2006) for sorghum and soybeans.
[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, SOYBEANS, AND SUNFLOWERS

M.M. Claassen and D.L. Regehr

Summary

A field experiment consisting of 11 three-year, no-till crop rotations began in 2001 in central Kansas on Ladysmith silty clay loam. Cropping systems with winter wheat (W), corn (C), grain sorghum (GS), double-crop grain sorghum ([GS]), soybeans (SB), double-crop soybeans ([SB]), and sunflowers (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 began in 2004. In 2006, highest W yields occurred in rotations in which W followed SB, averaging 65.7 bu/a. Several of these rotations involved [GS] or [SB]. Wheat following C and SF produced 7.7 and 26.9 bu/a less than W after SB. Row crops, particularly C, endured summer drought stress. Corn averaged 63.4 bu/a without a significant crop rotation effect. Grain sorghum production was greatest in rotations with GS following SB or W, ranging from 113.4 to 125.2 bu/a. Grain sorghum yields were lowest in rotations following [GS], averaging 92.6 bu/a, and yields were intermediate following [SB] or continuous GS. Outstanding [GS] yields of 83.9 to 99 bu/a resulted from late-season rainfall and favorable fall temperatures. Double-crop grain sorghum was favored by low antecedent wheat yields in the W-[GS]-GS-SF rotation. Soybeans produced an excellent average yield of 46.8 bu/a without significant differences among the seven rotations. Double-crop soybean yields also were relatively high, ranging from 27.5 to 34.6 bu/a and tended to be slightly higher in W-[SB]-GS-SF than in the other rotations. Sunflowers yielded 1,729 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 soybeans or sunflowers. One rotation consists entirely of row crops. Continuous grain sorghum serves as a monoculture check treatment. Double-crop soybeans 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 soybeans had been grown in year 2000. Lime was applied according to soil test recommendations 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]), soybeans (SB), double-crop soybeans ([SB]), and sunflowers (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 representing each crop in each rotation.

Plots to be planted to wheat were sprayed with 22 oz/a Roundup Ultra Max II + 2.55 lb/a AMSU with or without 2.67 oz/a 2,4-D_{LVE} 6EC in late September or early October 2005, to control volunteer crop growth and/or late emerged weeds. Overley wheat was planted into corn and soybean stubble on October 17 in 7.5-inch rows at 90 lb/a with a John Deere 1590 no-till drill with single-disk openers. Wheat was fertilized with 120 lb/a N and 32 lb/a P_2O_5 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 10, 2006.

Wheat plots to be planted to corn were sprayed with 22 oz/a Roundup Original Max + AMSU alone or with 3 oz/a Clarity in late July and late September 2005. These and all other plots to be planted to corn in 2006 were sprayed with 1.67lb/a AAtrex 90 DF + 0.67 qt/a 2,4-D_{LVE} 6EC + 1 qt/a COC for fallow and residual weed control. In early April, corn plots where wheat, [SB], or SB had been grown were sprayed with 22 oz/a Roundup Ultra Max II + 2.55 lb/a AMSU. Subsequently, weeds were controlled with 1.33 pt/a Dual II Magnum shortly after corn planting and with 22 oz/a Roundup Ultra Max II + 2.55 lb/a AMSU in late May. A White no-till planter with double-disk openers on 30-inch centers was used to plant Pioneer 35P80 RR with Poncho insecticide at approximately 19,000 seeds/a on April 14, 2006. All corn was fertilized with 30 lb/a N and 30 lb/a P_2O_5, banded 2 inches from the row at planting. Corn after wheat, [SB] and grain sorghum received an additional 95 lb/a N, and corn after soybeans received 65 lb/a N 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 7, 2006.

Wheat plots to be planted to grain sorghum were treated the same as corn during the preceding summer. In plots where grain sorghum was to follow W, GS, SB and [SB], 1.67 lb/a AAtrex 90 DF + 0.67 qt/a 2,4-D_{LVE} 6EC + 1 qt/a COC also were applied in late November 2005. Roundup alone or with a low rate of 2,4-D_{LVE} was applied to most plots in early April and mid-May. Dual II Magnum plus Roundup Ultra Max II + AMSU were applied to all plots eight days before grain sorghum planting. Sorghum Partners KS 585 treated with Cruiser insecticide and Concep safener was planted at 40,000 seeds/a in 30 inch rows with 30 lb/a N and 30 lb/a P_2O_5 banded 2 inches from the row on June 29. Sorghum after wheat, sorghum, [GS], and [SB] received an additional 60 lb/a of N, and sorghum after soybeans received 30 lb/a of N as 28-0-0 injected in a band 10 inches on either side of each row on July 20. Sorghum was harvested on November 8, 2006.

Double-crop grain sorghum plots received an application of 33 oz/a Roundup Original

Max + 0.55 lb/a AMSU just before planting. Pioneer 87G57 with Cruiser insecticide and Concep safener was planted on July 1 with the same procedures used for full-season grain sorghum. An additional 30 lb/a of N was injected on July 20. Postemergence application of 1.5 qt/a AAtex 4L +1 pt/a Superb HC COC was made with drop nozzles on August 12. Double-crop grain sorghum was harvested on November 8.

Wheat plots to be planted to soybeans were treated with Roundup applications in July and September, like those for corn and sorghum, plus a low rate of Roundup in late November. Corn and sorghum plots to be planted to soybeans were sprayed in late November with 5 oz/a Sencor 75 DF + 0.67 qt/a 2,4-D_{LVE} 6EC + 1 qt/a COC. In mid-May, all soybean plots were sprayed with Roundup plus a low rate of 2,4-D_{LVE} plus AMSU.

Asgrow AG3302 RR soybeans were planted at 115,000 seeds/a in 30-inch rows on May 20. During the season, a single application of Roundup at 22 oz/a was applied on June 21. Soybeans were harvested on October 3, 2006.

Double-crop soybeans had a preplant application of 33 oz/a Roundup Original Max + 0.55 lb/a AMSU. Asgrow A3302 RR soybeans were planted as a double crop at 122,000 seeds/a in 30-inch rows on July 1. Double-crop soybeans were sprayed with 22 oz/a Roundup Original Max + 0.55 lb/a AMSU + 0.25% v/v NIS on August 11. Full-season as well as double-crop soybeans were sprayed with Baythroid 2 at 2.8 oz/a on September 1 for control of a high population of woollybear caterpillars and was harvested on November 3, 2006.

All sunflower plots were sprayed with Roundup Ultra Max II plus a low rate of 2,4-D_{LVE} 6EC + AMSU in mid-May. Dual II Magnum at 1.33 pt/a + 33 oz/a Roundup Ultra Max II + 0.52 lb/a AMSU were applied on June 21. Triumph s672 sunflowers were planted at 28,000 seeds/a, with 30-30-0 fertilizer banded 2 inches from the row, on June 28. An additional 40 lb/a N was injected on July 20. Plots were sprayed with Baythroid 2 at 2.8 oz/a on September 1 for control of a high population of woollybear caterpillars that developed and caused notable leaf damage. Sunflowers were harvested on October 6.

Results

Wheat

Wheat stand establishment was excellent, but with slightly less than perfect stands in wheat following sunflowers. Heading tended to be earliest in wheat after soybeans or corn and latest in wheat after sunflowers, with an average difference of four to five days. Plant heights were five to six inches greater in wheat after corn or soybeans than after sunflowers (Table 4). Plant N concentration was inversely related to grain yield; that is, the lowest levels occurred where grain production was highest. Wheat after sunflowers averaged 2.70% N, 0.50 to 0.65% N more than after corn and soybeans, respectively. Highest wheat yields occurred in rotations where W followed SB, averaging 65.7 bu/a. Notably, these yields were obtained in one of the driest wheat growing seasons on record. Furthermore, these yields occurred in several rotations involving [GS] or [SB]. When averaged over all rotations, wheat following corn and sunflowers produced 7.7 and 26.9 bu/a less than wheat after soybeans.

Grain test weights averaged 61.6 to 61.9 lb/bu in wheat after corn or soybeans. Test weight of wheat after sunflowers was significantly less at 55.0 lb/bu. Grain protein levels followed the trends noted for plant N concentration, ranging from 13.0 to 14.0% among rotations where wheat followed corn or soybeans. Grain protein in wheat after sunflowers was significantly higher at 15.8 to16.0%. In general, antecedent crop effects were much more significant than overall rotation effects in determining wheat performance.

Corn

Corn emerged about eight days after planting. Final corn populations averaged 18,100 plants/a (Table 5) and were not significantly affected by crop rotation. Corn reached the half-silking stage at 74 to 76 days after planting, tending to be latest following wheat in rotation. Leaf N averaged 3.01 %, with no significant rotation effect. Lodging was minimal, ranging from 0 to 2%, without consistent relationship to crop rotation. Corn yields averaged 63.4 bu/a without rotation effect. Test weight was highest in corn after soybeans at 53.9 lb/bu and lowest in corn after wheat, with an average of 51.9 lb/bu. The number of ears/plant averaged 0.97 without a significant effect by crop rotation.

Grain sorghum

Grain sorghum planting was delayed by rainfall in June. Emergence occurred rapidly at four days after planting. Final populations ranged from 28,800 to 34,900 plants/a. Lowest full-season sorghum plant counts occurred in GS-C-SB, whereas populations differed somewhat across the remaining rotations. On average, full-season grain sorghum reached half-bloom stage at 59 days after planting. In W-[SB]-GS-SB, W-[GS]-GS-SB, and W-[GS]-GS-SF, half-bloom occurred two to three days later than in the other crop rotations. Leaf N levels generally ranged from 2.82 to 2.91% in most rotations, but with significantly lower mean values of 2.62% in grain sorghum following [GS].

Grain sorghum production was greatest in rotations where it followed soybeans or wheat, ranging from 113.4 to 125.2 bu/a. Grain sorghum yields were lowest in rotations following [GS], averaging 92.6 bu/a, and intermediate following [SB] or continuous GS. Grain test weight averaged 59.8 lb/bu, with minor differences among rotations. The umber of heads/plant ranged from 1.26 to 1.87. Lowest head counts tended to occur in rotations in which GS followed GS or [GS] and highest in GS-C-SB. Lodging was insignificant.

Remarkably, [GS] grain production was similar to that of the full season crop, with yields ranging from 83.9 to 99 bu/a. Outstanding [GS] yields were achieved because of late-season rainfall and favorable fall temperatures. Stands averaged 31,400 plants/a without treatment effect. But [GS] averaged 0.40% higher leaf N, matured three days later, produced 0.3 heads/plant more and yielded 15.1 bu/a more in W-[GS]-GS-SF than in W-[GS]-GS-SB. These rotation effects were believed to be the result of low antecedent wheat yields in the W-[GS]-GS-SF rotation.

Soybeans

Soybeans emerged six days after planting. Stands were excellent among all rotations (Table 6). Full-season SB developed plant heights that averaged 26 inches and an excellent mean yield of 46.8 bu/a without significant differences among the seven rotations. There was no lodging.

Double-crop soybean stands also were excellent. Plant heights averaged 26 inches, with no rotation effect. Double-crop soybeans reached maturity at 98 days without treatment effect. No lodging occurred. Yield of [SB] ranged from 27.5 to 34.6 bu/a, with a tendency toward increased yield in the W-[SB]-GS-SF rotation. This effect, as in the case of [GS], likely resulted from lower wheat yield just before [SB] planting.

Sunflowers

Sunflowers emerged five days after planting. Populations averaged 23,700 plants/a. Triumph s672 NuSun short-stature sunflowers reached half-bloom stage at 54 days and an average height of 35 inches. Yields averaged 1,729 lb/a, with 1% 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, 2006.

Crop	Crop Rotation[1]	Yield[2] 2006	Yield[2] 3-yr	Test Wt	Stand	Heading[3]	Plant ht	Plant N[4]	Grain Protein
		-------bu/a------		lb/bu	%	date	inches	%	%
Wheat	W-C-SB	60.9	59.9	61.9	100	22	30	2.12	13.7
	W-[SB]-C-SB	66.5	66.1	62.3	100	22	31	1.94	13.1
	W-SB-C	55.4	56.8	61.6	100	23	30	2.20	14.0
	W-GS-SB	67.5	66.1	61.8	100	22	30	2.16	13.2
	W-[SB]-GS-SB	67.1	66.4	61.9	100	22	30	2.08	13.0
	W-[GS]-GS-SB	66.4	64.2	62.0	100	22	31	1.97	13.4
	W-GS-SF	28.0	35.9	56.2	98	27	25	2.74	15.8
	W-[SB]-GS-SF	31.3	39.6	53.7	97	27	25	2.70	15.8
	W-[GS]-GS-SF	28.8	37.2	55.0	98	27	25	2.65	16.0
	LSD 0.05	7.9		3.0	1.2	0.8	1.3	0.18	1.01
	LSD 0.10	6.6		2.5	1.0	0.6	1.1	0.15	0.83
	Preceding crop main effect means:								
	Corn	55.4	56.8	61.6	100	23	30	2.20	14.0
	Soybeans	65.7	64.5	61.9	100	22	31	2.05	13.3
	Sunflowers	29.4	37.6	55.0	98	27	25	2.70	15.8
	LSD 0.05[5]	4.4		1.6	0.7	0.4	0.7	0.11	0.54
	LSD 0.10[5]	3.7		1.3	0.5	0.3	0.6	0.09	0.46

[1] C = corn, GS = grain sorghum, SB = soybeans, SF = sunflowers, 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, 2006.

Crop	Crop Rotation[1]	Yield[2] 2006	Yield[2] 3-Yr	Test Wt	Stand	Maturity[3]	Ears or Heads/ Plant	Lodging	Leaf[4] N
		-----bu/a-----		lb/bu	1000/a	date		%	%
Corn	W-C-SB	65.6	96.9	54.6	18.0	76	0.99	1	3.06
	W-[SB]-C-SB	64.6	96.4	53.9	18.2	75	0.96	0	3.05
	W-SB-C	61.9	91.6	51.9	18.6	74	0.97	2	2.95
	GS-C-SB	61.4	92.2	53.3	17.8	75	0.96	2	3.00
	LSD 0.05	NS		1.8	NS	1.1	NS	NS	NS
	LSD 0.10	NS		1.4	NS	0.9	NS	NS	NS
Sorghum	W-GS-SB	113.4	101.7	60.1	34.9	60	1.50	0	2.88
	W-[SB]-GS-SB	110.2	97.8	59.9	31.1	61	1.64	0	2.91
	W-[GS]-GS-SB	93.8	91.6	59.8	33.6	62	1.26	0	2.60
	W-GS-SF	125.2	103.6	60.3	33.3	60	1.60	0	2.85
	W-[SB]-GS-SF	111.4	96.6	60.8	33.5	59	1.55	1	2.91
	W-[GS]-GS-SF	91.4	92.6	59.4	31.1	63	1.38	0	2.63
	GS-C-SB	118.8	101.9	60.4	28.8	59	1.87	0	2.91
	GS-GS-GS	106.8	95.5	60.1	33.2	59	1.47	1	2.82
[Sorghum]	W-[GS]-GS-SB	83.9	79.9	58.9	31.8	53	1.49	0	2.48
	W-[GS]-GS-SF	99.0	85.9	58.1	31.0	56	1.79	1	2.88
	LSD 0.05	12.0		0.8	1.9	2.0	0.14	NS	0.21
	LSD 0.10	10.0		0.7	1.6	1.7	0.12	0.5	0.17
	<u>Preceding crop main effect means:</u>								
Sorghum	Wheat	119.3	102.7	60.2	34.1	60	1.55	0	2.87
	[Soybeans]	110.8	97.2	60.4	32.3	60	1.59	1	2.91
	Soybeans	118.8	101.9	60.4	28.8	59	1.87	0	2.91
	[Sorghum]	92.6	92.1	59.6	32.4	62	1.32	0	2.61
	Sorghum	106.8	95.5	60.1	33.2	59	1.47	1	2.82
	LSD 0.05[5]	10.8		0.6	1.9	1.4	0.11	NS	0.14
	LSD 0.10[5]	9.0		0.5	1.6	1.1	0.09	0.4	0.12

[1] C = corn, GS = grain sorghum, SB = soybeans, SF = sunflowers, 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 follows: corn – days from planting to 50% silking, and grain sorghum - number of 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 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 soybeans and sunflowers, Harvey County Experiment Field, Hesston, Kansas, 2006.

Crop	Crop Rotation[1]	Yield[2] 2006	Yield[2] 3-Yr	Stand[3]	Plant Ht	Maturity[4]	Lodging
		----------bu/a----------			inches	date	%
Soybeans	W-C-SB	44.3	45.0	100	25	121	0
	W-[SB]-C-SB	45.1	45.5	100	26	122	0
	W-SB-C	44.9	44.5	100	26	121	0
	W-GS-SB	47.5	44.0	100	26	121	0
	W-[SB]-GS-SB	48.2	44.3	100	26	121	0
	W-[GS]-GS-SB	49.8	44.3	100	26	121	0
	GS-C-SB	47.6	45.0	100	25	121	0
[Soybeans]	W-[SB]-C-SB	32.1	19.5	100	26	98	0
	W-[SB]-GS-SB	27.5	18.1	100	26	98	0
	W-[SB]-GS-SF	34.6	22.4	100	26	99	0
	LSD 0.05	6.6		NS	NS	1.5	NS
	LSD 0.10	5.5		NS	NS	1.2	NS
	Preceding crop main effect means:						
	Wheat	44.9	44.5	100	26	121	0
	Corn	45.7	45.2	100	25	121	0
	Sorghum	48.5	44.2	100	26	121	0
	LSD 0.05[5]	2.9		NS	NS	NS	NS
	LSD 0.10[5]	2.4		NS	NS	NS	NS
Sunflowers	W-GS-SF	1813	1981	23.2	35	54	1
	W-[SB]-GS-SF	1654	1785	24.4	35	54	1
	W-[GS]-GS-SF	1721	1829	23.6	35	54	1
	LSD 0.05	NS	NS	NS	NS	NS	NS
	LSD 0.10	NS	NS	NS	NS	NS	NS

[1] C = corn, GS = grain sorghum, SB = soybeans, SF = sunflowers, W = wheat, and [ ] = double crop.
[2] Means of four replications adjusted to 13% moisture (soybeans) or 10% moisture (sunflowers in lb/a).
[3] Stand expressed as a percentage for soybeans and as plant population in thousands per acre for sunflowers.
[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 soybeans = 2.3.

EFFECTS OF LATE-MATURING SOYBEAN AND SUNN HEMP SUMMER COVER CROPS AND NITROGEN RATE IN A NO-TILL WHEAT-GRAIN SORGHUM ROTATION

M.M. Claassen

Summary

Wheat and grain sorghum were grown in three no-till crop rotations, two of which included either a late-maturing Roundup Ready® soybean or a sunn hemp cover crop established after wheat harvest. Nitrogen (N) fertilizer was applied to both grain crops at rates of 0, 30, 60, and 90 lb/a. Experiments were conducted on adjacent sites where different phases of the same rotations were established.

On the first site, late-maturing soybean and sunn hemp cover crops grown for the second time in the rotations (2004) contained 90 and 125 lb/a N, respectively. Residual effects of soybeans on wheat were similar to those of sunn hemp. In the very dry wheat growing season of 2005 and 2006, plant heights and N levels showed no response to cover crop, but increased significantly with N rate. Wheat yield increases of 4.4 and 6.3 bu/a, respectively, in rotations with soybeans and sunn hemp occurred only at 60 lb/a N. Grain test weight was not substantially affected by either cover crop or N rate.

On the second site, grain sorghum followed cover crops grown for the first time in the rotations. Soybeans and sunn hemp average 2.42 and 4.14 ton/a of above-ground dry matter. Corresponding N yields of 103 and138 lb/a were potentially available to the succeeding grain sorghum crop. In the rotation without a cover crop, grain sorghum leaf N concentrations were significantly higher at only the two highest rates of N fertilizer. A similar trend in leaf N occurred in grain sorghum following soybeans. On the other hand, sorghum leaf N was higher at all rates of N and showed no response to N rate in the rotation with sunn hemp. When averaged across N fertilizer rates, soybeans and sunn hemp significantly increased sorghum leaf nutrient levels, by 0.12% N and 0.20% N, respectively.

Cover crops did not affect grain sorghum plant population or grain test weight, and tended to shorten only slightly the length of time to reach half-bloom. At zero fertilizer N, soybeans and sunn hemp increased sorghum yields by 30.9 and 34.7 bu/a. Averaged over N rate, these respective yield increases were 12.5 and 17.8 bu/a . Without a cover crop in the rotation, sorghum yields increased with N rate and reached a maximum of 100.6 bu/a at 60 lb/a. Nitrogen rate did not affect yield of sorghum after soybeans. Nitrogen rate increased yield of sorghum following sunn hemp significantly only at 60 lb/a N with a maximum of 109 bu/a.

Introduction

Research at the KSU Harvey County Experiment Field over an eight-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 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 the current experiment, late-maturing soybeans and sunn hemp, a tropical legume, were evaluated as summer cover crops for their impact on no-till sorghum grown in the spring after wheat harvest, and for residual effect on double-crop no-till wheat after grain sorghum. In 2002 and 2004, during the first two cycles of these rotations at the initial experiment location, the two cover crops produced average N yields of 118 and 122 lb/a, respectively. When averaged over N rates, soybeans and sunn hemp resulted in two-year average grain sorghum yield increases of 6.3 and 12 bu/a. Residual effects of cover crops on wheat averaged over N rates at the beginning of the second cycle were evidenced by yield increases of 4.0 and 2.3 bu/a.

Procedures

Experiments were established on adjacent Geary silt loam sites that were used for hairy vetch cover crop research in a wheat-sorghum rotation from 1995 to 2001. In keeping with the previous experimental design, soybeans and sunn hemp were assigned to plots where vetch had been grown, and remaining plots retained the no-cover-crop treatment. The existing factorial arrangement of N rates on each cropping system also was retained. In 2006, wheat was produced on site 1 at the beginning of the third cycle of the rotations. Grain sorghum was grown on the second site in the first cycle of the rotations.

Wheat

Weeds in wheat stubble were controlled with Roundup Ultra Max II herbicide applied nine days before cover crop planting. Asgrow AG701 Roundup Ready® soybeans 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, 2004, 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. Soybeans were 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. Nitrogen rates were reapplied as broadcast 34-0-0 on October 25, 2005. Variety Jagger winter wheat was then no-till planted at 90 lb/a with 32 lb/a P_2O_5 fertilizer banded as 0-46-0 in the furrow. Wheat was harvested on June 15, 2006.

Grain Sorghum

Weeds were controlled and cover crops managed with procedures similar to those previously noted for site 1. Soybeans and sunn hemp seed were no-till planted on July 9, 2005 and terminated in late September. Pioneer 8505 grain sorghum treated with Concep® safener and Cruiser® insecticide was planted at approximately 40,000 seeds/a on July 1, 2006. Atrazine and Dual II Magnum were preplant applied for residual weed control. The entire site 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 July 19, 2006. Grain sorghum was combine harvested on November 9.

Results

Wheat

During the nine days preceding cover crop planting in 2004, 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 soybeans and sunn hemp.

Although July rainfall was above normal, August and September were drier than usual. Late-maturing soybeans 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 N. Soybeans and sunn hemp suppressed volunteer wheat to some extent, but failed to give the desired level of late-summer control.

In 2005, soybeans 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. Yields averaged over cropping systems increased significantly with each 30 lb/a increment of fertilizer N.

The residual effect of cover crops in 2006 on winter wheat plant height was generally minor, and across cropping systems, increased by 4 to 7 inches with the first increment of N fertilizer. Plant N in wheat at early heading indicated that there was no residual N contribution from cover crops.

Fertilizer, however, significantly increased plant N incrementally with 60 and 90 lb/a of N. Wheat yields tended to be slightly greater in rotations with a cover crop. In the case of sunn hemp, the yield advantage of 3.2 bu/a was significant when averaged over N rates. But most of the rotation effect on yield was observed at N rates less than 90 lb/a. Cover crops had a minor but positive effect on grain test weight, mainly at low N rates. Test weight tended to increase slightly with 30 and 60 lb/a of N.

Grain Sorghum

During the week preceding cover crop planting in 2005, rainfall totaled 1.89 inches. A 1-inch rain fell three days after planting, but the remainder of July had a total of only 0.58 inch. Stand establishment was good with both soybeans and sunn hemp. August rainfall was well above normal. September was much drier than usual.

Late-maturing soybeans reached an average height of 27 inches, had minor pod development, and produced 2.42 ton/a of above-ground dry matter with an N content of 2.11% or 103 lb/a (Table 8). Sunn hemp averaged 86 inches in height and produced 4.14 ton/a with 1.67% N or 138 lb/a of N. Soybeans and sunn hemp gave partial suppression of volunteer wheat, but did not eliminate the need for herbicide control ahead of the wheat planting season.

Grain sorghum final stands averaged 26,717 plants/a. In 2006, July and August had a total of 31 days with temperatures of 95 ^{o}F or higher and 13 days with temperatures of 100 to 108 ^{o}F. July was dryer than usual. Above-normal rainfall in August, coupled with more moderate temperatures during the second half of the month, greatly benefitted the sorghum crop. Mean temperatures in September and October were 5.4 and 2.6 ^{o}F below normal. September rainfall was 1.8 inches below the long-term average, and October was also dryer than usual. First freezing temperatures of the fall arrived on October 18. This and subsequent freezes hastened sorghum grain maturation to some extent.

Where no cover crop was used in the rotation, grain sorghum leaf N concentration increased with each increment of N fertilizer, reaching significantly higher levels with 60 and 90 lb/a N. Similarly, where sorghum followed soybeans, leaf N increased significantly at only the 60 and 90 lb/a rates, but without an incremental relationship to N rate. In the rotation with sunn hemp, however, sorghum leaf N tended to be higher at all rates of fertilizer and had no meaningful response to N rate. The main effect of soybeans and sunn hemp, averaged across N fertilizer rates, significantly increased sorghum leaf nutrient levels by 0.12% N and 0.20% N, respectively.

Cover crops did not affect grain sorghum plant population or grain test weight. On average, sorghum following sunn hemp tended to reach half-bloom stage slightly earlier than in the other rotations. The number of heads/plant increased with both cover crops and N rates. At zero fertilizer N, sorghum after soybeans and sunn hemp produced yields of 92.0 and 95.8 bu/a, representing increases of 30.9 and 34.7 bu/a. The main effects of cover crops averaged over all N rates were evidenced by respective yield increases of 12.5 and 17.8 bu/a. Without a cover crop in the rotation, sorghum yields increased with fertilizer rate and reached a maximum of 100.6 bu/a at 60 lb/a N. Sorghum following soybeans averaged 96.1 bu/a and did not respond significantly to N rate. In the rotation with sunn hemp, sorghum grain production increased significantly only at 60 lb/a N with the high of 109 bu/a.

Table 7. Residual effects of soybean and sunn hemp summer cover crops and nitrogen rate on no-till wheat after grain sorghum , Hesston, Kansas, 2006.

Cover Crop[1]	N Rate[2]	Cover Crop Yield[3] Forage	Cover Crop Yield[3] N	Sorghum Yield 2005	Wheat Yield	Wheat Bushel Wt	Wheat Plant Ht	Wheat Plant N[4]
	lb/a	ton/a	lb/a	bu/a	bu/a	lb	in.	%
None	0	----	----	49.2	5.1	61.1	15	1.51
	30	----	----	74.0	22.2	61.7	21	1.31
	60	----	----	84.5	29.8	61.9	22	1.68
	90	----	----	96.9	35.1	61.4	23	2.13
Soybeans	0	2.30	93	73.4	8.4	61.7	16	1.46
	30	2.02	87	81.3	23.0	61.8	20	1.41
	60	2.53	109	92.8	34.2	62.0	24	1.73
	90	1.59	69	96.3	34.3	61.4	22	2.14
Sunn hemp	0	2.95	116	71.7	7.6	61.6	15	1.44
	30	3.10	118	87.2	24.3	62.1	22	1.50
	60	3.26	130	92.7	36.1	62.3	23	1.76
	90	3.47	136	106.7	36.6	61.5	23	1.97
LSD .05		0.71	32	9.7	4.9	0.57	2.3	0.20
Means:								
Cover Crop/ Termination								
None		----	----	76.2	23.1	61.5	20	1.65
Soybeans		2.11	90	85.9	25.0	61.7	21	1.68
Sunn hemp		3.19	125	89.6	26.2	61.9	21	1.67
LSD .05		0.35	16	4.9	2.4	0.28	NS	NS
N Rate								
0		2.62	105	64.8	7.0	61.5	15	1.47
30		2.56	102	80.8	23.2	61.9	21	1.41
60		2.89	119	90.0	33.4	62.0	23	1.72
90		2.53	103	100.0	35.3	61.4	23	2.08
LSD .05		NS	NS	5.6	2.8	0.33	1.3	0.12

[1] Cover crops planted on July 9, 2004 and terminated by early fall.
[2] N applied as 28-0-0 injected June 27, 2005 for sorghum and 34-0-0 broadcast on October 25, 2005 for wheat.
[3] Oven dry weight and N content for sunn hemp and soybeans on September 17 and October 4, 2004, respectively.
[4] Whole-plant N concentration at early heading.

Table 8. Effects of soybean and sunn hemp summer cover crops and nitrogen rate on no-till grain sorghum after wheat, Hesston, Kansas, 2006.

Cover Crop[1]	N Rate[2]	Cover Crop Yield[3] Forage	Cover Crop Yield[3] N	Grain Sorghum Grain Yield	Bushel Wt	Stand	Half[4] Bloom	Heads/ Plant	Leaf N[5]
	lb/a	ton/a	lb/a	bu/a	lb	1000's/a	days	no.	%
None	0	----	----	61.1	57.3	25.7	61	1.39	2.19
	30	----	----	74.5	58.9	27.8	60	1.44	2.29
	60	----	----	100.6	59.1	27.2	59	1.73	2.54
	90	----	----	98.3	59.1	25.0	60	1.94	2.74
Soybeans	0	2.41	101	92.0	59.3	27.6	59	1.60	2.44
	30	2.06	85	98.5	59.2	26.8	60	1.75	2.45
	60	2.89	125	98.4	59.0	25.7	60	1.89	2.67
	90	2.33	100	95.2	58.7	27.2	60	1.79	2.68
Sunn hemp	0	3.74	116	95.8	59.2	26.2	59	1.81	2.60
	30	4.13	150	102.7	59.0	27.8	58	1.70	2.49
	60	4.34	142	109.0	59.4	27.3	59	1.84	2.69
	90	4.37	145	98.2	59.0	26.5	60	1.83	2.76
LSD .05		0.72	31	9.4	NS	NS	1.6	0.25	0.31
Means: Cover Crop/ Termination									
None		----	----	83.6	58.6	26.4	60	1.62	2.44
Soybeans		2.42	103	96.1	59.1	26.8	59	1.76	2.56
Sunn hemp		4.14	138	101.4	59.1	26.9	59	1.80	2.64
LSD .05		0.36	15	4.7	NS	NS	0.8	0.13	0.16
N Rate									
0		3.07	108	83.0	58.6	26.5	59	1.60	2.41
30		3.09	118	91.9	59.0	27.5	59	1.63	2.41
60		3.61	133	102.7	59.2	26.7	59	1.82	2.63
90		3.35	123	97.2	59.0	26.2	60	1.85	2.73
LSD .05		NS	NS	5.4	NS	NS	NS	0.15	0.18

[1] Cover crops planted July 9, 2005 and terminated in early fall.
[2] N applied as 28-0-0 injected July 19, 2006.
[3] Oven dry weight and N content for sunn hemp and soybeans on September 26, 2005.
[4] Days from planting to half-bloom.
[5] Flag leaf at late boot to early heading.

EFFECTS OF CHLORIDE 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 banded or broadcast for sorghum preemergence at rates providing 10, 20, and 30 lb/a of Cl. The wheat experiment included fungicide treatments alone and in combination with Cl. Chloride levels in leaves of both crops were lowest in plots receiving no Cl fertilizer, although not as low as expected in sorghum. Chloride fertilizer significantly increased the concentration of Cl in crop leaves. Wheat yields increased by about 6 bu/a with 20 lb/a of Cl followed by Headline + Tilt or by Quilt, but Cl alone did not result in wheat yield enhancement. Grain sorghum yields also did not increase with Cl fertilizer with either broadcast or band placement.

Introduction

Chloride 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, with soil Cl of 2.4 parts per million at 0 to 24 inches. The area had been cropped to no-till wheat in 2004-2005. Jagger wheat with Raxil XT seed treatment was no-till planted on October 19, 2005, at 90 lb/a into wheat stubble from a previous thin stand. The basic fertilizer program on the site provided 120-32-0 lb/a of N-P-K, applied as 18-46-0 banded with the seed and 34-0-0 broadcast before planting. Chloride rates of 0, 10, 20, and 30 lb/a were broadcast as ammonium chloride (6-0-0-16.5) on 4-inch tillered wheat just after dormancy break (Feekes stage 3.5) on March 2, 2006. Treatments included 28-0-0 to provide equivalent N to that supplied by the highest rate of ammonium chloride. Fungicide treatments were applied to wheat at stage 9.5 on April 19 (Table 9). Leaf samples for nutrient analyses were collected at heading on April 26. Plots were combine harvested on June 10, 2006.

Grain Sorghum

The grain sorghum project also was on Ladysmith silty clay loam soil. A soil test indicated 1.9 parts per million Cl at 0 to 24 inches. After a wet-weather delay, Pioneer 8505 with Concep safener and Cruiser insecticide seed treatment, grain sorghum was no-till planted into soybean stubble on June 29, 2006, in rows spaced at 30 inches. Chloride rates of 10, 20, and 30 lb/a were broadcast or surface banded 5 inches from the row as ammonium chloride before sorghum emergence. UAN was added to achieve a constant N level across treatments, including the check. Nitrogen and P at 30 lb/a each were banded 2 inches from the row with the planter. An additional 60 lb/a N was injected as 28-0-0, 10 inches from the row three weeks after planting. Weeds were controlled with 1.11 lb/a atrazine 90 DF plus 1.33 pt/a Dual II Magnum broadcast before planting. Leaf samples for nutrient analyses were collected at the six-leaf to eight-leaf stage. Plots were harvested on November 7.

Results

Wheat

Emergence occurred within the normal time frame, and resultant stands were excellent. Rainfall in October was nearly two inches below normal, but 0.36 inches of rain was received shortly after planting. The remaining fall period brought a few light rains totaling 0.76 inch. In 2006, only March and April had near-normal precipitation. As a whole, the wheat growing season was the second driest on record at this location.

In mid-April, approximately 2% of lower wheat leaves were affected by powdery mildew and tan spot, respectively. The disease scenario changed little by the time wheat reached stage 9.5. Powdery mildew diminished with time, and tan spot did not progress in severity nor affect the upper wheat leaves. In mid-May, only a trace of leaf rust could be found. Because of weather conditions, most wheat leaves had dried up by the end of May.

Leaf Cl level increased numerically with each increment of Cl fertilizer. Differences in leaf Cl between the check and the lowest rates of Cl were not significant. Chloride alone had no effect on wheat yield, fungicides generally had a small numerical benefit which was not significant (data not shown), and the combination of chloride + fungicide increased yield by about 4 to 7 bu/a. Conventional wisdom would not anticipate an additive effect with the combination. The highest statistically-equal wheat yields occurred with Headline plus Tilt (6 + 2 oz/a) and no Cl, Headline plus Tilt (6 + 4 oz/a) following 20 lb/a of chloride, and Quilt (14 oz/a) following 20 lb/a of chloride. Yields for these treatments were 80.8, 80.5, and 84.1 bu/a, respectively. All fungicide and chloride treatments increased grain test weight significantly.

Grain Sorghum

The first significant rainfall of 0.75 inches occurred 11 days after planting and Cl treatment applications. Rainfall for the first two weeks after planting totaled one inch. At the end of the fourth week after planting, heavy rainfall over a two-day period totaled 3.37 inches. Late summer rains and moderating temperatures resulted in very good grain sorghum yields despite a generally stressful row-crop season.

Final grain sorghum stands averaged 28,130 plants/a. Some fall armyworm activity was observed over the experiment site, but insecticide application was not considered to be advisable. Grain sorghum leaf Cl concentration (Table 10) increased significantly with each increment of broadcast Cl fertilizer and with all but the highest rate of banded Cl. When averaged over Cl rate, band application of Cl was associated with slight increases in leaf N and P, and with decreases in leaf K and Cl. Length of time from planting to sorghum half-bloom stage, plant height, lodging, number of heads per plant, and grain test weight were not affected by treatments. Overall grain sorghum yields averaged 104 bu/a, but yield response to Cl rate was not consistent and generally not significant. Band application was not advantageous.

Table 9. Effects of chloride fertilization and fungicides on no-till continuous winter wheat, Hesston, Kansas, 2006.[1]

Cl[2]	Yield[1]		Bushel Wt	Leaf[4]			
	2006	2005		N	P	K	Cl
lb/a	----------bu/a----------		lb	----------------------------%----------------------------			
0	76.0	29.9	60.9	4.14	0.283	2.26	0.183
10	76.6	32.5	61.4	4.11	0.294	2.28	0.212
20	76.3	37.5	61.5	4.15	0.283	2.37	0.298
30	75.8	33.1	61.4	4.00	0.282	2.28	0.429
20 + Headline + Tilt	80.2	----	61.8	3.99	0.281	2.31	0.349
20 + Quilt	83.9	----	62.0	4.17	0.283	2.32	0.365
LSD .05	4.6	3.9	0.35	NS	NS	0.09	0.121

[1] All data are the means of four replications.
[2] Broadcast as ammonium chloride (6-0-0-16.5) on March 3, 2005 and March 2, 2006. Headline, Tilt and Quilt fungicides were applied with 0.25% NIS on April 19, 2006.
[3] Yields adjusted to 12.5% moisture.
[4] Flag leaf and flag leaf minus one at heading (April 26, 2006).

Table 10. Effects of chloride fertilization on no-till continuous grain sorghum, Hesston, Kansas, 2006.[1]

Cl[2]	Placement	Grain Yield[3]	Bushel Wt	Half Bloom	Lodg-ing	Leaf[4]			
						N	P	K	Cl
lb/a		bu/a	lb	DAP	%	-----------------------%------------------------			
0	----	105	59.2	60	1	3.45	0.209	1.88	0.218
10	Broadcast	112	58.8	60	2	3.45	0.211	1.92	0.476
20	Broadcast	105	59.2	60	1	3.29	0.202	2.03	0.713
30	Broadcast	92	58.2	61	3	3.22	0.201	1.90	0.788
10	Band	102	59.0	60	1	3.49	0.209	1.83	0.423
20	Band	108	58.7	61	1	3.48	0.210	1.83	0.576
30	Band	100	58.4	60	1	3.61	0.219	1.88	0.602
LSD 0.10		NS	NS	NS	NS	0.22	NS	NS	0.069
Main effect means:									
Cl Rate									
10		107	58.9	60	1	3.47	0.210	1.87	0.449
20		106	58.9	60	1	3.38	0.206	1.93	0.644
30		96	58.3	60	2	3.41	0.210	1.89	0.695
LSD 0.10		6.8	NS	NS	NS	NS	NS	NS	0.058
Application									
	Broadcast	103	58.7	60	2	3.32	0.205	1.95	0.659
	Band	103	58.7	60	1	3.53	0.213	1.84	0.533
	LSD 0.10	NS	NS	NS	NS	0.12	0.007	0.11	0.047

[1] All data are the means of four replications.
[2] Broadcast or banded 5 inches from the row as ammonium chloride (6-0-0-16.5) before sorghum emergence.
[3] Yields adjusted to 12.5% moisture.
[4] Uppermost expanded leaf at 6- to 8-leaf stage.

FUNGICIDE EFFECT ON SOYBEANS

M.M. Claassen

Summary

Headline fungicide has been reported to increase soybean yield even in the absence of leaf disease. To evaluate crop response under dryland conditions in central Kansas, four soybean varieties (Asgrow AG3302, Pioneer 93M50, KS 3406RR, and Ohlde 3334 NRR) were no-till planted into 2005 wheat stubble in late June 2006. Headline 2.09 EC at 6 fl oz/a was applied in mid-August when soybeans were in stage R3. At six weeks after application, the progression of leaf yellowing across all varieties averaged about 8% less where Headline had been applied. Ohlde 3334 NRR was the only variety responding positively to Headline, with a yield increase of 3.7 bu/a.

Introduction

Historically, soybean production in Kansas generally has not required the use of a fungicide for disease control. But the prospective need for control procedures in the advent of a possible occurrence of soybean rust has heightened interest in the evaluation of foliar fungicides such as Headline. There have been reports that Headline had a positive effect on soybeans even in the absence of disease by prolonging the life of soybean leaves and ultimately, by increasing soybean yield. This project was initiated to evaluate the response of several soybean varieties to Headline in the absence of significant disease under dryland conditions.

Procedures

The experiment site was located on a Smolan silt loam where a no-till wheat-soybean crop rotation was established. The experiment utilized a randomized complete block design with six replications of eight treatments consisting of four soybean varieties grown with and without Headline fungicide. Varieties Asgrow AG3302, Pioneer 93M50, KS 3406RR, and Ohlde 3334 NRR were no-till planted into 2005 wheat stubble on June 27, 2006, at 8 seeds/ft in 30-inch spaced rows. Headline 2.09 EC treatment was applied at 6 fl oz/a with 0.25% NIS v/v on August 14, when soybeans were in stage R3. Baythroid 2L insecticide was applied on September 2, to control woolybear caterpillar. Soybean leaf maturation was monitored in terms of change in color and complete senescence. Soybeans were harvested by plot combine on October 20.

Results

The first significant rainfall occurred one week after planting. Soybean emergence and stand establishment were good. Following a stressful mid-season with high temperatures and below normal rainfall, soybeans benefitted from more moderate temperatures and rains after mid-August. First freezing temperatures of the fall arrived on October 18 and did not affect soybeans. Woolybear caterpillar posed a significant threat in late August and early September. Insecticide application provided effective control. Harvesting conditions were excellent. There was no lodging and little or no shattering.

Brown spot and bacterial blight were observed across the site. However, because they occurred at very low levels and represented an insignificant effect on soybean yield, it was determined that disease ratings were not meaningful. Soybean leaves began to turn yellow between five and six weeks after Headline application. At six weeks after application, soybeans were evaluated to assess the extent of leaf yellowing. Both variety and fungicide effects on yellowing were significant. When averaged over all varieties, the progression of yellowing was about 8%

less where Headline had been applied (Table 11). At the same time, the amount of leaf loss (complete desiccation) was low, ranging between 1 and 5% among varieties. Headline effect on leaf loss was not significant at P=0.05. Soybeans reached the R8 stage (95% mature pod color) at 99 to 103 days after planting, with plant heights of 34 to 39 inches. While significant differences in these parameters occurred among varieties, Headline effect on pod maturity and plant height was not significant.

Soybean yields were remarkably good and reflected significant differences among varieties. Ohlde 3334 NRR was the only variety responding positively to Headline, with a yield increase of 3.7 bu/a. While the overall average yield for soybeans treated with Headline was 1.3 bu/a greater than the untreated, this difference was not significant.

Table 11. Soybean response to Headline fungicide, Hesston, Kansas, 2006.

Variety	Treatment[1]	Leaf Yellowing[2]	Leaf Loss[2]	Maturity[3]	Plant ht	Yield[4]
		%	%	DAP	inches	bu/a
Asgrow AG3302	Fungicide	36	4	99	36	49.3
	No Fungicide	44	6	99	36	48.8
Pioneer 93M50	Fungicide	39	3	103	39	47.8
	No Fungicide	41	3	102	39	47.4
KS 3406RR	Fungicide	28	3	102	34	44.6
	No Fungicide	47	6	101	34	44.4
Ohlde 3334 NRR	Fungicide	8	1	103	37	40.2
	No Fungicide	13	2	103	37	36.5
LSD 0.05		13	3	1	1	3.7
Main effect means:						
Asgrow AG3302		40	5	99	36	49.0
Pioneer 93M50		40	3	102	39	47.6
KS 3406RR		38	4	102	34	44.5
Ohlde 3334 NRR		10	1	103	37	38.3
LSD 0.05		9	2	1	1	2.6
	Fungicide	28	3	102	36	45.5
	No Fungicide	36	4	101	37	44.2
	LSD 0.05	7	NS	NS	NS	NS

[1] Foliar application of Headline 2.09 EC fungicide + NIS (6 fl oz/a + 0.25% v/v) made at soybean stage R3 on August 12, 2006.
[2] Leaf ratings on September 23.
[3] Days after planting.
[4] Yields adjusted to 13% moisture.

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

M.M. Claassen

Summary

Three Pioneer corn hybrids (38H66, 35P80, and 33B49) representing 98-day, 106-day, and 112-day maturities, were planted in a soybean rotation under no-till conditions on March16, March 31, and April 14, with final populations of 14,000, 18,000, and 22,000 plants/a. The growing season was characterized by mid-season drought stress. All treatment factors significantly affected corn, but plant population was least influential. Planting date had the largest effect on length of time to reach half-silk stage. March16 and March 31 planting dates delayed silking by 23 and 10 days versus April 14 planting. Corn yields averaged 67 bu/a when planted in mid-March, but declined by 13 and 33% with successive plantings in late March and mid-April. Hybrid 38H66 produced an average of 64 bu/a, whereas the later-maturing 35P80 and 33B49 had 9% and 23% lower yields. Yields were not affected by plant population, averaging 57 bu/a regardless of the number of plants/a. In 2004, yields were largest with the latest planting date, but in 2005 and 2006, highest yields occurred with the earliest planting. In 2004 and 2005, maximum yields occurred with latest maturing hybrid, and highest plant population. Grain test weight in 2006 was affected most by planting date, decreasing significantly with each planting delay. Test weight also declined with increasing hybrid maturity and increasing plant population. Number of ears/plant was not influenced by planting date, but declined as hybrid maturity and plant population increased.

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 112 days, and plant populations of 14,000 to 22,000.

Procedures

The experiment was conducted on a Ladysmith silty clay loam site which had been cropped to no-till soybeans in 2005. 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 just after 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 38H66, Pioneer 35P80, and Pioneer 33B49 representing maturities of 98, 106, and 112 days to black layer, respectively, were no-till planted at approximately 26,000 seeds/a into moist soil on March16, March 31, and April 14. These hybrids with the Roundup Ready trait represented the same maturities as the hybrids without this trait grown in 2004 and 2005. Weeds were controlled with a March 16 application of 1.67 lb/a atrazine 90 DF + 1.6 pt/a Dual II Magnum + 1 qt/a COC. A postemergence treatment with 22 oz/a Roundup Original Max + 1.7 lb/a AMSU was broadcast on May 19. 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 August 25.

Results

Rainfall totaled 1.71, 0.44, and 0.80 inches during the first 10 days after the respective planting dates. Corresponding intervals from planting to emergence were 23, 12, and 7 days. Averaged across planting date, plant populations before hand thinning averaged 90 to 94% of the planting rate. Freezing temperatures did not occur after corn emergence. Mid-season drought greatly reduced corn yield potential (See 2005-2006 Weather Information, pp. 1-2).

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 16 and March 31 planting dates delayed silking by 23 and 10 days versus April 14 planting (Table 12). Average hybrid differences in silking date ranged from 1 to 5 days.

Corn yields were significantly affected by planting date and hybrid, but not plant population. Among the possible two-way interactions between these treatment variables, the planting date x hybrid effect was significant in most instances. Corn yielded an average of 67, 58, and 45 bu/a when planted on March16, March31, and April 14. Average yields for 38H66, 35P80, and 33B49 were 64, 58, and 49 bu/a. Plant populations of 14,000, 18,000, and 22,000 all produced an average of 57 bu/a. Yields of all hybrids were maximized by the earliest planting and declined with succeeding planting dates. At the last planting date, however, yield of 33B49 was reduced 10.8 to 9.1 bu/a more than that of 35P80 and 38H66, respectively. The highest yield of 77 bu/a occurred with 38H66 planted on March 16 with a population of 22,000.

Test weights averaged 52.9 lb/bu and were affected most by planting date. The highest test weight, 56.5 lb/bu, occurred with the earliest hybrid planted March 16 at the lowest plant population. There was a trend for test weight to decline with delay in planting, increasing hybrid maturity, and increasing plant population. The number of ears/plant ranged from 0.98 to 1.11 among overall hybrid and plant population means, decreasing with increasing hybrid maturity and plant population. Planting date had no effect on ears/plant. Lodging was minimal, ranging from 0 to 7% without an overall plant population effect. Most lodging occurred with 33B49 planted April 14.

12. Dryland corn hybrid response to planting date and plant populations, Harvey County Experiment Field, Hesston, Kansas, 2006.

Planting[1] Date	Hybrid[2]	Plant Population	Yield[3] 2006	Yield[3] 2005	Yield[3] 2004	Moist	Bu Wt	Ears/ Plant	Days to Silk[4]	Lodging
		no./a	----------bu/a---------			%	lb/bu			%
March 16	38H66	14,000	68	92	100	12.0	56.5	1.18	89	2
		18,000	72	103	110	11.9	55.0	1.03	89	1
		22,000	77	112	112	12.0	54.2	1.00	90	1
	35P80	14,000	63	92	108	11.4	54.1	1.05	94	2
		18,000	67	105	121	11.7	54.5	1.00	94	0
		22,000	67	114	127	11.5	54.1	1.00	95	1
	33B49	14,000	65	98	121	12.0	55.3	1.00	95	1
		18,000	61	113	135	11.4	54.5	0.99	95	0
		22,000	63	124	142	11.6	55.3	0.98	95	0
March 31	38H66	14,000	65	84	127	11.7	54.6	1.20	76	1
		18,000	70	98	119	12.0	54.8	1.04	76	0
		22,000	65	107	130	11.6	53.5	0.99	77	0
	35P80	14,000	58	86	111	11.5	53.7	1.08	80	0
		18,000	57	98	127	11.8	53.5	1.01	81	0
		22,000	62	106	137	11.7	53.4	0.98	81	3
	33B49	14,000	52	102	134	11.5	53.0	1.02	82	1
		18,000	50	105	141	11.8	52.7	1.02	83	0
		22,000	44	114	146	11.1	52.7	0.97	83	1
April 14	38H66	14,000	51	77	112	12.0	52.1	1.41	68	1
		18,000	51	83	124	11.2	52.4	1.11	68	1
		22,000	57	100	132	11.8	52.5	1.01	68	0
	35P80	14,000	47	86	117	11.8	51.1	1.02	70	0
		18,000	51	95	137	11.7	50.5	0.98	70	2
		22,000	46	99	144	11.6	49.0	0.98	70	2
	33B49	14,000	40	96	129	11.9	50.0	0.99	72	6
		18,000	31	103	150	11.6	47.7	0.96	72	5
		22,000	33	115	164	12.0	47.2	0.93	73	7
LSD .05 Means in same DOP[4]			7.4	7.5	8.5	NS	0.85	0.05	0.74	3
Means in different DOP			8.9	8.1	10.5	NS	1.04	0.06	0.93	3
DOP*Hybrid[5]			0.004	0.04	0.004	NS	0.0001	0.0001	0.0001	0.0001
DOP*Population[6]			NS	NS	0.001	NS	0.040	0.004	NS	NS
Hybrid*Population[7]			0.008	NS	0.002	NS	0.056	0.0001	NS	NS

(cont. next page)

Table 12 (cont.). Dryland corn hybrid response to planting date and plant populations, Harvey County Experiment Field, Hesston, Kansas, 2006.

Planting[1] Date	Hybrid[2]	Plant Population	Yield[3] 2006	2005	2004	Moist	Bu Wt	Ears/ Plant	Days to Silk[4]	Lodging
		no./a	----------bu/a---------			%	lb/bu			%
	Main effect means:									
	Planting Date									
	March 16		67	106	120	11.7	54.8	1.02	93	1
	March 31		58	100	130	11.6	53.5	1.03	80	0
	April 14		45	95	134	11.7	50.3	1.04	70	3
	LSD 0.05		5.6	4.0	6.8	NS	0.66	NS	0.6	2
	Hybrid									
	38H66		64	95	118	11.8	53.9	1.11	78	1
	35P80		58	98	125	11.6	52.7	1.01	82	1
	33B49		49	108	140	11.7	52.0	0.98	83	2
	LSD 0.05		2.5	2.5	2.8	NS	0.28	0.02	0.2	1
	Plant Population									
	14,000		57	90	118	11.7	53.4	1.11	81	1
	18,000		57	100	129	11.7	52.8	1.01	81	1
	22,000		57	110	137	11.6	52.4	0.98	81	1
	LSD .05		NS	2.5	2.8	NS	0.28	0.02	0.2	NS

[1] DOP. Actual planting dates were March 18, April 2, and April 15 in 2004; and March 14, April 4, and April 16 in 2005.

[2] Pioneer brand. Hybrids were 38H67, 35P12, and 33B51in 2004 and 2005. Maturities were 97, 105, and 111 days.

[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 differing with hybrid; NS = not significant.

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

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

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 a focus on comparison of glyphosate tolerant (GT) versus non-GT herbicide programs. Weed competition consisted of dense large crabgrass and moderate Palmer amaranth and domestic sunflower populations. Nearly all treatments provided excellent large crabgrass control through early July. Notable late-season large crabgrass development occurred, resulting in deterioration of control ratings. Best treatments for season-long large crabgrass control generally were those including an effective preemergence component with residual activity. Sunflower control was excellent with treatments involving mesotrione and/or glyphosate based products. Most treatments gave excellent early control of Palmer amaranth, but at the end of the season, differences in efficacy were notable. Late-season control was best with Lexar preemergence plus Lexar early postemergence and with Keystone preemergence plus Hornet postemergence. But ten other treatments gave statistically comparable results on Palmer amaranth.

Corn showed no herbicide injury symptoms of consequence, but severe drought resulted in low yields that were not well correlated with treatments. In comparison with the untreated check, nine of 20 treatments improved yields by 25 to 47 bu/a. The herbicide treatments compared in this experiment represented a wide range of input cost.

Introduction

Glyphosate-tolerant crops have allowed growers to reduce herbicide costs and use no-till systems more economically. Repeated reliance on glyphosate in consecutive crops, however , has become a source of concern in some areas because of the rise in glyphosate tolerance in populations of certain weed species. Corn is one of the crops for which a wide variety of herbicides is available, allowing growers to utilize products of more diverse chemistry and modes of action. This experiment was conducted to evaluate weed control with some of the newer non-glyphosate herbicides alone or in combination with glyphosate as compared with a total glyphosate program.

Procedures

Soybeans were grown on the experiment site in 2005. Soil was a Geary silt loam with pH 6.8 and 2.3% 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 sunflowers also were planted across all plots in 30-inch rows. Corn was fertilized with 90 lb/a N and 30 lb/a P_2O_5. Pioneer 33N12 RR LL was planted into moist soil at approximately 19,100 seeds/a in 30-inch rows on April 27, 2006. Seedbed condition was excellent. All herbicide treatments (Table 13), replicated three times, were broadcast in 15 gal/a of water with Greenleaf TurboDrop TDXL025 venturies in combination with Turbo Tee 11005 nozzles at 30 psi. Preemergence (PRE) applications were made shortly after planting. Early postemergence (EPOST), postemergence (POST), and sequential postemergence (SEQ) treatments followed on May 23, May 26 and June 13, respectively. On these dates, large crabgrass was 0.5 to 1 inch, 1 to 3 inches, and

0.5 to 3 inches in height. Palmer amaranth was 0.5 to 1 inch, 1 to 2 inches, and 1 inch. Domestic sunflowers were 2.5 inches, 3 to 4 inches, and 0 inch, respectively. Plots were not cultivated. Crop injury and weed control were rated several times during the growing season. Corn was harvested on September 15, 2006.

Results

Corn was planted into an excellent seedbed and emerged 13 days later. During the first 10 days after planting and preemergence herbicide application, rainfall totaled 2.49 inches. Only light rains occurred during the week before each of the respective postemergence treatments. Corn reached the early-silking stage at the end of June and early July. Hot and dry conditions prevailed during this period and extended until August. Above-normal rainfall in August arrived too late to be of much benefit to corn. The improved moisture environment, however, resulted in resurgence of late-season weed germination and growth. Crop injury was very minor and inconsequential or nonexistent.

Moderate populations of Palmer amaranth and domestic sunflowers developed along with dense populations of large crabgrass. At the time of the June and July evaluations, all herbicide treatments but one gave excellent to perfect control of Palmer amaranth. The exception was Touchdown Total plus Liberty early postemergence, showing fair initial control which deteriorated by late June. At the end of the season, Palmer amaranth control was notably good with Lexar preemergence plus Lexar early postemergence and with Keystone preemergence plus Hornet postemergence. Ten of the remaining treatments provided statistically comparable late-season control. Very poor to fair control at that time was observed with Touchdown Total plus Liberty early postemergence; Keystone preemergence plus Glyphomax postemergence; Guardsman Max preemergence plus Distinct postemergence; Roundup alone with single or sequential application; and Lexar preemergence plus Touchdown postemergence.

Initial sunflower control in early June was excellent to perfect after treatments involving Callisto, Lexar, Lumax, Roundup Ultra Max II, Touchdown Total, Glyphomax Plus, and Expert. Guardsman Max preemergence plus Distinct postemergence gave fair control of sunflowers initially, with improvement to excellent control two weeks later. Keystone preemergence plus Hornet postemergence gave poor control in early June, but excellent control by late June. Radius plus AAtrex preemergence gave very poor control of sunflowers in June and early July, with some improvement late in the season.

Large crabgrass control was excellent to perfect in early June with all treatments except Touchdown Total plus Liberty early postemergence, which showed fair control. By early July, control ratings for the respective treatments generally remained at the same level, except that a significant decline occurred following single application of Roundup Ultra Max II alone or with Impact; and Touchdown Total plus Liberty. Large crabgrass development was notable late in the season. Control ratings deteriorated with most treatments, especially those without an effective residual component. Eight treatments gave highest late-season large crabgrass control averaging 84-95%.

Corn yields averaged 27 bu/a, reflecting severe drought conditions during the growing season. Yields were low, variable, and not well correlated with treatments. Nine of 20 treatments significantly improved corn yield by 25 to 47 bu/a. All but two treatments significantly improved grain test weight. The costs of the herbicide treatments differed substantially, ranging from $19.12 to $44.43/a.

Table 13. Weed control in corn, Harvey County Experiment Field, Hesston, Kansas, 2006.

Herbicide Treatment[1]	Product Form	Rate/a	Unit	Timing[2]	Injury[3] 6/7	Lacg[4] Control 9/1	Paam[5] Control 9/1	Dosf[6] Control 9/1	Yield	Cost[7]
					%	%	%	%	bu/a	$/a
1 Lexar	3.7 SE	3	qt	PRE	0	91	88	100	12	27.05
2 Lexar	3.7 SE	1.5	qt	PRE	0	95	91	100	36	31.72
Lexar +	3.7 SE	1.5	qt	EPOST						
NIS		0.25	% v/v	EPOST						
3 Bicep II Magnum	5.5 SC	2.1	qt	PRE	0	88	85	100	39	37.41
Callisto +	4 SC	3	fl oz	POST						
AAtrex +	4 L	0.5	pt	POST						
COC +		1	% v/v	POST						
AMSU		1	% w/v	POST						
4 Keystone	5.25 SE	2	qt	PRE	0	77	95	100	21	31.83
Hornet +	85.6 WG	3	oz wt	POST						
COC +		1	% v/v	POST						
AMSU		1	% w/v	POST						
5 Guardsman Max	5 SC	2	qt	PRE	1	87	75	100	51	33.37
Distinct +	70 WG	4	oz wt	POST						
NIS +		0.25	% v/v	POST						
AMSU		1	% w/v	POST						
6 Radius +	4 SC	18	fl oz	PRE	0	84	82	71	18	27.40
AAtrex	4 L	1	qt	PRE						
7 Harness Xtra	5.6 L	2	qt	PRE	0	78	82	100	15	37.95
Roundup Ultra Max II +	4.5 SL	22	fl oz	POST						
AMSU		1	% w/v	POST						
8 Roundup Ultra Max II +	4.5 SL	22	fl oz	POST	0	45	76	100	31	19.12
AMSU		1	% w/v	POST						
9 Roundup Ultra Max II +	4.5 SL	22	fl oz	POST	0	71	79	100	36	31.11
AMSU		1	% w/v	POST						
Roundup Ultra Max II +	4.5 SL	22	fl oz	SEQ						
AMSU		1	% w/v	SEQ						
10 Bicep II Magnum	5.5 SC	1.6	qt	PRE	0	83	86	100	21	31.62
Touchdown Total +	4.17 SL	24	fl oz	POST						
AMSU		1	% w/v	POST						
11 Bicep II Magnum	5.5 SC	1.6	qt	PRE	0	89	85	100	30	44.43
Touchdown Total +	4.17 SL	24	fl oz	POST						
Callisto +	4 SC	3 fl oz		POST						
AMSU		1	% w/v	POST						

Table 13. Weed control in corn, Harvey County Experiment Field, Hesston, Kansas, 2006.

Herbicide Treatment[1]	Product Form	Rate/a	Unit	Timing[2]	Injury[3] 6/7	Lacg[4] Control 9/1	Paam[5] Control 9/1	Dosf[6] Control 9/1	Yield	Cost[7]
					%	%	%	%	bu/a	$/a
12 Lexar	3.7 SE	1.6	qt	PRE	0	82	78	100	19	32.98
Touchdown Total +	4.17 SL	24	fl oz	POST						
AMSU		1	% w/v	POST						
13 Lexar	3.7 SE	1.6	qt	EPOST	0	76	83	100	33	28.97
Touchdown Total +	4.17 SL	24	fl oz	EPOST						
AMSU		1	% w/v	EPOST						
14 Roundup Ultra Max II +	4.5 SL	22	fl oz	POST	0	50	87	100	25	28.44
Impact +	2.8 SC	0.5	fl oz	POST						
AMSU		1	% w/v	POST						
15 Expert +	4.9 SC	3	qt	POST	0	84	84	100	26	28.80
AMSU		1	% w/v	POST						
16 Keystone	5.25 SE	2	qt	PRE	0	75	69	100	16	32.92
Glyphomax Plus +	4 SL	1	qt	POST						
AMSU		1	% w/v	POST						
17 Lexar	3.7 SE	1.6	qt	PRE	0	87	82	100	26	39.65
Liberty +	1.67 SL	24	fl oz	POST						
AMSU		1	% w/v	POST						
18 Touchdown Total +	4.17 SL	24	fl oz	EPOST	0	37	53	100	30	28.65
Liberty +	1.67 SL	24	fl oz	EPOST						
AMSU		1	% w/v	EPOST						
19 Lumax +	3.94 SE	2.5	qt	PRE	0	88	80	100	40	28.51
AAtrex	4 L	1.5	pt	PRE						
20 Untreated					0	0	0	0	0	
LSD 0.05					NS	11	13	9	NS	

[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 27; EPOST = early postemergence on May 23; POST = postemergence on May 26; and SEQ = sequential postemergence on June 13.

[3] Injury and weed control ratings also were taken at various times between May 16 and July 7.

[4] Lacg =large crabgrass.

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

[6] Dosf = domestic sunflowers.

[7] Total herbicide cost based on prices from an area supplier and spraying cost of $4.01 per acre per application. Treatments involving glyphosate or glufosinate include an added seed cost of $30/unit ($7.13/a) for the herbicide 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 an irrigation experiment field to serve expanding irrigation development in north-central Kansas. The original 35-acre field was located nine 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 Reservoir 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 two 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 predominate 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 a 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.

2006 Weather Information

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

	Rainfall, inches			Temperature, ^{0}F		Growth Units	
	Scandia 2006	Belleville 2006	Average 30-year	Daily Mean 2006	Avg Mean	2006	Average
April	3.7	2.5	2.3	57	52	335	217
May	3.6	2.6	3.7	65	63	492	421
June	1.8	1.6	4.6	76	73	698	679
July	4.7	2.9	3.4	80	78	818	807
August	6.3	5.1	3.4	77	77	751	780
Sept	4.2	3.8	3.6	63	68	409	538
Total	24.3	18.5	20.9			3503	3442

MAXIMIZING IRRIGATED SOYBEAN YIELDS IN THE GREAT PLAINS

W.B. Gordon

Summary

In 2004, studies were initiated to determine 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, nitrogen (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. Phosphorous 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 applications 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. Soybeans were sprinkler-irrigated. Planting dates were May 8, 2004, May 10, 2005, and May 10, 2006 . 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/a 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/a 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.

Again in 2006, soybean yield was not affected by row spacing or by plant population. Soybean yield was positively affected by the addition of only the first increment of fertilizer (30 lb/a P_2O_5). Yield of plots receiving 30 lb/a P_2O_5 increased by 30 bu/a over unfertilized check plot. Unlike the previous two years, addition of higher rates of P and K did not result in further yield increases. Addition of Mn also did not improve 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 statewide 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 P and almost five times as much K 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. Phosphorous 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 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 Mn. Soil test values for the experimental area in 2006 were: pH, 7.0; Bray-1 P, 16 ppm; and exchangeable K, 280 ppm. Fertilizer was broadcast in mid-March. The soybean variety Asgrow 3305 was planted on May 10, 2006. Soybean was sprinkler irrigated.

Results

In no year of the experiment did increased plant populations or reduced row spacing result in increased yield (Tables 2 and 3).

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 4). 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 5). Applying additional K or N did not result in any yield increase, but addition of Mn to the mix did significantly increase yield.

In 2006, yield was not affected by row spacing, plant population or by an interaction of factors (Table 6). In 2006, yield was improved by addition of 30 lb/a P_2O_5 by 30 bu/a over the unfertilized check plot (Table 7). Unlike previous years, further addition of fertilizer inputs did not improve soybean yields.

Table 2. 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 3. 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 4. Plant population and fertility effects on soybean yield (average over row spacing), North Central Kansas Experiment Field, 2004.

	Yield	
Treatments	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	

Table5. Fertility effects on soybean yield (average over row spacing and plant population), North Central Kansas Experiment Field, 2005.

Treatments	
	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

Table 6. Soybean yield as affected by row spacing and plant population (average over fertility treatments), North Central Kansas Experiment Field, 2006.

	Yield	
Row Space	150,000 plants/a	255,000 plants/a
	- - - - - - - - - bu/a - - - - - - - - -	
30 inch	77.8	73.7
7.5 inch	76.9	78.9
LSD (0.05)	NS*	

*Not Significant

Table 7. Fertility effects on soybean yield (average over row spacing and plant population), North Central Kansas Experiment Field, 2006.

Treatments	Yield
	bu/a
Check	49.9
Low P	79.9
Low P-Low K	81.8
Low P-High K	79.9
High P-Low K	81.6
High P-High K	79.6
N-P-K	81.8
N-P-K-Mn	80.1
LSD (0.05)	4.8

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 soybeans may have altered physiological processes that affect manganese (Mn) uptake and metabolism. Glyphosate may also adversely affect populations of soil micro-organisms responsible for reduction of Mn. This study was conducted in order to determine if glyphosate-resistant soybeans respond differently than conventional soybeans to applied Mn, and, if so, to develop liquid fertilization strategies that will prevent or correct deficiencies. Two separate experiments were conducted.

In experiment I, the glyphosate-resistant soybean variety KS 4202RR and its conventional isoline were grown on a Crete silt loam soil with a pH of 7.0 at the North Central Kansas Experiment Field, located near Scandia, KS. Granular Mn sulfate was applied at planting in a band beside the row to give rates of 2.5, 5, and 7.5 lb/a Mn. A no-Mn check plot was also included. Soybeans were planted without tillage in early May 2005 and 2006. Experiment II consisted of combinations of starter and foliar applied chelated liquid Mn treatments. Both experiments were sprinkler irrigated.

Averaged over the 2-year period in experiment I, the conventional soybean variety yield was 7 bu/a greater than its glyphosate-tolerant isoline when no Mn was applied. Addition of Mn improved yield of the glyphosate-resistant variety, but the yield of the conventional isoline decreased at the highest Mn rate. Leaf tissue Mn at full-bloom in the glyposate-resistant variety was less than half of the conventional variety. Application of liquid-chelated Mn also proved to be effective in improving yield of glyphosate-resistant soybean. Soybean yield was maximized with a combination of .3 lb/a Mn applied as a starter and another .3 lb/a applied at the four-leaf stage or foliar application of 0.3 lb/a Mn at the four-leaf, eight-leaf, and full-bloom stage. These two treatments both improved yield by 8 bu/a over the untreated check. Full yield benefit was not achieved with starter only application even at a higher rate of Mn.

Introduction

There is evidence to suggest that glyphosate-resistant soybean yield 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 soybeans are 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 that soybean root exudates have been changed, and plants no longer solublize enough soil Mn. Application of glyphosate also may retard Mn metabolism in the plant. Application of glyposhate may have an adverse effect on populations of soil micro-organisms that are responsible for reduction of Mn to a form that is plant available. 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, chlorophyll content decreases and the ultrastructure of the thylakoids is drastically changed. Manganese acts as a cofactor, activating some 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 decreased disease resistance of Mn-deficient plants. In nodulated legumes such as soybeans that transport nitrogen (N) in the form of allantoin and allantoate to the shoot, degradation of these ureides in leaves and the seed coat is catalyzed by an enzyme with an absolute requirement of Mn. Ureides account for most N transported in the zylem sap to aerial portions of soybeans. Manganese tissue 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 gyphosphate-resistant soybeans respond to applied Mn in a different manner than conventional soybeans do and, if so, what fertilization practices can best correct the problem. There is little current information on MN fertilization of soybeans in Kansas.

The objective of this research was to determine if glyphosate-resistant soybeans respond differently to applied Mn than conventional soybean does and, if so, to develop fertilization strategies that will prevent or correct deficiencies, leading to improved yields 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. In the top 6 inches of soil the pH was 7.0. Manganese fertilizer treatment was pre-plant banded soil applications of Mn 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 as a starter at planting and as a foliar treatment 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

In experiment I, yield of the glyphosate-resistant variety KS 4202RR was 7 bu/a lower than its conventional isoline when no Mn was applied (Figure 1). The application of 2.5 lb/a Mn improved yield and equaled that of the conventional isoline. Yield of the conventional isoline declined with increasing Mn rate. Tissue Mn concentration (upper most 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 2).

In experiment II, yield of the glyphosate–resistant soybean variety KS 4202 RR was maximized by a combination of Mn applied as a starter two inches to the side and two inches below the seed at a planting rate of 0.33 lb/a Mn and a foliar application at the same rate applied at the 4-leaf stage (Table 8). A starter alone application at either 0.3 or 0.6 lb/a Mn did not give results equaling the combination of starter and foliar treatment.

Application of foliar applied Mn at 0.33 lb/a at the V4, V8, and R2 stages of growth produced yields equal to the starter plus one foliar application at the V4 stage. One or two foliar applications were not as affective as the starter plus foliar or the three foliar applications. Higher rates of starter applied Mn and single foliar applications will be investigated in 2007 to determine if timing is critical or if higher rates applied earlier in the growing season may be as effective as lower rates applied more frequently.

This research confirms that glyphosate-resistant soybean varieties do not accumulate Mn in the same manner as conventional varieties and will respond to application of Mn in high yield environments.

Table 8. Foliar applied manganese effects on soybean yield, North Central Kansas Experiment Field, 2006.

Stage of Growth	Yield
	bu/a
Starter (0.33 lb)	66
Starter (0.66 lb)	70
Starter (0.33 lb) + V4 (0.33 lb)	74
V4 (0.33 lb)	66
V4 + V8 (0.33 +0.3 lb)	72
V4+V8 +R2 (0.33+0.33+0.33 lb)	74
Untreated Check	66
LSD (0.05)	3

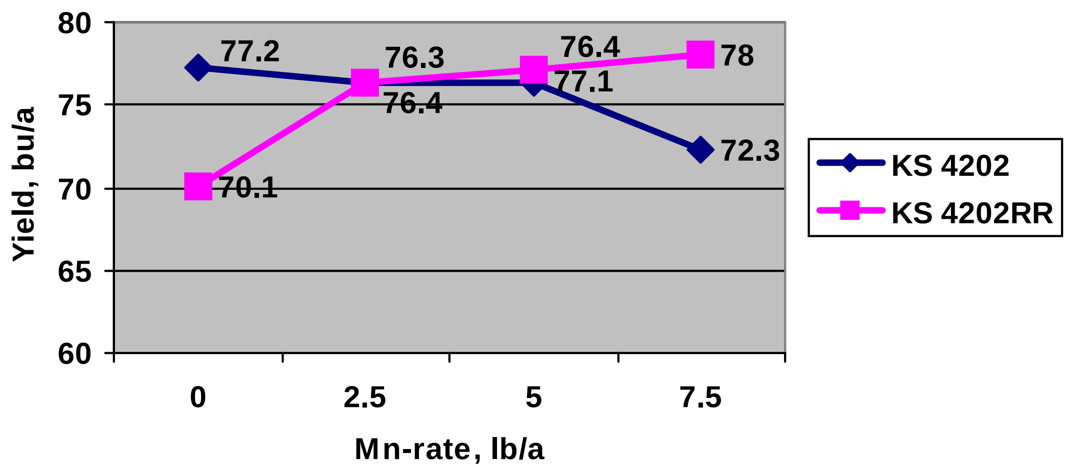

Figure 1. Soybean yield response to applied manganese, North Central Kansas Experiment Field, 2005-2006.

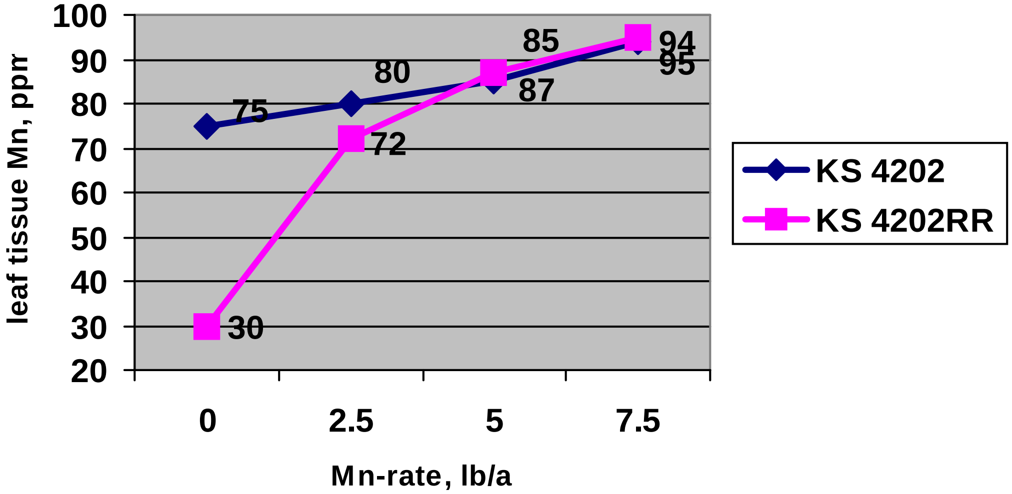

Figure 2. Soybean leaf tissue Mn concentration (uppermost expanded trifoliate at full bloom), North Central Kansas Experiment Field, 2005-2006.

NITROGEN MANAGEMENT FOR NO-TILLAGE CORN AND GRAIN SORGHUM PRODUCTION

W.B. Gordon

Summary

No-tillage production systems are being used by an increasing number of producers in the central Great Plains because of several advantages, including reduction of soil erosion, increased soil water-use efficiency, and improved soil quality. However, the large amount of residue left on the soil surface can make nitrogen (N) management difficult. Surface applications of urea-containing fertilizers are subject to volatilization losses. Leaching can also be a problem on course 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. The use of urease inhititors applied with urea-containing fertilizers can reduce volatilization losses. Recently, a new product that is a co-polymer of maleic and itaconic acids has become available (Nutrisphere-N) and has shown potential in reducing urea N losses. Two studies were conducted, one with irrigated corn, and one with dryland grain sorghum. The irrigated corn study compared urea, UAN (28%), a controlled release polymer-coated urea (ESN), Agrotain, Agrotain Plus+, Nutrisphere –N and ammonium nitrate at 3 N rates (80, 160, and 240 lb/a). A no-N check plot also was included. The grain sorghum study consisted of untreated urea, ammonium nitrate, ESN, and urea treated with Agrotain or Nutriphere-N. Nitrogen rates were 40, 80, and 120 lb/a as well as a no N check. Both studies were conducted on Crete silt loam soils. In both the corn and grain sorghum experiments, the treated urea products yielded better than the untreated urea and were similar to ammonium nitrate. There were no significant differences in yield of ESN, Agrotain, or Nutrisphere-N. In the corn experiment that included UAN (28%), yield of UAN treated with Agrotain Plus or Nutrisphere-N was greater than that of untreated UAN. If producers wish to broadcast urea-containing fertilizer on the soil surface in no-tillage production systems there are several products available that are very effective in limiting N losses and increasing N–use efficiency.

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-tillage systems can make N management difficult. Surface application of N fertilizers is a popular practice with producers. Nitrogen losses due to volatilization from broadcast urea-containing fertilizers in no-tillage production systems can be significant. Depending on conditions, losses can be from 10% to 20% of the applied N. 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 course-textured soils. Polymer coated urea, long used in turf fertilization, has the potential to make N management more efficient when surface applied in no-tillage agricultural systems. The urea granule is coated, but allows water to diffuse across the membrane. Nitrogen release is then controlled by temperature. A polymer-coated urea product is now available for crop use and is marketed under the name of ESN. The use of urease inhititors applied with urea-containing fertilizers can reduce volatilization losses. In the soil urea is hydrolyzed relatively quickly by the soil enzyme urease. Agrotain, a commercially available urease inhititor, has in numerous studies proven to be effective in reducing N losses due to volatilization. Agrotain Plus is a product that contains both a urease inhibitor and a nitrification inhibitor (DCD). Recently, a new product that is a co-polymer of maleic and itaconic acids has become available (Nutrisphere-N) and has shown potential in reducing urea-N losses. The cation nickel is essential for the action of urease; Nutisphere-N is thought to sequester or inactivate the nickel ions rendering urease inactive. The objective of these experiments were to evaluate N efficiency from surface broadcast applications of urea-containing N, and to try to reduce N loss and improve efficiency with the use of products designed to limit N volatilization and loss.

Procedures

Two experiments were conducted at the North Central Kansas Experiment Field on a Crete silt loam soil. An irrigated corn experiment was conducted at Scandia and a dryland grain sorghum experiment was located at Belleville. At the irrigated site, soil pH was 7.0; organic matter was 2.8%; Bray-1 P was 28 ppm; and exchangeable K was 240 ppm. The previous crop was corn. The corn hybrid DeKalb DKC60-19 was planted without tillage into corn stubble on April 20, 2006, at the rate of 31,000 seeds/a. Nitrogen was applied on the soil surface immediately after planting. Treatments consisted of controlled released polymer-coated urea (ESN), Nutrisphere-N coated urea, Agrotain coated urea, urea, and ammonium nitrate applied at 3 rates (80, 160, and 240 lb/a). A no-N check plot also was included. Additional treatments included UAN (28%), Agrotain treated UAN, Agrotain Plus+ treated UAN, and Nutrisphere-N treated UAN. The experimental area was adequately irrigated throughout the growing season. Plots were harvested on October 20, 2006.

At the dryland site, soil pH was 6.5; organic matter was 2.5%; Bray-1 P was 38 ppm; and exchangeable K was 450 ppm. The previous crop was corn. The grain sorghum hybrid Pioneer 85G01 was planted at the rate of 62,000 seed/a on May 20, 2006. Nitrogen was broadcast on the soil surface immediately after planting. Treatments consisted of urea, ammonium nitrate, ESN, urea treated with Nutrisphere-N, and Agrotain treated urea applied at 40, 80, and 120 lb/a N.

Results

Grain yield of irrigated corn plots receiving untreated urea were lower than plots receiving urea treated with Agrotain, ESN, or Nutrisphere-N at all levels of applied N (Tables 9). Yields achieved with Agrotain, ESN, and Nutrisphere were equal to those of ammonium nitrate. Yield with UAN (28%) was also lower than those of UAN treated with Agrotain, Agrotain Plus+, or Nutrisphere-N. When averaged over N rates, yields of all treated N products were greater than untreated urea or UAN (Table 10). There were no significant differences in yields of Agrotain, Agrotain Plus+, ESN, and Nutrisphere. The lower yields with urea and UAN indicate that volatilization of N may have been a significant problem. The dryland grain sorghum study results were similar to the irrigated corn experiment. Yield of plots receiving untreated urea was significantly lower than plots receiving urea treated with Agrotain, Nutrisphrere-N, or ESN (Table 11). There were no differences in yield of the three products tested.

Study results suggest that the efficiency of surface broadcast urea-containing fertilizers in no-tillage production systems can be improved by use of several products that are effective in reducing N volatilization losses.

Table 9. Effects of N source and rate on corn grain yield, earleaf N, and grain N, Scandia, Kansas, 2006.

N Source	N Rate	Yield	Earleaf N	Grain N
	lb/a	bu/a	%	%
	0-N Check	138.2	1.72	1.13
Urea	80	152.0	2.30	1.22
	160	169.3	2.65	1.26
	240	183.1	2.68	1.30
ESN	80	171.6	2.89	1.28
	160	186.6	2.95	1.32
	240	196.9	3.05	1.40
Nutrisphere-N	80	165.8	2.89	1.29
	160	187.7	2.94	1.36
	240	196.9	3.06	1.41
Urea+Agrotain	80	171.6	2.91	1.30
	160	179.7	2.96	1.36
	240	196.6	3.04	1.38
UAN (28%)	80	156.6	2.45	1.24
	160	167.0	2.69	1.28
	240	180.8	2.74	1.27
UAN+Agrotain	80	170.5	2.88	1.30
	160	191.2	2.98	1.35
	240	195.8	3.03	1.39
UAN+Agrotain Plus+	80	168.2	2.90	1.31
	160	185.4	2.99	1.38
	240	195.8	3.08	1.42
UAN+Nutrisphere-N	80	170.5	2.87	1.30
	160	192.0	3.01	1.38
	240	195.8	3.04	1.41
Ammonium Nitrate	80	173.9	2.86	1.30
	160	187.8	2.96	1.35
	240	195.8	3.05	1.40
Average(not including check)		181.1	2.88	1.33

Table 10. Effects of N source (averaged over rate) on corn grain yield, earleaf N and grain N, Scandia, Kansas, 2006.

Treatment	Yield	Earleaf N	Grain N
	bu/a	- - - - - - - - - %	- - - - - - - - -
No N check	152.0	1.72	1.13
Urea	168.1	2.52	1.26
ESN	185.0	2.96	1.33
Nutrisphere-N	183.5	2.96	1.35
Urea+Agrotain	182.6	2.97	1.35
UAN	168.1	2.62	1.26
UAN+Agrotain	185.8	2.96	1.35
UAN+Agrotain Plus+	183.1	2.99	1.37
UAN+Nutrisphere-N	186.1	2.97	1.36
Ammonium Nitrate	185.8	2.96	1.35
LSD (0.05)	6.2	0.09	0.04
CV%	6.8	4.5	4.9

Table 11. Effects of N source and rate on grain sorghum yield, Belleville, Kansas, 2006.

Treatment	N-Rate	Yield
	lb/a	bu/a
Check	--------	71
Urea	40	108
	80	122
	120	128
ESN	40	120
	80	130
	120	132
Urea+Agrotain	40	116
	80	129
	120	133
Urea+Nutrisphere-N	40	120
	80	133
	120	132
Ammonium Nitrate	40	118
	80	131
	120	133
N-Source Treatment Means		
Urea		119
ESN		127
Agrotain		126
Nutrisphere-N		128
Ammonium Nitrate		127
LSD(0.05)		5
CV%		6

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 yields averaged 89 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 developed more leaves than shorter-season sorghum did, and thus, 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 2006, and distribution was ideal for grain sorghum production. In the irrigated experiment (excluding the dryland check), when averaged over populations and hybrids, corn yielded 152 bu/a and grain sorghum yielded 171 bu/a. Only when 10 inches of irrigation water was applied and corn population was at its highest did corn outyield grain sorghum. 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 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. It 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 2006, 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 over planted and thinned to desired populations. Corn was planted on April 18, 2006, and grain sorghum was planted on May 20, 2006. Crops were planted without tillage into wheat stubble.

An irrigated experiment was conducted in 2006. 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 three levels 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. Irrigations levels were 0, 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 21, 2006 and grain sorghum was planted on May 19, 2006. Crops were planted into soybean stubble without any additional tillage.

Results

In the dryland experiment, when averaged over populations and hybrids, corn yield averaged 89 bu/a and grain sorghum yielded 137 bu/a (Table 12).

In 2006, corn yield was reduced at the highest plant population, regardless of hybrid. The yield of the earliest grain sorghum hybrid (DKS 36-00) was lowest at the low plant population, whereas plant population had no effect on yield of the full-season hybrid (DKS 53-11). The latest-maturing grain sorghum hybrid (DKS 53-11) yield was the greatest and the earliest (DKS 36-00) yield was the least. Longer-season sorghums developed more leaves than shorter season sorghum did, and thus, 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 2006, and distribution was ideal for grain sorghum production.

In the irrigated experiment, when averaged over populations and hybrids, corn yielded 152 bu/a and grain sorghum yielded 171 bu/a (Figure 3). Corn significantly outyielded sorghum only when plant population was highest and when irrigation water was maximum. Water-use efficiency (pounds of grain/inch of water) of grain sorghum was superior to corn under dryland and limited-irrigation conditions. When 10 inches of irrigation water was applied, corn water-use efficiency was superior to sorghum. Grain sorghum has demonstrated its ability to compete with corn in both dryland and limited-irrigation production systems.

Table 12. Grain sorghum and corn yield as affected by hybrid and plant population, North Central Experiment Field, Belleville, Kansas, 2006.

Crop	Hybrid	Population	Yield
			bu/a
Grain Sorghum	DKS 36-00	Low	115.2
		Medium	121.3
		High	122.6
Grain Sorghum	DKS 42-20	Low	128.1
		Medium	139.0
		High	144.1
Grain Sorghum	DKS 53-11	Low	155.4
		Medium	154.3
		High	150.0
Grain Sorghum Average			136.7
Corn	DKC 50-20	Low	98.1
		Medium	90.0
		High	83.2
Corn	DKC 58-80	Low	90.0
		Medium	90.3
		High	75.3
Corn	DKC 60-19	Low	95.0
		Medium	95.1
		High	86.3
Corn Average			89.3
LSD (0.05)			5.1

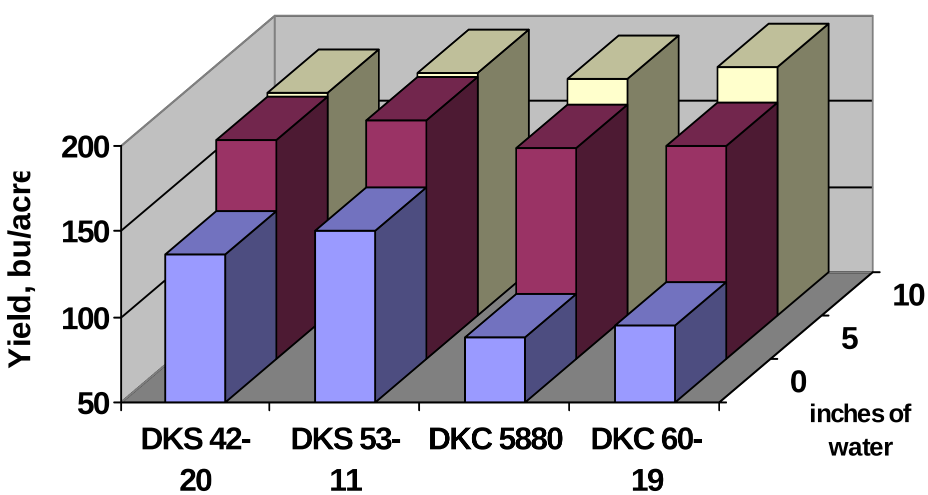

Figure 3. Grain yield as affected by irrigation level (average over population), Scandia, 2006.

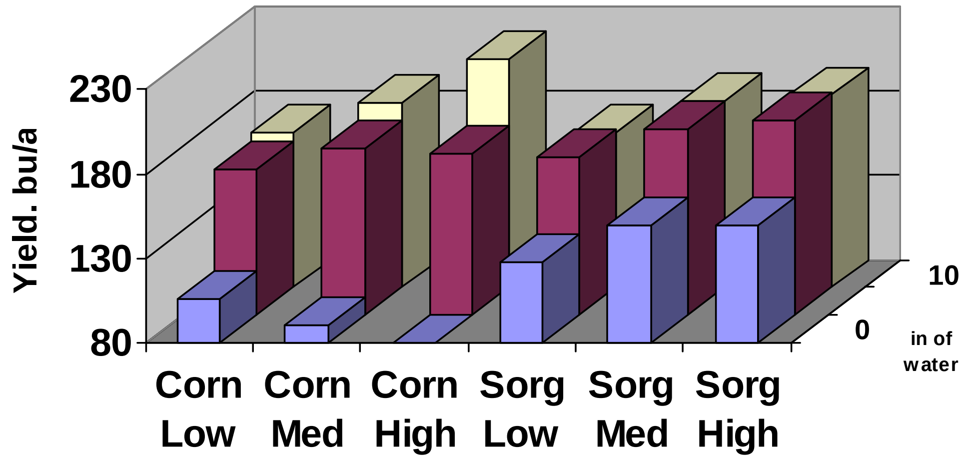

Table 4.Yield as affected by irrigation level and population, Scandia, 2006.

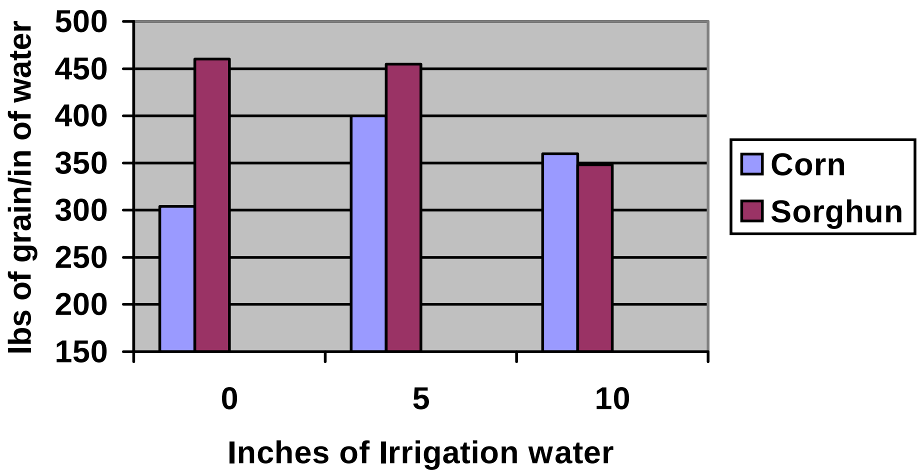

Figure 5. Water use efficiency of corn and grain sorghum.

IMPROVING THE EFFICIENCY OF PHOSPHORUS FERTILIZERS

W.B. Gordon

Summary

Crop recovery of applied phosphorus (P) fertilizer can be quite low during the season of application. Specialty Fertilizer Products has developed and patented a family of dicarboxylic co-polymers that can be used as a coating on granular, or mixed into, liquid phosphate fertilizers. The registered trade name for the new product is AVAIL® The polymer is reported to sequester antagonistic cations out of the soil solution, thus keeping P fertilizer in a more available form for plant uptake. To evaluate the effectiveness of this product, experiments were conducted at the North Central Kansas Experiment Field from 2001 to 2004, using mono-ammonium phosphate (MAP, 11-52-0) coated with AVAIL® on corn and soybean.

In 2003 to 2005, AVAIL was evaluated in liquid ammonium polyphosphate fertilizer (10-34-0) applied as a starter for corn production. Treatments in the corn experiment consisted of applying MAP at rates to give 20, 40, or 60 lb/a P_2O_5, either treated with AVAIL® or untreated. A no P check plot was included.

The soybean experiment consisted of applying either treated or untreated MAP at rates to give 30 or 60 lb/a P_2O_5. A no-P check was again included. The phosphate fertilizer was banded beside the row in both the corn and soybean experiments. The liquid starter experiment conducted from 2003 to 2005 consisted of a no-starter check and a 30-30-5 treatment applied alone or with AVAIL® at various concentrations. Fertilizer was placed two inches to the side and two inches below the seed at planting. Soil test P values were in the medium category in all experiments.

When averaged over years and P rates, the AVAIL® treated MAP increased corn grain yield 18 bu/a over the untreated MAP. Tissue P concentration was greater in the AVAIL® treated plots than in untreated plots at both the six-leaf stage and at mid-silk. When averaged over years and P rates, soybean yield was improved 9 bu/a with the use of AVAIL® treated P fertilizer.

In 2003 to 2005, liquid starter fertilizer mixed with AVAIL® increased corn grain yield 9 bu/a over the untreated starter treatment.

In 2005 and 2006, fall application of AVAIL® treated MAP were investigated for irrigated corn production. The experiment consisted of untreated MAP applied at the rates of 30, 60, and 90 lb/a P_2O_5 and AVAIL® treated MAP applied in either the fall or the spring. Fall and spring applications of P fertilizer were equally effective. Fall applied AVAIL® treated MAP preformed as well as spring applied and yielded 13 bu/a greater than untreated MAP did. Influencing reactions in the micro-environment around the fertilizer granule or droplet has proven to have a significant benefit to the availability of applied P fertilizer.

The use of AVAIL® increased P uptake and yield of corn and soybean.

Introduction

Phosphorus occurs in soils mainly as inorganic P compounds but also as low concentrations of P in the soil solution. Most soils contain relatively small amounts of total P, and only a small fraction of the total P is available to plants. Most inorganic P compounds in soils have a very low solubility. Phosphorus generally occurs in soils as the anions $H_2PO_4^-$ or HPO_4^{-2}, depending on the soil pH. These anions readily react with soil cations such as calcium, magnesium, iron, and aluminum to produce various phosphate compounds of very limited water solubility. Crop recovery of applied P fertilizer can be less than 25% during the season of application. Specialty Fertilizer Products has developed and patented a family of dicarboxylic co-polymers that can be used as a coating on granular or mixed into liquid phosphate fertilizers. The registered trade name of the new product is AVAIL®. The polymer is a high-charge density polymer (cation exchange capacity of approximately 1,800 meq/100 grams) that is reported to sequester multivalent cations that would normally form insoluble precipitates with P fertilizer. The polymer does not react with the P but does react with antagonistic positively charged multivalent cations. The process is supposed to create a zone of access and higher P availability, allowing more P to be taken up and used by plants. The objective of this research was to evaluate the use of AVAIL® with phosphorus fertilizer for corn and soybean production.

Procedures

Experiments were conducted from 2001 to 2004 at the North Central Kansas Experiment Field on a Crete silt loam soil in order to evaluate the effectiveness of the dicarboxylic polymer, AVAIL® , in increasing P availability and yield of corn and soybean. The corn experiment consisted of applying granular MAP (11-52-0) at rates to give 20, 40 or 60 lb/a P_2O_5 either treated with 0.25% AVAIL® or untreated. A no P check plot was included. The MAP fertilizer was sub-surface banded at planting. Soil test values at the experimental site were: organic matter, 2.8%; pH , 6.2; and Bray-1 P, 22 ppm. A liquid fertilizer starter test was conducted with corn in 2004 to 2006. Treatments consisted of liquid starter (30-30-5) applied with or without various concentrations of AVAIL® . A no-starter check also was included. The fertilizer was placed two inches to the side and two inches below the seed at planting. The soybean experiment consisted of applying granular MAP at rates to give 30 or 60 lb/a P_2O_5, either with or without AVAIL, plus a no P check. As in the corn experiment the MAP was applied in a sub-surface band at planting. Soil test values were: organic matter, 2.5%; pH, 6.7; and Bray-1 P, 23 ppm. Because MAP contains nitrogen (N) and rates were calculated on the basis of P content, N in the form of ammonium nitrate was added so that all treatments received the same amount of N.

In 2005 and 2006, fall applications of AVAIL® treated MAP were compared with spring applied in order to determine if the polymer retained its effectiveness over the winter period. Treatments consisted of MAP applied at 30, 60, and 90 lb/a P_2O_5, AVAIL® treated MAP applied at the same rates in either the fall or spring. A no-P check also was included. Fall applications were made in mid-November and spring applications were made in early April. All experiments were irrigated.

Results

When averaged over years and P rates, the AVAIL® treated MAP increased corn grain yield by 18 bu/a over the untreated MAP (Table 13). The AVAIL® treated MAP gave greater grain yield at all rates of applied P. Ear leaf P concentration at silking was greater in the AVAIL® treated plots than in the untreated plots. The use of AVAIL® with P fertilizer did result in improved plant P uptake (Table 14).

When averaged over years and P rates, MAP plus AVAIL® treated plots increased soybean yield by 9 bu/a more than the untreated MAP plots did (Table 15). Phosphorus uptake at the full bloom stage was increased by the use of AVAIL® applied with MAP (Table 16). When AVAIL® was applied with liquid starter fertilizer, yields were increased by 9 bu/a over the untreated starter (Table 17). Phosphorus uptake in the AVAIL® treated plots was greater than the untreated plots at both the six-leaf stage and at silking.

Studies with AVAIL® in liquid starter fertilizers indicate that polymer concentrations in high volume fluid starters need to be in the 1.5% by volume range to produce the desired effects. This percentage is of the entire fluid mix, not just the P component. Further studies have shown that a lower 2.0 pH polymer formulation is more effective than a higher 5.5 pH formulation and allows for side band placement concentration to be reduced to 0.5% by volume.

In 2005 and 2006, fall applications of AVAIL® treated MAP were investigated for irrigated corn production (Table 18). Fall and spring applications of P fertilizer were equally effective. Fall applied AVAIL® treated MAP preformed as well as spring applied and yielded 13 bu/a greater than untreated MAP.

Influencing reactions in the micro-environment around the fertilizer granule or droplet has proven to have a significant benefit to the availability of applied P fertilizer. The use of AVAIL® with P fertilizer increased plant P uptake and yield of corn and soybeans.

Table 13. Corn yield response to phosphorus and AVAIL®, North Central Kansas Experiment Field, 2001 - 2003.

Treatment	2001	2002	2003	Average
lb/a P_2O_5	- - - - - - - - - -	- - - - - - - - - bu/a	- - - - - - - - - -	- - - - - - - - -
20 untreated	188 B*	142 D	182 D	171 D
40 untreated	191 B	169 C	188 C	182 CD
60 untreated	190 B	173 BC	195 BC	186 BC
20 + AVAIL	194 B	173 BC	210 B	192ABC
40 + AVAIL	195 B	190 AB	210 A	198AB
60 + AVAIL	209 A	194 A	210A	204A
Check	174 C	120 E	169A	154 E
LSD (0.05)	9	17	10	12

* Means separated using Duncan's Multiple Range Test. Means followed by the same letter are not significantly different.

Table 14. Applied phosphorus and AVAIL effects on corn earleaf P concentration, North Central Kansas Experiment Field, 2001 - 2003.

Treatment	2001	2002	2003	Average
lb/a P_2O_5	- - - - - - - - - -	- - - - - - - - - % P	- - - - - - - - - -	- - - - - - - - -
20 untreated	0.229 D*	0.229 E	0.238 D	0.232 D
40 untreated	0.239 C	0.247 CD	0.248 C	0.245 C
60 untreated	0.251 B	0.257 B	0.255 B	0.254 B
20 + AVAIL	0.236 C	0.240 D	0.244C	0.240 C
40 + AVAIL	0.257 A	0.253 BC	0.258 B	0.256 B
60 +AVAIL	0.261 A	0.274 A	0.265 A	0.267 A
Check	0.199 E	0.212 F	0.204 E	0.205 E
LSD (0.05)	0.005	0.007	0.006	0.006

* Means separated using Duncan's Multiple Range Test. Means followed by the same letter are not significantly different.

Table 15. Soybean yield response to phosphorus and AVAIL®, North Central Kansas Experiment Field, 2002 - 2004.

Treatment	2002	2003	2004	Average
lb/a P_2O_5	- bu/a	- - - - - - - - - - - - - - - - - - - -		
30 untreated	62 C*	41 C	69 C	58 C
60 untreated	62 C	48 B	74 B	61 B
30 + AVAIL	70 B	57 A	78 A	68 A
60 +AVAIL	73 A	58 A	79 A	70 A
Check	52 D	32 D	60 D	48 D
LSD (0.5)	2	3	1	2

*Means were separated using Duncan's Multiple Range Test. Means followed by the same letter are not significantly different.

Table 16. Applied phosphorus and AVAIL® effects on whole plant P uptake at full bloom, North Central Kansas Experiment Field, 2002 - 2004.

Treatment	2002	2003	2004	Average
lb/a P_2O_5	- bu/a	- - - - - - - - - - - - - - - - - - - -		
30 untreated	6.51 C	7.37 D	9.64 C	7.84 B
60 untreated	6.86 BC	8.02 C	10.84 B	8.57 B
30 + AVAIL	8.56 AB	9.16 B	13.13 A	10.28 A
60 + AVAIL	10.20 A	10.18 A	12.91 A	11.09 A
Check	4.17 D	4.67 E	5.37 D	4.64 C
LSD (0.05)	1.15	0.91	0.45	0.83

Table 17. AVAIL® in liquid starter fertilizer, North Central Kansas Experiment Field, 2003-2005.

Treatment	Yield	V6 P Uptake	Ear Leaf P
	bu/a	lb/a	%
No starter	195	1.42	0.212
Starter	214	1.96	0.257
Starter + AVAIL	223	2.30	0.300
LSD (0.05)	5	0.20	0.011

Table 18. Timing of P application effects on yield of corn (average over P rates), North Central Kansas Experiment Field, 2005-2006.

Material	Timing	Yield
		bu/a
Check		178
MAP	Fall	202
	Spring	204
MAP+AVAIL	Fall	216
	Spring	217
LSD(0.05)		8

CHLORIDE FERTILIZATION FOR GRAIN SORGHUM

W.B. Gordon

Summary

Research in Kansas indicates that wheat often responds to chloride (Cl) fertilization. In many cases, Cl slowed the progression of leaf diseases on wheat. In other cases, Cl response occurred on soils where Cl levels were low, indicating that some soils in Kansas my be deficient in Cl.

In 2004, research was initiated to evaluate Cl fertilization on dryland grain sorghum at the North Central Kansas Experiment Field.

Results indicate that Cl fertilization can increase grain sorghum yield and leaf tissue Cl concentrations on soils that have less than 20 lb/a Cl in the top 24 inches of soil.

Procedures

Chloride rates (0, 20, and 40 lb/a Cl) and method of application were evaluated on grain sorghum at the North Central Kansas Experiment Field on a Crete silt loam soil. Methods of application included broadcast on the soil surface immediately after planting and as a starter placed two inches to the side and two inches below the seed at planting. The Cl source used was liquid ammonium chloride (6% N and 16.5% Cl). Ammonium chloride (NH_4Cl) was added to a starter fertilizer containing 30 lb/a N and 30 lb/a P_2O_5. Plots receiving broadcast NH4Cl received the same amount of starter fertilizer but without the NH_4Cl. Nitrogen (N) was balanced on all plots to 150 lb/a N regardless of NH_4Cl treatment. The experiment was conducted for three years in areas where soil-test Cl was 14 to18 lb/a Cl.

Results

Application of Cl increased grain sorghum yield in all three years of the experiment (Table 19). When averaged over years and methods of application, addition of 20 lb/a Cl increased yield up to 11 bu/a over the untreated check. Applying Cl at a higher rate than 20 lb/a Cl did not significantly increase grain yield. Applying Cl as a 2x2 starter significantly increased grain yield in only one of the three years of the study. When averaged over years, there was no difference in application method.

Results of this experiment suggest that when soil test Cl levels are below 20 lb/a, consistent increases in yield can be obtained with the application of Cl containing fertilizer.

Table 19. Grain sorghum yield response to chloride, North Central Kansas Experiment Field, 2004-2006.

Method	Rate	2004	2005	2006	Average
Check	0	120.3	115.2	125.8	120.4
Broadcast	20	127.0	124.2	133.2	128.1
	40	132.8	128.1	136.2	132.4
2 x 2	20	130.0	131.5	140.5	134.0
	40	131.0	131.3	139.0	133.8
Mean values					
Rate	0	120.3	115.2	125.8	120.4
	20	128.5	127.9	136.9	131.0
	40	131.9	129.7	137.6	133.1
LSD (0.05)		5.2	3.9	4.9	4.8
Method					
Broadcast		129.9	126.2	134.7	130.3
2 x 2		130.5	131.4	139.7	133.9
		NS*	NS	4.2	NS

*NS=Not significant

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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 South Central 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, oats, 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 2004, the Kansas State University Foundation took possession of approximately 300 acres of land southwest of Partridge. 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 the Conservation Reserve Program (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 over looks some of the soil types present in the older survey and it is believed that the descriptions 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 different from those on the current Field. The south quarter (CRP) has mostly Shellabarger fine sandy loams with 1 to 3 percent 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, 2004, and 2005 was 0.946, 3.14 and 2.22 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 23.02 inches of precipitation in 2006, 6.93 inches above the 30-year (most recent) average of 29.95 inches. Had it not been for the wet December (2.44 inches –1.55 above normal) it would have been worse in terms of fall moisture. 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 KSU automated weather station (http://www.oznet.k-state.edu/wdl/) because of the distance between the two rain gages. As with all years, distribution within the year and the rainfall intensity are the determining factors in the usefulness of the precipitation.

In 2006, only the month of December was considerably above normal. Near-normal precipitation and cool temperatures in April, May, and June, were ideal for winter annual crop development. Below-normal precipitation in July, August, September, and October were not ideal for the summer annual crops.

A frost-free growing season of 206 days (March 27-October 19, 2006) was recorded. This is 23 days more than the average frost-free season of 183 days (April 19-October 17) most of which were in the Spring.

Table 1. Precipitation at South Central Kansas Experiment Field, Hutchinson, Kansas (10 SW 143930).

Month	Rainfall (inches)	30-yr Avg* (inches)	Month	Rainfall (inches)	30-yr Avg (inches)
2005			April	2.78	2.71
September	0.47	2.73	May	4.23	4.04
October	1.02	2.49	June	4.44	4.37
November	0.19	1.38	July	1.87	3.72
December	0.31	0.90	August	2.52	3.25
2006			September	1.31	2.71
January	0.07	0.73	October	1.49	2.51
February	0.0	1.08	November	0.08	1.29
March	1.79	2.65	December	2.44	0.89
			2006 Total	23.02	29.95

* Most recent 30 years.

CROPS 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.

2006 Kansas Wheat Seed Book. KAES Contribution No. 07-8-S.
2006 Great Plains Canola Research. KAES Report of Progress .
2006 Kansas Performance Tests with Corn Hybrids. KAES Report of Progress SRP 968.
2006 Kansas Performance Tests with Grain Sorghum Hybrids. KAES Report of Progress SRP 969.
2006 Kansas Performance Tests with Sunflower Hybrids. KAES Report of Progress 972 .
2006 Kansas Performance Tests with Alfalfa Varieties. KAES Report of Progress 971.
2006 Kansas Performance Tests with Soybean. KAES Report of Progress 970.

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 then 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 inches per year, 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 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, and allow producers several options under the 1995 Farm Bill. But the fertilizer nitrogen (N) requirement for many crops is often greater under NT than 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 was an Ost loam. The sites had been in wheat before the start of the cropping systems. The research was replicated four or five times using a randomized block design with a split-plot arrangement. The main plot was crop and the subplot 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 are harvested at maturity to determine grain yield, moisture, and test weight.

Continuous Wheat

These plots were established in 1979 and modified in 1987 to include both CT and NT. The CT 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. Since the fall of 1994, winter wheat has been planted in mid-October each year. 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 N rates and tillage treatments were retained. It is hoped that doing this will give field data on the effects of canola on wheat yields in a continuous-wheat cropping system. These plots were seeded to winter wheat in the fall of 2007.

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 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 lb/a N treatments in the grain sorghum portion of the rotation. Yield data can be found in Field Research 2000, KSU Report of Progress 854.

Wheat after Soybean

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

Results

Continuous Wheat – Canola 2006

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, KSU Report of Progress 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 CT and NT treatments within N rates. Conditions in the springs of 1998 and 1999 were excellent for grain filling in wheat. But the differences in yield between CT and NT wheat still expressed themselves. 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. Data for the years 1996 through 2000 can be found in Kansas State University Field Research 2006, UNN May 2006, page SC 8. The wet winter and late spring of 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.

As indicated above, these plots were seeded to canola in the fall of 2005. The canola in the NT plots did not survive. The yield data for the conventional tillage plots is presented in Table 2. There was a yield increase for each increase in N rate. But the increase was not significant above the 50 lb/a rate. The N fertilizer was applied in the fall, and the effects of the winter kill were more noticeable at the lower N rates.

A N rate study with canola was established at the Redd Foundation land to more fully evaluate the effects of fertility on canola.

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. 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 with spring wheat reflect the lack of response to N 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/a N. In the past, those differences stopped at the 75 lb/a N 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. Data for the years 1991 through 2000 can be found in Kansas State University Field Research 2006, UNN May 2006, page SC 9. 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 through 2006 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, yields in plots with 0 and 25 lb/a N rates were less than those in the 50 to 125 lb/a rates, but there is not a significant difference in yields for those N rates. 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 through 2000 wheat yields can be found in Kansas State University Field Research 2006, UNN May 2006, page SC-10. Over these four years, there did 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. In 2003, cheat was the limiting factor in this rotation. 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 and 2006 (Table 4) when compared with the wheat yields, either continuous wheat or in rotation with soybean. It is believed that the lack of a third crop taken to maturity influenced yield in a positive way.

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 conducted to determine the best herbicides and time of application to control grasses.

Soybean and Grain Sorghum Rotations

Soybeans were added to intensify the cropping system in South Central Kansas. They also have the ability, being a legume, to add nitrogen to the soil system. For this reason, nitrogen is not applied during the time when soybeans are planted in the plots for the rotation. This gives the following crops the opportunity to utilize the added N and allows checking the yields against the yields for the crop in other production systems. Yield data for the soybeans 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. This can be seen in the yields for 2001, 2003, 2005, and 2006, when summer growing season moisture was limited. In three of the eleven years that the research has been conducted, there has been a significant effect of N on soybean yield. In two of the three years that N application rate did affect yield, it was only at the lesser N rates. This is a similar affect 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), which intensifies 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).

The lack of precipitation in 2005 and 2006 can be seen in the grain sorghum yields for 2006. Where the cropping system has been intensified (soybean, wheat, and grain sorghum) the grain sorghum yields were reduced when compared to the less intense rotation (wheat, winter cover crop, grain sorghum).

Other system 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)- grain sorghum.

Table 2. Wheat (2001-05) canola 2006 yields[1] by tillage and nitrogen rate in a continuous wheat cropping system, KSU South Central Experiment Field, Hutchinson, Kansas.

N	2001		2002		2003		2004		2005		2006	
Rate[2]	CT[3]	NT	CT	NT	CT	NT	CT	NT	CT	NT	CT	NT
	bu/a											
0	50	11	26	8	54	9	66	27	47	26	10	0
25	53	26	34	9	56	9	68	41	63	36	19	0
50	54	35	32	8	57	22	65	40	68	38	26	0
75	58	36	34	7	57	42	63	37	73	43	28	0
100	54	34	35	5	56	35	64	43	73	40	31	0
125	56	36	32	5	57	38	63	31	69	35	31	0
LSD(0.01)*	10	10	6	NS	NS	18	NS	9	14	14	6	0

* 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] Data for years prior to 1996 can be found in Field Research 2000, KSU Report of Progress 854. Data for years 1996 through 2000 can be found in Kansas State University Field Research 2006, UNN May 2006, page SC 8.

[2] Nitrogen rate in lb/a.

[3] CT = conventional, NT = no-tillage.

Table 3. Wheat yields[1] after soybean in a soybean-wheat-grain sorghum rotation with nitrogen rates, KSU South Central Experiment Field, Hutchinson, Kansas.

N Rate	2001	2002[2]	2003	2004	2005	2006
lb/a	- - - - - - - - - - - -	- - - - - -	bu/a	- - - - - -	- - - - - -	- - - - - -
0	12	9	31	40	30	29
25	16	10	48	46	43	38
50	17	9	59	48	49	46
75	17	7	65	46	52	46
100	20	8	67	43	50	52
125	21	8	66	40	48	50
LSD (0.01)*	7	4	3	5	5	3
CV (%)	23	24	4	6	6	5

[1] Data for the years 1991 through 2000 can be found in Kansas State University Field Research 2006, UNN May 2006, page SC 9.
[2] Yields severely reduced by hail.
* 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.

Table 4. Wheat yields[1] after grain sorghum in a wheat-cover crop-grain sorghum rotation with nitrogen rates, KSU South Central Field, Hutchinson, Kansas.

N Rate	1997	1998	1999	2000	2001	2002[2]	2003	2004	2005	2006
lb/a		- - - - - - - -	- - - - - -	- - - - - -	- - - - - -	bu/a	- - - - - -	- - - - - -	- - - - - -	- - - - - -
0	17	25	26	4	45	10	9	47	59	38
HV[3]	43	50	39	16	45	10	5	36	63	58
50	59	52	50	21	41	8	4	35	56	61
WP[3]	43	51	66	21	41	9	8	37	60	64
100	52	56	69	26	39	5	5	32	55	58
SC[3]	53	54	70	22	42	6	6	36	55	55
LSD (0.01)*	21	12	5	5	5	3	NS	8	6	5
CV (%)	26	14	6	16	6	20	70	12	6	7

[1] Data for the years 1997 through 2000 can be found in Kansas State University Field Research 2006, UNN May 2006, page SC 10.
[2] Yields severely reduced by hail.
[3] HV hairy vetch, WP winter pea, SC sweet clover.
[4] 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.

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

N Rate[1]	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
lb/a	- - - - - - - - - - - - -					bu/a				- - - - - - - - - - - - -	
0	16	26	22	33	25	7	22	5	53	20	18
25	17	29	23	35	21	8	22	6	50	19	18
50	18	30	23	36	23	9	22	6	50	18	18
75	20	29	24	36	24	8	21	7	51	18	18
100	22	31	25	37	21	9	21	7	51	19	18
125	20	25	24	34	22	8	22	7	49	19	19
LSD (0.01)*	3	NS	NS	NS	NS	NS	NS	1.4	NS	NS	1
CV (%)	10	12	6	12	15	13	7	17	6	11	5

[1] N rates are not applied to the soybean plots in the rotation.
[2] 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.

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

N Rate	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
lb/a	- - - - - - - - - - - - -					bu/a				- - - - - - - - - - - - -	
0	32	13	57	52	55	15	34	10	86	86	19
25	76	29	63	67	56	15	41	10	112	90	18
50	93	40	61	82	54	13	43	9	129	97	16
75	107	41	60	84	49	9	43	8	136	95	14
100	106	65	55	77	50	7	46	8	141	101	12
125	101	54	55	82	49	7	47	9	142	95	12
LSD (0.01)*	8	13	NS	13	NS	NS	8	NS	9	12	4
CV (%)	5	18	10	9	10	58	11	24	4	7	18

* 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.

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

N Rate	1996	1997	1998	1999	2000	2001	2002[2]	2003	2004	2005	2006
lb/a						bu/a					
0	73	26	69	81	68	17	22	21	92	84	20
HV[1]	99	36	70	106	54	17	21	16	138	93	21
50	111	52	73	109	66	13	25	15	135	90	28
WP[1]	93	35	72	95	51	19	23	17	138	101	23
100	109	54	67	103	45	12	25	14	136	89	27
SC[1]	94	21	72	92	51	19	19	19	94	80	28
LSD (0.01)*	13	14	NS	21	16	6	NS	5	19	16	6
CV (%)	8	22	13	12	16	21	20	22	9	10	19

[1] HV hairy vetch, WP winter pea, SC sweet clover.
[2] Yields affected by hot dry conditions in July and bird damage.
[3] 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.

CANOLA RESEARCH

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Summary

Winter canola (canola) has been a developing alternative crop in Kansas and the southern Great Plains since the early 1980s. With the advent of new varieties, production research has once again moved into the picture. Two fertility studies were conducted at the field. The first is a spring nitrogen (N) rate study and the second is a fall N rate study. The fall N rate study was the result of discussions of the external research advisory committee. Canola was seeded in the fall of 2005 on the area that has been in the long term winter wheat by N rates. This was done to generate data to show the effects of canola on the succeeding winter wheat crop where wheat had been grown continuously. The spring N rate study is looking at the effects of N top dressed in the spring before bolting of the canola.

This study also involves no-till and conventional tillage but is planted rotationally. Other canola research at the South Central Field includes, canola for forage, canola in rotation with winter wheat and grain sorghum with N rates, and date and rate of planting.

Introduction

Kansas is in the Great Plains region of the U.S. Canola Association's breakdown of the United States. This region has witnessed a record increase in winter canola acres from 2003 to 2006, made possible partly by improvements in winter hardiness and yield potential of adapted canola cultivars bred by Kansas State University with funding from the National Canola Research Project (NCRP). Almost 60,000 acres of winter canola were planted in the Region in the fall of 2005 with the majority being seeded in the states of Kansas, Oklahoma, and Texas. Record-breaking drought, however, impacted the 2005-2006 growing season from seeding through the early stages of grain fill. The effects of this drought were also seen in the winter wheat crop. The drought severely reduced the yield potential of the crop across the Region.

Another environmental factor having a negative effect on yield was spring regrowth. Plants that were stressed through the fall and winter months started to put on secondary branches that flowered and produced seed. This regrowth (a process similar to grain sorghum producing secondary tillers after a stress period) was the result of cool wet weather in late April and early May. This secondary growth caused differences in maturity of the plants at harvest. In addition, an unprecedented aphid pressure caused plant desiccation and further yield reductions. Even though the drought might have reduced the number of acres planted to canola in the fall of 2006, the number of first time producers increased because of the availability of crop insurance. Areas where continuous winter wheat production is common are being targeted for potential growth of this crop, with the emphasis that planting canola in rotation with winter wheat will mitigate the insect, weed, and disease pressures inherent to monoculture systems of continious wheat. Agronomic management studies coordinated by K-State researchers are ongoing in the region, including studies examining fertility rate, planting date and rate, harvesting methods, grazing potential, tillage systems, and crop rotations.

Since 1992, a canola breeding program for the Great Plains region has been located at the K-State Department of Agronomy. To build on the existing program and further the advancement of canola as an alternative crop, K-State and Oklahoma State Universities combined available resources in the summer of 2005 to hire a new canola breeder. This individual is stationed at K-State Department of Agronomy, with nursery evaluations in both Kansas and Oklahoma to aid in developing cultivars with a broad range of adaptability to the Great Plains region. Crosses are performed each winter in the greenhouse to develop new populations. Segregating populations are evaluated at one or more locations and plants with superior traits are advanced through the F2 to F5 generations. Traits of primary importance include increased winter hardiness, superior yield potential, and general adaptability to the region. Additional traits of interest being incorporated into the germplasm base include herbicide tolerance (both tolerance to the carry-over of sulfonylurea products used on preceding wheat crops and direct application of glyphosate and imidazolinone), reduced height, shatter resistance, and fatty acid profiles of potential economic importance. Superior lines in the F6 generation are evaluated throughout the region in a three-tiered yield trial system.

A series of experiments are underway, designed to answer some of these important questions and aid in the ability to maximize productivity of winter canola in the Great Plains. The majority of these projects are funded outside the U.S. Canola Association's NCRP Great Plains Canola Research Program, but the results are vital to the prioritizations of the breeding program.

Crop Establishment

Moisture availability at planting is a limiting factor in establishing the crop in the semi-arid Great Plains. No-till management conserves moisture in the soil profile. While no-till conserves soil moisture, however, difficulty in obtaining and maintaining a stand of winter canola in no-till appears to be one of the limitations we face with this crop. Establishment has a strong influence on winter survival of the crop, and some cultivars may have reduced survivability under no-till.

Studies are being conducted comparing no-till and conventional till management practices in hopes of eliminating this limitation. Date of planting and seeding rate studies are being conducted to determining the extremes of the planting window and the effect of planting date and seeding rate on final seed yield. The goal is that these studies can be expanded to examine the interaction of planting system, no-till versus conventional till. Planting date also appears to have a significant bearing on winter survival.

Another important factor in canola production is fertilizer and nutrient management. Time of N and phosphorus (P) application, and application rate on winter survival and final seed yield of canola are well understood in many parts of North America, but comprehensive knowledge under southern Great Plains conditions is not available. High rates of pre-plant N fertilizers applied in the fall can lead to excessive fall vegetative growth, elevated crown height (sometimes referred to as high-leg), which can reduce winter survival. Studies are established on the Redd Foundation land to evaluate multiple rates of N and P applied both at the time of seeding and in early spring to determine optimum rates and maximize winter survival.

Crop rotation effects on yield, disease, and pest pressure are being evaluated in long-term rotation studies at the South Central Field and at the Redd Foundation to determine the ability of canola to fit with the crops currently under cultivation. At present, most data documenting rotational benefits of including canola in a crop rotation come from research outside of the region. Reports from commercial producers are encouraging, but research data is limited. Crop rotation studies may enable the breeding program to develop new varieties with improved pest and disease tolerances.

In 2006 and 2007, the USDA Risk Management Agency (RMA) issued written agreements to insure winter canola in the Great Plains Region. Previously, the RMA required three years of canola production history before a written agreement could be obtained. This was often a hindrance to first-time canola growers who would not accept the risk of growing winter canola without adequate insurance coverage. But recent changes in the documentation state that three years' production history of a similar commodity is necessary. The commodity chosen for Kansas was winter wheat because it is a crop grown in the Region that possesses a similar risk profile.

Across Kansas and Oklahoma, several canola grain delivery points have been established. More delivery points will alleviate the economic burdens on producers whose only prior option was to deliver canola grain to an established crusher. A crushing facility near Okeen, OK, as well as several grain elevators in the Region accepted last season's crop. Another small-scale crushing facility is located near Burden, KS. Feasibility studies are underway in central Kansas and north-central Oklahoma for additional crushing and bio-diesel processing facilities. The number of facilities will likely increase in the region as acreages continue to grow. Established crushing facilities (sunflower, cotton, and soybean) have the capacity to crush additional oilseeds, so only minor investment would be required to crush harvested canola grain.

Collaborative efforts are underway to reestablish an oilseed/canola council for the Great Plains. A group of university researchers, private industry workers, and national commodity group officials have organized and discussed the potential benefits and direction for the council. The council will bring together research and extension faculty, knowledgeable growers, and private industry from states in the region having an interest in advancing canola as a rotational crop. Annual meetings of membership will provide a forum for technology transfer, collaborative research efforts, and an opportunity to voice concerns and questions. In addition to this council, an external research advisory committee has been established to coordinate research and extension activities of canola. Input from the committee will be used in an advisory manner for planning joint research objectives between K-State and Oklahoma State. The committee meets annually to discuss and plan production research studies to be conducted the following season. Both the oilseed council and research advisory committee will be key voices in publicly addressing canola's role as a viable rotational crop for the southern Great Plains.

Procedures

Research was conducted at the KSU South Central Experiment Field, Hutchinson. The conventional tillage plots were offset disk and plowed shortly after wheat harvest and field cultivated just before planting. The no-tillage plots were treated with glyphosate to control weeds as needed. All plots received 40 lb/a P_2O_5 before planting.

The canola was planted in the long-term continuous wheat plots (F24) on September 13, 2005, with Sumner at a rate of 5 lb/a. Nitrogen rates of 0, 25, 50, 75, 100, and 125 lb/a were applied with a Barber metered screw applicator on September 21, 2005. An area of 6 × 24 feet was harvested from the plots on June 16, 2006 to determine seed yield, test weight, and grain moisture.

The spring N rate plots were planted with Sumner canola (Sumner was used due to the use of SU herbicides on the winter wheat the previous year) on September 16, 2005 at a rate of 5 lb/a. The plot areas received a uniform application of 30 lb/a N and 40 lb/a P_2O_5 before planting. Nitrogen rates of 0, 25, 50, and 100 lb/a were applied to the plots on April 4, 2006. The plots were harvested on June 21, 2006, to determine seed yield, test weight, and moisture. Seed samples from both test were sent in for percent oil analysis.

Results

Fall N Rates

The no-till plots in this study did not survive the winter, so there is no data for these plots. The conventional plots came through the winter quite well with some differences in growth due to N rate (higher N rates had slightly more growth). It was noted after the freeze on March 23 and 24, 2006, that the lower N rates (0 and 25 lb/a) seemed to have suffered more from the freeze. At this point, it is not known if this affected yield more than the N rate itself.

Table 8 contains data from the fall N rate and its effects on canola grain yield, moisture, test weight, plant height, and oil. All N treatments were significantly greater than the 0 N treatment. The 50, 75, 100, and 125 lb N treatments were not significantly different from each other, but they were all significantly greater than the 0 and 25 lb N treatments. It is interesting to note that oil content (%) decreased as N rate increased. Further research is needed in this area to determine the long term affects of applying all the N fertility in the fall.

Spring N Rates

Unlike the no-till plots in the fall N rate study, the no-till plots in the spring study survived. When compared to the conventional tilled plots, however, the canola in the no-till had reduced growth, plants were slower to bolt, less vigorous, and considerably shorter than those in the conventional tilled plots. We did not see the differences after the March freeze in these plots (most likely because of the uniform fall N application).

Table 9 shows data for canola seed yield and oil percent under two tillage systems at different spring nitrogen rates. Generally, as N rate increased the percent oil decreased under both tillage systems. Grain yields in this study were lower than the fall N study. Further research is needed to determine if this is an effect of N application timing.

Table 8. Fall nitrogen rate affects on canola grain yield, moisture, test weight, plant height and seed oil, KSU South Central Experiment Field, Hutchinson, Kansas, 2006.

N Rate	Yield[1]	Moist	Test Weight	Plant Height	Seed Oil
lb/a	lb/a	%	lb/bu	inches	%
0	514	9.6	49.6	26.3	38.3
25	963	9.8	49.3	28.0	38.4
50	1299	9.0	49.5	31.3	37.4
75	1378	10.0	50.5	31.3	37.0
100	1546	10.1	50.1	33.0	36.5
125	1548	12.1	48.6	35.0	35.8
Mean	1208	10.1	49.6	30.8	37.2
CV	16.9	9.6	1.9	9.4	---
LSD (0.05)	308	NS	NS	4.4	0.8

[1] Yields reported at 8 percent moisture.

Table 9. Canola seed yield and oil as affected by spring application of nitrogen, KSU South Central Experiment Field, Hutchinson, Kansas, 2006.

N	Conventional		No-Till	
Rate[2]	Yield[1]	Oil	Yield	Oil
	lb/a	%	lb/a	%
0	727	37.5	295	36.4
25	879	37.0	345	36.6
50	705	36.6	347	34.8
75	921	37.0	179	35.0
100	911	36.3	240	34.5
Mean	829	36.9	261	35.5
LSD. (0.05)	167	0.9	83	1.0

[1] Yields reported at 8 percent moisture.
[2] All plots received 30 lb/a N and 40 lb/a P_2O_5 before planting.

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 conditions typical of requirements in the state in May and June. Spring cereals (oats, 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 2006 were dry earlier in the spring but cooler and wetter then normal during May and June. These conditions resulted in excellent forage yields for most varieties, despite planting into sub-optimal soil moisture conditions. Spring cereal grain yield and test weight were above average due to the favorable conditions in May and June.

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 is often 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 K-State South Central Experiment Field, Hutchinson on an Ost loam. The site was fallowed during 2005 with the following tillage operations: moldboard plow, chisel plow, tandem disk, pre-plant field cultivation. Fertilizer was applied as follows: 40 lb/a P_2O_5, 75 lb/a N as urea (46-0-0) broadcast pre-plant and 50 lb/a N (46-0-0) broadcast post-emergence. 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 six hard red spring wheat varieties were planted.

Each plot was 35 ft × 5 ft, consisting of six rows, eight inches apart and planted with a plot drill for grain and 20 ft × 5 ft for forage. Seeding rate was two bu/a. All plots were planted on March 2. Planting was delayed due to dry soil conditions. Forage yield was determined using a Carter plot forage harvester and a harvest area of 15 ft × 3ft. Total wet weight was determined and a sub-sample taken to determine forage moisture. Forage yields were determined on a dry weight basis on June 20, 2006.

Grain yields were determined using a Gleaner E plot combine and a harvest area of 30 ft × 5 ft. Sub-samples were taken to determine grain moisture and yields adjusted to 12.5% moisture. Grain was harvested on June 26, 2006.

Results

Oat

During 2006, fall and winter conditions were much drier than normal and quite mild. Conditions improved during spring resulting in above average precipitation with cooler than normal temperatures. This resulted in excellent forage and grain yields despite poor conditions at planting.

Oat forage yields averaged four and one-half tons per acre (Table 10), with a range of 7,700 to 10,800 lb/a dry matter. In this study, forage yields were not significantly different across the 18 varieties. Typical recommendations for Kansas indicate that oat varieties with the highest grain yield produce the most forage, however, in 2005 and 2006 this was not true (Tables 10 and 11). 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 an example of this. Grain yields were quite good considering the late planting and late 50% heading date, and averaged 55 bu/a (Table 11). Two varieties, Forage Plus and CHD-2301-SO had grain yields that were only 40% of the test average. If these two varieties are eliminated, the test average grain yield is 59 bu/a. Both are late maturing, forage-type oats that headed over one week later than the test average. Typically, test weights are well below the 32 lb/bu standard, however, temperature and moisture conditions were conducive to grain fill and maturity in 2006 (Table 11).

Spring Wheat and Triticale

In 2005, spring wheat and triticale varieties did not mature until late June. A severe hail storm did not allow for grain harvest and only total dry matter production was determined. As stated in the oat section, where winter conditions were dry and warm, spring conditions resulted in much higher forage and grain yields than expected.

Dry matter yields averaged approximately 3.75 tons/a, ranging from 6,300 to 8,800 lb/a dry matter. The winter triticale variety, EH-DP-WT, which barely produced any heads and was extremely late, produced almost 3.5 tons/a dry matter which was essentially all leaf material. The two spring triticale varieties produced significantly more dry matter than all except Granger hard red spring wheat (HRSW).

Grain yields are expressed in lb/a since HRSW and triticale have much different test weight standards. Both grains headed at approximately the same time as the oat varieties (Table 13). Based upon tests conducted previously at the Hutchinson field over the last 20 plus years, grain yield and test weight were much higher for the HRSW varieties than would be expected in an average year (Table 13). The winter triticale produced no grain. Unlike 2005, no leaf diseases were noted in the HRSW varieties.

Hard red spring wheat varieties are being examined in this study for two reasons, potential spring forage production, and to provide a data base for questions that arise periodically concerning planting HRSW as a substitute for winter wheat during certain years. Planting HRSW for grain is not recommended unless a producer intends to keep it on-farm as feed. It is very important to keep HRSW separated from hard red winter wheat. This test continues in 2007.

Table 10. Spring oat dry matter (forage) yield and two year average, KSU South Central Experiment Field, Hutchinson, Kansas, 2005-2006.

	Dry Matter Yield		
Variety	2005	2006	2-year average[1]
	---------------------------- lb/a ----------------------------		
Bates	7700	7900	7800
Blaze	9700	10,800	10,250
Chaps	7600	-------	
CHD-2301-SO	5700	9000	7350
Dane	7400	7900	7650
Don	6800	------	
Drumlin	------	9500	
Esker	9200	8800	9000
Forage Plus	8500	8200	8350
Gem	9400	8800	9100
INO9201	9000	------	
Jay	7700	------	
Jerry	8400	------	
Jim	8400	------	
Kame	------	10400	
Leonard	------	9700	
Moraine	8100	9400	8750
Ogle	8000	7700	7900
Reeves	8100	9900	9000
Richard	9200	9200	9200
Spurs	7900	8900	8400
Stallion	-----	9800	
Thunderleaf	-----	8000	
Winona	-----	8900	
Mean	8100	9000	8600
LSD (.05)*	1580	NS	

[1]Not all varieties were present in both years.

* 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 oat heading date, grain moisture, test weight and grain yield , and two-year average grain yield, KSU South Central Experiment Field, Hutchinson, Kansas, 2005-2006.

Variety	Heading Date[1]	Grain Moisture	Test Weight	Grain Yield 2006	Grain Yield 2005	Grain Yield 2-yr avg[2]
		%	lb/u	bu/a	bu/a	bu/a
Bates	5/20	8.2	33.3	59.1	51.6	55.4
Blaze	5/23	8.3	32.2	58.3	52.4	55.4
Chaps	----	----	----	----	64.0	
CHD-2301-SO	5/31	8.0	27.4	20.6	10.2	15.4
Dane	5/19	7.8	29.3	62.1	57.6	59.9
Don	----	----	----	----	57.0	
Drumlin	5/25	8.2	30.5	42.4	----	
Esker	5/24	7.8	31.5	53.0	57.5	55.3
Forage Plus	6/2	9.1	28.6	22.3	12.3	17.3
Gem	5/25	7.6	31.1	57.8	49.1	53.5
INO9201	----	----	----	----	58.6	
Jay	----	----	----	----	55.1	
Jerry	----	----	----	----	52.5	
Jim	----	----	----	----	60.1	
Kame	5/21	8.3	32.2	73.6	----	
Leonard	5/27	8.1	29.4	48.6	----	
Moraine	5/21	8.1	32.2	57.3	58.2	57.8
Ogle	5/22	7.9	30.8	72.3	56.7	64.5
Reeves	5/23	8.4	31.5	50.7	46.4	48.6
Richard	5/25	8.2	30.1	50.8	45.5	48.2
Spurs	5/21	8.3	33.8	60.1	66.6	63.4
Stallion	5/25	8.4	33.3	60.8	----	
Thunderleaf	5/20	8.2	33.7	68.6	----	
Winona	5/20	8.3	32.8	60.7	----	
Mean	5/23	8.2	31.3	54.8	50.6	49.5
LSD (.05)*	0.7 days	0.45	1.39	8.01	11.9	

[1] Month/Day
[2] Not all varieties were present both years
*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 12. Spring wheat and triticale harvest moisture and dry matter (forage) yield for 2006, dry matter (forage) yield for 2005, and two year average forage yield, KSU South Central Experiment Field, Hutchinson, Kansas.

Variety	Grain[1]	Harvest Moisture	Dry Matter Yield 2006	Dry Matter Yield 2005	Dry Matter Yield 2-Year Average[2]
		%	lb/a	lb/a	lb/a
Briggs	HRSW	55.8	7570	6610	7090
Forge	HRSW	55.3	6690	6230	6460
Granger	HRSW	56.3	7940	6040	6990
Ingot	HRSW	----	----	5680	----
Oxen	HRSW	55.3	6640	5870	6260
Russ	HRSW	57.0	7330	6240	6790
Traverse	HRSW	58.0	6280	----	----
Walworth	HRSW	----	----	5890	----
EH-DP-WT	WT	72.3	6880	6790	6840
EH-CTI-ST	ST	61.7	8810	6360	7590
EH-P-ST	ST	59.7	8810	7030	7920
Mean		59.1	7440	6280	7100
LSD (.05)*		0.44	1230	980	

[1] HRSW = Hard Red Spring Wheat; ST = Spring Triticale; WT = Winter Triticale
[2] Not all varieties were present in both years.
* 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 13. Spring wheat and triticale heading date, grain moisture, test weight and grain yield, KSU South Central Experiment Field, Hutchinson, Kansas, 2006.

Variety	Grain[1]	Heading Date[2]	Grain Moisture	Test Weight	Grain Yield
			%	lb/u	lb/a
Briggs	HRSW	5/17	11.1	56.6	1560
Forge	HRSW	5/14	11.3	56.8	1650
Granger	HRSW	5/20	11.7	54.2	1800
Oxen	HRSW	5/18	10.7	54.6	1732
Russ	HRSW	5/19	10.6	54.8	1394
Traverse	HRSW	5/19	10.5	55.8	1790
EH-CTI-ST	ST	5/20	12.8	52.2	1830
EH-P-ST	ST	5/20	11.9	52.2	1940
EH-DP-WT	WT	6/19	----	----	----
Mean		5/22	10.1	48.6	1530
LSD (.05)*		1.7 days	1.0	1.99	175.9

[1] HRSW = Hard Red Spring Wheat; ST = Spring Triticale; WT = Winter Triticale
[2] Month/Day
*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.

EVALUATION OF WINTER 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, considered best adapted to climatic conditions typical of the state. It is also the predominant winter annual small grain planted for forage (pasture, hay, silage). Other fall planted small grain cereals such as winter triticale and rye exist that possess the potential of providing high quantity and adequate quality forage. In addition, the grain, while not yet 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 winter triticale and rye compared to traditional hard red winter wheat. This test also provides information for producers interested in winter triticale as a potential feed substitute for winter wheat. In 2006, conditions for growth and development were dry from September through early spring, but cooler and wetter then normal during May and June. These conditions resulted in excellent forage yields for most varieties, despite planting into sub-optimal soil moisture conditions and very poor fall growth. Grain yield and test weight were better than expected due to favorable conditions in May and June.

Introduction

Hard red winter wheat is the predominant small grain cereal planted in Kansas as a food and feed grain and forage (typically as pasture). While able to supply excellent pasture under adequate weather conditions, other winter small grain cereals are available that possess winter hardiness and drought tolerance comparable or better to that of winter wheat, primarily triticale and rye. Interest in these two grains is increasing for several reasons. The prolonged dry conditions throughout much of Kansas have caused producers to look for more drought tolerant winter small grains for pasture. The increasing cost of feed grains and alfalfa has producers seeking cheaper feed options. Finally, although these alternative winter cereals are not new, recent emphasis on breeding for winter hardiness has resulted in newer, better adapted varieties.

While primary interest in winter triticale and rye is as forage, they both possess potential as feed grains and to a more limited extent, food grain.

The primary objective of this long-term study is to determine the forage and grain yield potential of alternative winter cereals as compared to traditional hard red winter wheat.

Procedures

Research was conducted at the K-State South Central Experiment Field, Hutchinson on an Ost loam. The site was planted to grain sorghum during 2004 and planted to soybeans as a cover crop during 2005 with the following tillage operations: offset disk (August 1, 2005), moldboard plow (August 19, 2005), tandem disk (September 6, 2005), pre-plant field cultivation (September 21, 2005). Fertilizer was applied as follows: 75 lb/a N as urea and 40 lb/a P_2O_5 broadcast as a mixture of 11-52-0 and 46-0-0 on September 21, 2005 and 75 lb/a N as urea broadcast on January 19, 2006. No post-emergence herbicides were applied.

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 set for grain. The test consisted of two hard red winter wheat varieties (Jagger and Overly), one rye (Thundergreen), six winter triticales (336, Thundertall, Thundercale, Thundercale K, Thundercale V, and T-XTRI), and a triticale/rye blend (633 K blend). Jagger and Overly were selected as wheats for comparison winter wheat was used for comparison as they are common grazing wheats.

Each plot was 35 ft × 5 ft, consisting of six rows, eight inches apart and planted with a plot drill. Seeding rate was two bushels per acre. All plots were planted on October 5, 2005. Planting was delayed due to extremely dry soil conditions. Forage yield was determined using a Carter plot forage harvester and a harvest area of 15 × 3 ft. Total wet weight was determined and a sub-sample taken to determine forage moisture. Forage yields were determined on a dry weight basis. Forage yields were determined on May 15, 2006. This was when most plots were in the late milk/early dough stage.

Grain yields were determined using a Gleaner E plot combine and a harvest area of 30 ft X 5 ft on. Sub-samples were taken to determine grain moisture and yields adjusted to 12.5% moisture. Grain was harvested on June 26, 2006.

Results

In 2005 and 2006, fall and winter conditions were much drier and warmer than normal (see introduction). This resulted in delayed planting and poor growth through the winter. Spring was wet and overall cool, however, providing excellent conditions for crop development and resulting in excellent growth. Above normal precipitation in May and early June allowed for normal grain maturation and slightly delayed forage harvest.

Forage yields averaged over five tons per acre (Table 14) with a range of 9,700 - 13,700 lb/a dry matter. Moisture content of wheat varieties was significantly less than triticale or rye as they were slightly more mature (early dough versus milk stage), Protein levels for triticale and rye were comparable to Jagger and Overly, however, overall quality (as measured by ADF, NDF, and RFV) was less for rye and triticale varieties. Overall forage yield for rye and triticale varieties were comparable to significantly better than the two wheat check varieties.

Grain yields were quite good considering the delayed planting and dry fall/winter conditions, averaging 2300 lb/a (Table 15). Yields are reported in lb/a instead of bu/a due to the difference in bushel weights between grains. Significantly delayed heading for rye and triticale varieties compared to the two wheat varieties did not negatively affect grain yield. Grain moisture was not significantly different between entries. Test weights for rye and triticale were closer to accepted standards than for Jagger and Overly.

The first year of this study indicates that these newer triticale and rye varieties have the potential to equal or exceed two traditional wheat varieties in forage production. The quantity of grain produced indicates their potential as a feed stuff.

These two trials are continuing in 2007 and have been expanded to include new winter barley varieties.

Table 14. Winter cereal harvest , forage yield (dry matter) for 2006, 2005 grain yield, and two-year average grain yield, KSU South Central Experiment Field, Hutchinson, Kansas.

Variety	Grain	Harvest Moisture	Crude Protein	ADF[1]	NDF[2]	RFV[3]	Forage Yield
		%	%	%	%		lb/a
Thundergreen	Rye	61.5	11.8	41.7	64.1	82.0	10810
633 K	Blend	58.8	10.7	35.3	58.1	98.2	11380
336	WT	58.2	10.6	35.7	59.4	95.7	12420
Thundercale	WT	57.8	11.7	33.9	54.7	115.3	11480
Thundercale K	WT	61.5	11.8	35.5	57.4	99.2	11840
Thundercale V	WT	62.4	11.8	33.6	60.1	93.2	11320
Thundertall	WT	65.1	10.8	40.4	62.6	85.2	12210
T-XTRI	WT	58.9	10.8	39.3	61.3	88.7	13740
Jagger	HRWW	54.0	11.0	31.9	53.7	111.0	9720
Overly	HRWW	51.5	11.2	30.9	50.3	120.0	11580
Mean		59.0	11.2	35.8	58.2	98.9	11650
LSD (.05)*		0.06	NS	2.63	1.36	6.9	2140

[1] ADF = Acid Detergent Fiber
[2] NDF = Neutral Detergent Fiber
[3] RFV = Relative Feed Value
*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. Winter cereal heading date, plant height, grain moisture, test weight, and grain yield, KSU South Central Experiment Field, Hutchinson, Kansas, 2006.

Variety	Grain[1]	Heading Date[2]	Plant Height	Grain Moisture	Test Weight	Grain Yield[3]
			inches	%	lb/bu	lb/a
Thundergreen	Rye	4/29	45	10.7	40.0	2590
633 K	Blend	4/23	37	10.9	48.0	2120
336	WT	4/23	38	11.0	47.9	2390
Thundercale	WT	4/22	39	10.6	48.6	2430
Thundercale K	WT	4/26	37	10.9	49.8	2940
Thundercale V	WT	4/26	42	10.9	47.7	2070
Thundertall	WT	4/30	50	10.7	51.3	1970
T-XTRI	WT	4/25	49	10.8	49.4	1990
Jagger	HRWW	4/22	28	10.9	56.5	2310
Overly	HRWW	4/22	28	10.3	55.8	2460
Mean		4/22	39	10.8	49.5	2330
LSD (.05)*		1.2 days	1.7	NS	1.2	453

[1] Rye; Blend = Rye and Triticale; WT = Winter Triticale; HRWW = Hard Red Winter Wheat
[2] Month/Day
[3] grain moisture adjusted to 12.5% moisture.
*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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