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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, including 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 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 with a slowly permeable clay subsoil. The soil is derived from old alluvium. Water intake is slow, averaging less than 0.1 in. per hour when saturated. This makes the soil susceptible to runoff and sheet erosion.

2003 Weather Information

Precipitation during 2003 totaled 33.11 inches, which was 3.67 inches less than the 35-yr average (Table 1). Severe moisture deficit and heat stress occurred during the middle-to-late parts of the growing season. Rainfall during April, May, and June was average. Rainfall in July and most of August was 4.07 inches below average.On August 30 and 31, 6.54 inches of rain fell, breaking the heat and drought.

The coldest temperatures during 2003 occurred in January, with four days in single digits and one day with 5°F below zero. Cold temperatures returned during February 6 and 7 and February 24 and 25, with 3 days in single digits and one day with 4°F below zero . The overall coldest temperature recorded in 2003 was 5°F below zero on January 23. There were 48 days during the summer in which temperatures exceeded 90 degrees. The two hottest days were July 18 and August 21, when daily temperatures reached 105 and 106°F, respectively. The hottest ten-day period was August 17 through August 26, when daily temperatures averaged 102°F. The last freeze in the spring was April 10 (average is April 18), and the first killing frost in the fall was October 26 (average is October 21). The number of frost-free days was 193, compared with the long-term average of 185.

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

Month	2003	35-yr. avg.	Month	2003	35-yr. avg.
January	0.33	1.03	July	1.22	3.37
February	2.15	1.32	August	8.61	3.59
March	1.33	2.49	September	2.06	3.83
April	4.53	3.50	October	0.66	3.43
May	4.53	5.23	November	0.91	2.32
June	4.94	5.21	December	2.04	1.45
Annual Total				33.11	36.78

INTEGRATED AGRICULTURAL MANAGEMENT SYSTEMS FOR PROTECTION OF KANSAS SURFACE WATERS

Marais Des Cygnes River Basin

K.A. Janssen and G.M. Pierzynski

Summary

The purpose of this study was to evaluate, in a field-scale setting, the effects of different combinations of tillage-, fertilizer-, and herbicide-management practices on controlling cropland runoff losses of sediment, nutrients, and herbicides from a terraced Kansas field in the Marais Des Cyges River Basin. Six years of runoff-water collections show that no-till with fertilizer pre-plant deep-banded and herbicide split between early pre-plant and planting is one of the best combinations for balanced protection of water quality.

Introduction

Water quality is an issue that concerns everyone. Total Maximum Daily Loads (TMDL) are being implemented in Kansas for various contaminants in streams and water bodies. Contaminants of most concern are sediment, nutrients, pesticides, and fecal coliform bacteria. In watersheds with waters not meeting standards, farmers and other land owners will be encouraged to reduce contaminant loading by implementing Best Management Practices (BMP).

For crop producers, numerous BMP are available to reduce soil erosion and sediment in runoff from cropland. But no-till has been shown to be one of the most effective BMPs because it targets sediment control at the origination point. Tillage/planting systems such as no-till, however, provide little opportunity for incorporating fertilizer, manure, and herbicides. When surface-applied, an increased percentage of these crop inputs contact runoff waters, and that results in increased contaminant loading.

Consequently, to attain balanced water-quality control, a comprehensive management strategy beyond just no-till is needed. A system of farming is needed that uses combinations of best management practices (BMP) so that all runoff contaminates are controlled. We refer to such a strategy as "Integrated Agricultural Management Systems."

The purpose of this study was to test, in a field-scale setting, effects of different combinations of tillage, fertilizer, and herbicide management practices for balanced water quality protection.

Methods

The study location was on an approximately 10-acre, parallel-terraced field near Lane in southeast Franklin County, Kansas. Soils in the field were a mixture of Eram-Lebo with some Dennis-Bates complex (Argiudolls, Hapludolls, and Paleudolls). The result of a Bray-1 P soil test initially was 13 ppm, which is a low-to-medium P soil content, according to recommendations from Kansas State University Research and Extension.

Three combinations of tillage, fertilizer, and herbicide management practices were evaluated, starting in 1998. The combinations were: (1) no-till, with fertilizer and herbicides broadcast on the soil surface; (2) no-till, with fertilizer deep-banded (3-5 inch depth) and herbicides broadcast on the soil surface; and (3) chisel-disk-field cultivate with fertilizer and herbicides incorporated by tillage. All treatments were replicated twice and were established between terraces to facilitate runoff-water collection. The crops grown were grain sorghum and soybean in alternate years in rotation. The rate of fertilizer applied for grain sorghum was 70 lb N, 33 lb P_2O_5, and 11 lb K_2O per acre. No fertilizer was applied for soybean. Atrazine (1.5 lb/a ai) and Dual (metolachlor 1.25 lb/a ai) herbicides were applied for weed control in grain sorghum. For soybean, Roundup Ultra (glyphostate 1 lb/a ai) and metolachlor (1.25 lb/a ai) herbicides were applied.

Rainfall amounts were recorded, and runoff was collected by instrumentation of all treatment areas between terraces with weirs and automated ISCO samplers. The runoff water collected was analyzed for sediment, nutrients, and herbicide concentrations. Mass losses of contaminants were calculated by multiplying the runoff concentrations times runoff volumes.

Results

Rainfall and Runoff

Averaged across all runoff sampling dates and years (1998-2003), rainwater that ran off was 3.22 inches (34%) in the no-till system and 1.92 inches (20 %) in the chisel-disk-field cultivate system (Figure 1). Part of the reason that runoff was greater in no-till than in the chisel-disk-field cultivate system was that no-till conserves surface soil moisture, which then generates runoff more quickly. Also, each time the soil in the chisel-disk-field cultivate system was tilled, it loosened and dried the soil, which then increased the soil's capacity to absorb rainwater.

Soil Erosion and Sediment Losses

Even though runoff was less in the chisel-disk-field cultivate system, the amount of soil loss was three times greater, compared with that of no-till (Figure 2). With the chisel-disk-field cultivate system, the 6-yr average growing-season soil loss was 0.67 ton/a, whereas no-till average loss was 0.22 ton/a.

Nutrient and Herbicide Losses

Total P losses in the runoff paralleled soil losses (Figure 3). This is because sediment P in runoff generally accounts for most total P losses. Soluble P and atrazine losses in the runoff water were greatest with surface P fertilizer and herbicide applications in no-till (Figures 4 and 5). Incorporation of P fertilizer and atrazine with tillage decreased losses. Deep-banding fertilizer P in no-till also reduced soluble P losses. Concentrations of soluble P and atrazine in runoff were generally greatest during the first couple of runoff events after application (data not shown), because that was when the largest portion of these materials were still present on the soil surface and had not yet been absorbed into the soil.

Conclusions

These data confirm that no-till is one of the most effective BMP for reducing soil erosion and sediment P in runoff from cropland. If fertilizer and herbicides are surface-applied, however, losses of these crop inputs may be increased compared with those from incorporation by tillage. Therefore, to assure balanced runoff-water protection, it will be important to subsurface apply P fertilizer when planting crops no-till. This could be in the form of pre-plant deep banding (3-5 inch coulter knife depth on 15 in. centers, which was used here), 2x2 inch band placement of fertilizer with the planter, or some combination of the two strategies. Steps to reduce herbicide losses when planting crops no-till will also be needed. This might be accomplished partly by timing the herbicide applications when there is less opportunity for runoff-producing rains (fall and early spring) or as post-emergence applications instead of planting-time applications.

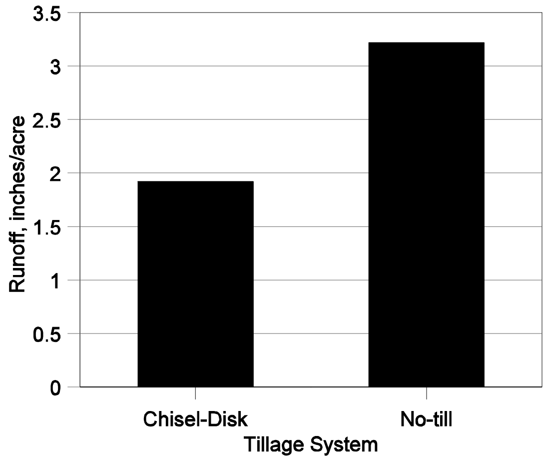

Figure 1. Volume of runoff as influenced by tillage (6-yr growing-season avg.).

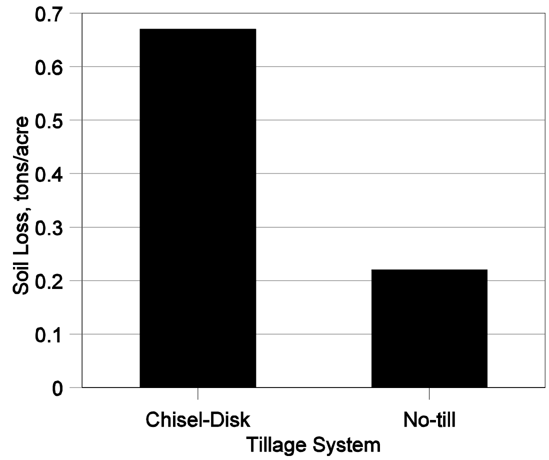

Figure 2. Soil loss as influenced by tillage (6-yr growing-season avg.).

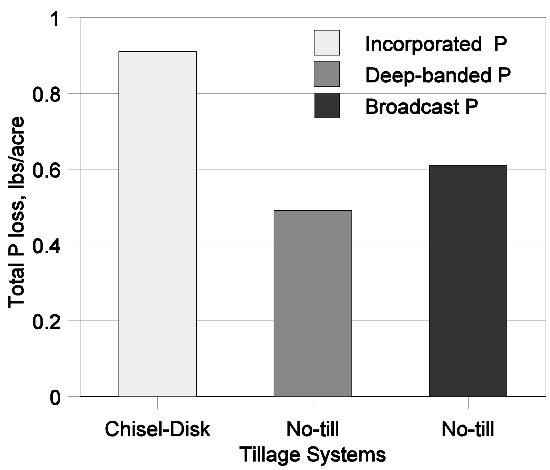

Figure 3. Total P loss as influenced by tillage and P placement (6-yr growing-season avg.).

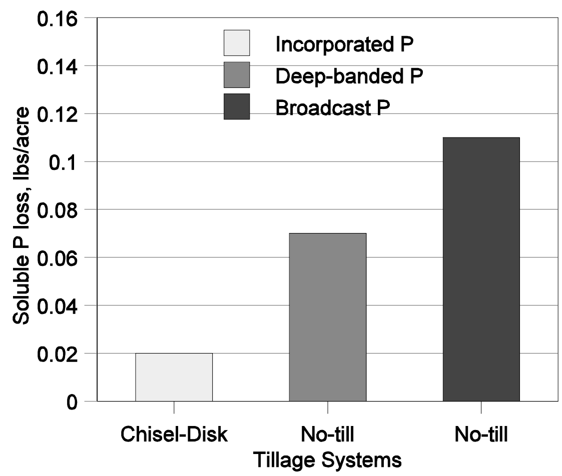

Figure 4. Soluble P loss as influenced by tillage and P placement (6-yr growing-season avg.).

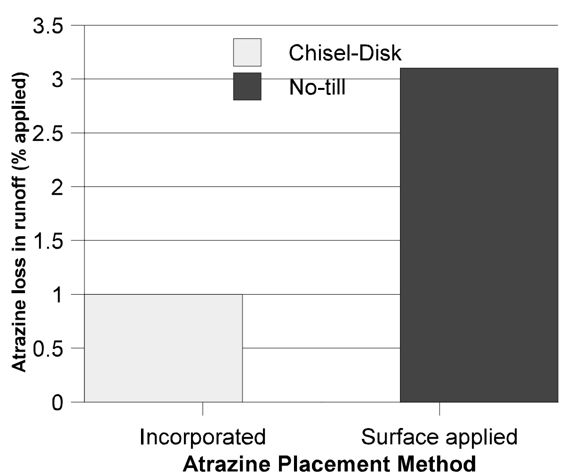

Figure 5. Atrazine loss as influenced by tillage and placement (3-yr growing-season avg.).

FORAGE PRODUCTION OF BERMUDAGRASS CULTIVARS IN EASTERN KANSAS

J.L. Moyer, K.A. Janssen[1], K.W. Kelley, and C.M. Taliaferro[2]

Summary

Plot coverage in Ottawa in early summer, 2003, was better for ‘Greenfield’, ‘Midland 99', and ‘Wrangler’ than for ‘CD 90160’, ‘Midland’, or ‘LCB84x16-66’. Yields for 2003 were higher ($P<0.05$) for ‘LCB84x19-16’, ‘Ozark’, ‘LCB84x16-66’, and Midland 99 than for the other entries. At Columbus, early-summer coverage for sprigged plots in 2003 was better for ‘Guymon’ than for CD 90160, Ozark, Midland, or LCB84x16-66. Total yields for 2003 were highest for ‘Midland 99’. Five entries yielded less than the top three. Three-year total yields were higher for Midland 99, Ozark, and LCB84x19-16 than for all other entries. Seeded plot yields in 2003 of Wrangler were higher than yields of CD 90160. Total 3-year production was similar for the three entries, but plots of CD 90160 contained weedier forage.

Introduction

Bermudagrass can be a high-producing, warm-season perennial forage for eastern Kansas when not affected by winterkill. Producers in southeastern Kansas have profited from the use of more winter-hardy varieties that produced more than common bermudas. Seeded types may offer cost savings or other advantages in marginal areas. Further developments in bermudagrass breeding should be monitored to speed adoption of improved, cold-hardy types.

Procedures

Tests Established in 2000

Plots were sprigged at 1-ft intervals with plants in peat pots on April 27, 2000, at the East Central Experiment Field, Ottawa, and on April 28 at the Columbus Unit of the Southeast Agricultural Research Center, except for entry CD 90160, which was seeded at 8 lb/a of pure, live seed. At the same time, another set of plots at Columbus was seeded with seed-producing cultivars that were also included in the sprigged trial. All plots were 10 x 20 ft each, arranged in four randomized complete blocks. Sprigged plots were subsequently sprayed with 1.4 lb/a of S-metolachlor. Plot coverage by bermudagrass was assessed periodically at both locations. Pots of CD 90160 were added to plots and were watered on July 3, 2002.

In 2003, 1 lb/a of hexazinone (Velpar®) was applied to the Columbus plots in March, and 0.6 lb of 2,4-D was applied at Ottawa in May. Application was made of 120-70-90 lb/a of N-P_2O_5-K_2O at Columbus in April, 2003, and 100 lb/a of N at Ottawa in May. In July, 85 lb/a of N was applied at each location.

Strips (20 x 3 ft) were cut for yield determination on June 28, July 25, and October 22, 2003, at Columbus and on July 16 and October 16 at Ottawa. Subsamples were collected for determination of moisture.

Test Established in 2002

Five bermudagrass entries were seeded at 8 lb/acre of pure, live seed for hulled seed or at 5 lb/acre of hulless seed at the Mound Valley Unit of the Southeast Agricultural Research Center on May 7, 2002. After 5.5

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inches of rain on May 8-9 caused some washing of plots, they were harrowed lightly and reseeded on May 22. Plots were sprayed with 2,4-D on June 7, and were assessed for maturity and coverage and cut on July 22 and again on September 5. Plots were harvested twice in 2002. In 2003, plots were harvested on June 4, July 11, and August 7. Subsamples were collected from the 20 x 3 ft strips taken for yield to determine moisture content of forage.

Results

Ottawa 2000 Test

Conditions in the summer of 2003 were difficult because of extreme drought. In late summer, Ottawa began to receive some moisture that enabled growth for a late-fall cutting after dormancy.

Plot coverage in the spring of 2003 was better ($P<0.05$) for Greenfield, Midland 99, and Wrangler than for CD 90160, Midland, or LCB84x16-66 (Table 2). After the dry summer of 2003, Midland 99, LCB84x19-16, and Greenfield had the most complete coverage. Poorest coverage was shown by CD 90160, Midland, and Wrangler.

Maturity in terms of seedhead production indicates poor forage quality (Table 2). In fall, 2003, Greenfield, Midland 99, and Ozark were less mature than four of the other cultivars, whereas Wrangler, Midland and CD 90160 were more mature than the others.

Forage yields of the first cutting in 2003 were higher ($P<.05$) for LCB 84x19-16, Ozark, and LCB84x16-66 than for Midland or Wrangler (Table 2). Second-cut yields were higher for LCB 84x19-16, Ozark, Midland 99, and LCB 84x16-66 than for the other entries. Wrangler, Greenfield, and Guymon produced less than the other entries. Total 2003 forage yield was higher ($P<.05$) for LCB 84x19-16, Ozark, LCB84x16-66, and Midland 99 than for the other entries (Table 2)

Total forage production for the three years after establishment was greater ($P<0.05$) for LCB84x19-16 than for all other entries. Forage yields for Ozark, LCB84 x16-66, and Midland 99 were more than those of the other cultivars, whereas Midland produced less than all other entries, and CD 90160 did not produce harvestable forage.

Columbus 2000 Test

In Columbus, plot coverage of the sprigged plots in early summer, 2003, was most complete for Guymon, which had significantly more coverage than four other cultivars (Table 3). The least coverage was made by CD 90160, in spite of the addition of plugs in 2002, and was significantly less than that of the top four cultivars. By late summer, 2003, sprigged plots of Greenfield had better cover than two of the other eight cultivars. Conversely, LCB84x16-66 and CD 90160 had poorer coverage than the top four cultivars (Table 3).

Maturity of sprigged plots in terms of seedhead production in fall, 2003, was less ($P>0.05$) for Midland 99 than for five other cultivars (Table 3). Ozark and Greenfield were less mature than four other cultivars, whereas CD 90160 was more mature than all others.

Forage yields of the first cutting were higher ($P<0.05$) for Guymon than for five other cultivars (Table 3). Entries CD 90160 and LCB84x16-66 yielded less than the top four cultivars. Second-cut yields were higher for Midland 99, Ozark, and LCB84x19-16 than for the other six entries. Third-cut yields were higher for Midland 99, LCB84x16-66, Ozark, and LCB84x19-16 than for four other entries (Table 3).

Total forage yields of sprigged plots in 2003 were higher ($P<0.05$) for Midland 99 than for all other cultivars (Table 4). In turn, Ozark and LCB84x16-19 produced more total forage than did the other cultivars, except for LCB84x16-66. Three-year total yields were higher for Midland 99, Ozark and LCB84x19-16 than for all other entries (Table 4).

Seeded plot coverage was greater ($P<0.05$) for Guymon and Wrangler than for CD 90160, both in early and late summer (Table 5). First-cut forage yields of seeded plots in 2003 followed the same trend as coverage, with CD 90160 yielding less than the other cultivars. By the second cut, however, yields were similar for the three cultivars, and third-cut yield of CD 90160 was higher than yields of Wrangler and Guymon (Table 5).

Maturity in terms of seedhead production in fall, 2003, was less (P>0.05) for Guymon than for the other cultivars (Table 5). Wrangler was, in turn, less mature than CD 90160.

Total 2003 forage production of plots seeded at Columbus in 2000 was higher for Wrangler than for CD 90160, with Guymon forage production being intermediate (Table 6). Forage yields totaled over a three-year period were similar, but forage of CD 90160 contained more weedy forage.

Mound Valley 2002 Test

The seeded plots at Mound Valley were fully covered by June, 2003. Forage production by June 4 was greater (P<0.05, Table 7) for Guymon than for 'Cherokee' or 'Cheyenne'. Cheyenne and Cherokee had greater production than Guymon, Wrangler, or 'Johnston's Gold' in the second cutting. There was no significant (P>0.10) difference among cultivars for third-cut yields, but total 2003 production was greater for Cheyenne than for the other cultivars (Table 7).

Table 2. Plot Coverage, Maturity, and Forage Yield of Bermudagrass Sprigged in 2000, Ottawa Experiment Field, Department of Agronomy.

Entry	Plot Cover† July 2003	Plot Cover† Oct. 2003	Maturity‡ Oct. 2003	Forage Yield 25 July 2003	Forage Yield 16 Oct. 2003	Forage Yield Total 2003	Forage Yield 3-Year Total
				- tons per acre @ 12% moisture -			
CD 90160	0.2	0.8	3.9	- -	- -	- -	- -
Greenfield	4.5	4.0	1.0	3.33	1.26	4.59	11.70
Guymon	3.8	3.5	2.2	3.16	1.50	4.67	12.18
LCB 84x16-66	2.8	3.8	2.2	3.61	3.50	7.11	16.48
LCB 84x19-16	3.8	4.2	2.5	4.10	3.72	7.81	19.16
Midland	1.5	2.0	3.8	1.36	2.02	3.38	8.72
Midland 99	4.2	5.0	1.2	3.39	3.57	6.96	16.08
Wrangler	4.0	3.0	4.0	3.02	1.17	4.19	11.58
Ozark	3.0	3.5	1.5	3.89	3.70	7.60	16.88
Average	3.1	3.3	2.5	3.23	2.52	5.76	14.01
LSD 0.05	0.8	0.9	0.9	0.57	0.37	0.78	1.59

† Ratings from 0 to 5, where 5=100% coverage.
‡Ratings from 0 to 5, where 5=100% headed.

Table 3. Plot Coverage and Forage Yield in 2003 of Bermudagrass Sprigged in 2000, Columbus Unit, Southeast Agricultural Research Center.

	Plot Cover†		Maturity‡	Forage Yield		
Entry	June 28	July 25	July 25	June 28	July 25	Oct. 22
				- tons per acre @ 12% moisture -		
CD 90160	1.5	2.8	4.8	1.72	0.74	2.99
Greenfield	3.0	4.0	1.2	3.14	0.72	1.49
Guymon	4.2	4.0	2.0	3.67	0.52	1.53
LCB 84x16-66	1.8	2.5	2.5	1.95	0.84	3.44
LCB 84x19-16	3.2	4.0	3.0	2.48	1.46	3.19
Midland	1.8	3.5	3.0	2.34	0.89	2.50
Midland 99	3.2	4.0	1.0	3.21	1.98	3.58
Wrangler	3.2	3.5	2.8	3.27	0.35	1.85
Ozark	1.8	3.2	1.2	2.44	1.67	3.28
Average	2.6	3.5	2.4	2.69	1.02	2.65
LSD 0.05	1.5	1.1	1.2	1.00	0.50	0.54

†Ratings from 0 to 5, where 5=100% coverage.
‡Ratings from 0 to 5, where 5=100% headed.

Table 4. Forage Yield of Bermudagrass Sprigged in 2000, Columbus Unit, Southeast Agricultural Research Center

	Forage Yield			
Entry	2001	2002	2003	3-Yr Total
	- - - - - - - - - - tons per acre @ 12% moisture - - - - - - - - - -			
CD 90160	- -†	- -†	5.45	- -
Greenfield	4.69	7.03	5.36	17.08
Guymon	4.92	5.78	5.72	16.42
LCB 84x16-66	3.75	7.98	6.24	17.97
LCB 84x19-16	4.87	8.75	7.13	20.76
Midland	4.12	7.11	5.74	16.97
Midland 99	5.84	8.78	8.78	23.40
Wrangler	5.34	5.85	5.47	16.65
Ozark	6.45	9.04	7.40	22.89
Average	5.00	7.20	6.36	19.02
LSD 0.05	1.04	1.16	1.18	2.25

†Contained other grasses.

Table 5. 2003 Plot Coverage and Forage Yield of Bermudagrass Seeded in 2000, Columbus Unit, Southeast Agricultural Research Center.

	Plot Cover†		Maturity‡	Forage Yield		
Entry	June 28	July 25	July 25	June 28	July 25	Oct. 22
				- tons per acre @ 12% moisture -		
CD 90160	1.8	3.0	4.8	1.07	0.73	3.06
Guymon	4.2	4.5	2.2	3.03	0.54	1.65
Wrangler	4.0	5.0	3.0	3.54	0.62	1.61
Average	3.3	4.2	3.3	2.54	0.63	2.11
LSD 0.05	1.2	1.0	0.6	0.49	NS	0.67

†Ratings from 0 to 5, where 5=100% coverage.
‡Ratings from 0 to 5, where 5=100% headed.

Table 6. Forage Yield of Bermudagrass Seeded in 2000, Columbus Unit, Southeast Agricultural Research Center

	Forage Yield			
Entry	2001	2002	2003	3-Yr Total
	---------- tons per acre @ 12% moisture ----------			
CD 90160	3.51†	4.78†	4.86	13.14
Guymon	3.62	5.66	5.22	14.51
Wrangler	3.38	5.37	5.77	14.52
Average	3.50	5.27	5.28	14.06
LSD 0.05	NS	0.67	0.68	NS

†Contained other grasses

Table 7. Forage Yield in 2003 of Bermudagrass Seeded in 2002, Mound Valley Unit, Southeast Agricultural Research Center.

	Forage Yield			
Entry	June 4	July 11	Aug. 7	Total
	------ tons per acre @ 12% moisture ------			
Cherokee	0.82	1.47	0.47	2.76
Guymon	1.60	0.66	0.47	2.73
Wrangler	1.30	0.68	0.49	2.47
Johnston's Gold	1.33	0.88	0.54	2.75
Cheyenne	1.11	1.57	0.60	3.29
Average	1.23	1.05	0.52	2.80
LSD 0.05	0.41	0.29	NS	0.50

STRIP-TILL AND NO-TILL TILLAGE/FERTILIZER SYSTEMS COMPARED FOR CORN

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

Summary

Strip-till and no-till tillage/fertilizer systems were compared for corn using different fertilizer configurations on a somewhat poorly drained, upland soil in east-central Kansas. Averaged across all fertilizer treatments, fall strip-till increased stand, 6-leaf dry matter, nutrient uptake, and yield, compared with no-till. Fall-applied fertilizer performed as well as spring-applied fertilizer. More testing is needed, but fall strip-till with fall banded fertilizer shows promise as an option for no-till corn production. Additional trials are planned for next year.

Introduction

Corn producers in east-central and southeast Kansas need to reduce sediment and nutrient losses via runoff. Losses at field edges show that conventional tillage systems are losing significantly more sediment and total phosphorus (P) in runoff than no-till loses. No-till systems have been shown to reduce sediment and total P losses by two to three times, compared with losses from conventional systems. For corn, however, no-till can cause serious challenges some years. Non-irrigated corn in eastern Kansas needs to be planted early (middle March - early April) and grow rapidly to produce grain before hot and dry conditions occur in the middle to later part of July. The increased amounts of residue, along with smaller soil pores and reduced air exchange and water evaporation, associated with no-till, can keep soils cooler and wet longer in the spring. That, in turn, can delay planting and reduce early-season nutrient uptake and growth. Application of starter fertilizer can offset some of the effects of slower early-season growth with no-till, but delayed planting and slow early-season growth remains a deterrent to no-till corn planting.

In the cold northern states, timely early planting of corn is also important. Corn needs to be planted early to mature before fall freezing weather. Strip-tillage is a conservation tillage system that is gaining favor with northern corn producers. Strip-tillage is a hybrid between no-till, conventional till, and ridge-till. Tillage is confined to narrow strips where the seed rows are to be planted. Row middles are left untilled. The tilled strip creates a raised bed 3 to 4 inches high, which improves early-season soil drainage and warming. By spring, the raised bed usually settles down to 1 to 2 inches high, and the field is level after planting. Banding fertilizer is generally performed in the same strip-tillage operation. Banding fertilizer under the row can improve fertilizer use efficiency, compared with that of broadcasting, by placing fertilizer in a position to be readily useable by young, developing corn roots. Strip-tillage, with fertilizer banded below the row, would also seem to be applicable for eastern Kansas corn production.

The objectives of this study were 1) to compare the effectiveness of strip-tillage and no-tillage systems with different fertilizer configurations for upland, rain-fed corn in east-central Kansas, and 2) to assess the effects of fall versus spring applications of N-P-K-S fertilizer on growth, grain yield, and nutrient uptake of corn.

Procedures

The study site was at the East Central Experiment Field at Ottawa, on a somewhat poorly drained Woodson silt loam soil that had been no-tilled for the previous five years. The previous crop was corn, and the corn stalks were shredded before the tillage systems and fertilizer treatments were established. The tillage/fertilizer systems and the dates fertilizers were applied are shown in Table 8. All strip-till and fall-applied fertilizer operations were performed after fall soil temperatures had dropped below 50^{o} F degrees. Burn-down herbicide for pre-plant weed control was applied on March 31, 2003, and consisted of 1qt/a atrazine 4L + 0.66pt/a 2,4-D LV4 + 1 qt/a COC. Pioneer 35P12 corn was planted on April 10, 2003. Pre-emergence herbicide consisting of 0.33 qt/a atrazine 4L + 1.33 pt/a Dual II Magnum® was applied April 23, 2003. Plant stand counts were taken on May 20, 2003, and whole above-ground plants (six plants per plot) were taken for biomass and nutrient uptake measurements at the 6-leaf growth stage. Harvest was August 28, 2003.

Results

Moisture during the fall and winter months after the establishment of the fall strip-till applications was less than normal, but late-winter and early-spring moisture were slightly more than normal. Rainfall during May and June was near normal. July and most of August were hot and very dry. Overall air temperatures during the corn planting period were normal to below normal.

<u>Corn Emergence, Plant Stands, and Early-Season Growth</u>

In general, emergence was more uniform in strip-till corn rows than in no-till rows. Plant stands were 15% better in strip-till treatments, compared with no-till (Table 8). Early-season corn growth (dry-matter accumulation), when averaged across similar fertilizer treatments, was 30% greater with fall strip-till and fall- applied fertilizer than with no-till and planting-time fertilizer application.

<u>Nutrient Uptake</u>

Nitrogen, phosphorus, potassium, and sulfur uptake in lbs/a for corn, when averaged across all fertilizer rates, was 39, 39, 9, and 56% greater, respectively, with fall strip-till and fall-applied fertilizer than with no-till and 2x2 planting-time fertilizer application.

<u>Yield</u>

Fall strip-till by itself increased corn grain yield 11.6 bu/a, compared with no-till (0-0-0-0 fertilizer treatments). With fall strip-till and 40-30-5-5 lbs/a fertilizer applied at planting, fall strip-till increased corn yield 9.7 bu/a, compared with the same fertilizer amount applied for no-till. At the 80-30-5-5 lbs/a fertilizer rate, there were no statistically significant differences in yield between the tillage systems. The 120-30-5-5 fertilizer rate did not increase yields, compared with the 80-30-5-5 rate, in either tillage system. The 120-30-5-5 fertilizer rate, when applied 2x2 at planting with fall strip-till, reduced yields compared with those of the 40-30-5-5 2x2 planting rate. This is a warning that too high a fertilizer concentration in the loosened strip-till soil zone near the time of planting may cause some negative effects. The highest overall corn yield was produced with fall strip-till and 80-30-5-5 applied in the fall. There was no indication that fall-applied fertilizer performed less well than spring-applied fertilizer. If anything, the trend was in favor of fall-applied fertilizer.

Conclusions

The results for this first year's study with fall strip-till and fall-applied fertilizer look promising. Additional studies are planned for next year.

Table 8. Strip-till and no-till tillage/fertilizer comparison study for corn, Ottawa, KS, 2003.

Treatments	Yield	Plant Stand	6-Leaf Stage Plant Dry Matter	6-Leaf Stage Nutrient Uptake N	P	K	S
	bu/a	1000/a	lb/a	- - - - - - - lb/a - - - - - - -			
Fall Strip-Till + Fall Applied (11/2/02) **Fertilizer (N-P-K-S lb/a)**							
1. Check 0-0-0-0	78.0	21.1	124	4.0	0.54	2.4	0.25
2. 40-30-5-5	85.5	21.1	305	10.8	1.21	5.4	0.67
3. 80-30-5-5	96.1	21.2	335	12.8	1.37	6.0	0.72
4. 120-30-5-5	91.0	21.8	345	13.9	1.37	6.4	0.77
5. 80-15-2.5-2.5 fall + 40-15-2.5-2.5 at planting	88.6	21.1	363	14.7	1.50	10.4	0.75
Fall Strip-Till + Planting Time (2x2) Applied (4/10/03) **Fertilizer (N-P-K-S lb/a)**							
6. 40-30-5-5	89.7	21.0	423	14.1	1.70	7.7	0.81
7. 80-30-5-5	87.6	21.3	361	14.4	1.45	6.5	0.72
8. 120-30-5-5	78.4	22.2	326	13.7	1.31	6.3	0.66
No-Tillage + Planting Time (2x2) Applied (4/10/03) **Fertilizer (N-P-K-S lb/a)**							
9. Check 0-0-0-0	66.4	18.4	97	2.9	0.43	2.4	0.18
10. 40-30-5-5	80.0	18.8	254	9.3	1.06	6.0	0.51
11. 80-30-5-5	90.4	18.8	231	9.4	0.94	5.4	0.43
12 120-30-5-5	85.5	18.1	193	8.3	0.80	4.7	0.42
No-Tillage + Preplant Deep-Band (15" Centers) Applied (3/26/03) **Fertilizer (N-P-K-S lb/a)**							
13. 120-30-5-5	87.0	18.9	201	8.2	0.78	4.3	0.41
LSD (0.05)	9.4	2.4	91	3.2	0.32	2.3	0.17

HARVEY COUNTY EXPERIMENT FIELD

Introduction

Research at the Harvey County Experiment Field deals with many aspects of dryland crop production on soils of the Central Loess Plains and Central Outwash Plains of central and south-central Kansas, and is designed to directly benefit the agricultural industry of the area. The focus is primarily on wheat, grain sorghum, and soybeans, but also includes 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 St., is all Ladysmith silty clay loam with 0-1% slope. The second tract (South Unit), located 4 miles south and 2 miles west of Hesston, is composed of 142 acres of Ladysmith, Smolan, Detroit, and Irwin silty clay loams, as well as Geary and Smolan silt loams. All have 0-3% slope. Soils on the two tracts are representative of much of Harvey, Marion, McPherson, Dickinson, and Rice Counties, as well as adjacent areas.

These are deep, moderately well to well-drained upland soils with high fertility and good water-holding capacity. Water runoff 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.

2002/2003 Weather Information

Significant rains in early October delayed wheat planting, but alleviated very dry soil conditions resulting from below-normal rainfall during July, August, and September. A wet period in late October followed wheat planting. November and December were much dryer than usual. Average October temperatures were 9°F below normal. November also was somewhat cooler than usual, but December temperatures were above average. Fall wheat development was good.

Winter precipitation was below normal in January, but above normal during the other winter months. Mean temperatures continued slightly above normal in January. Coldest temperatures of the winter occurred in late February. Mean temperatures were somewhat below normal in February and March. Wheat stands continued to be good, with excellent winter survival.

Rainfall was about 1.1 to 1.5 inches above normal in April and only slightly below normal in May and the first half of June. April temperatures were equal to long-term averages, whereas May and June averaged about 4°F below normal. Soil-borne mosaic symptoms appeared in late March in susceptible wheat varieties. Low levels of tan spot were present. Leaf rust and, to a lesser extent, stripe rust appeared in late May. Weather factors resulted in a favorable grain-filling period that culminated in record-high wheat yields and excellent test weights.

Planting-time soil moisture was generally adequate for normal row-crop stand establishment. Subsequent rainfall varied considerably, depending on planting date. April and early-May plantings received considerably more rainfall during the first 10 days than those of mid-June. In July and August, average temperatures were nearly 2 °F above normal. During these months, there were 21 days with temperatures at or above 100 °F. Little rain fell between late June and August 28. These weather factors combined to produce severe drouth stress. Incomplete pollination and grain filling occurred in corn.

Half-bloom stage and grain maturation in sorghum were delayed. Soybean maturation also was delayed.

Drouth conditions were broken by copious rains at the end of August. Above-normal precipitation followed in September and early October. More favorable moisture, below-normal temperatures, and an extended frost-free fall period permitted some degree of sorghum and soybean recovery. Yields of both crops were affected by planting date. Soybean seed quality was generally good or better than expected. No significant diseases or insects in row crops were observed, with the exception of minor chinch bug activity in corn and grain sorghum at some locations. Drouth increased lodging somewhat in corn, but little lodging occurred in grain sorghum.

Freezing temperatures occurred last in the spring on April 10. First killing temperatures occurred next on October 26. The frost-free season of 199 days was about 31 days longer than normal.

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

Month	N Unit	S Unit	Normal	Month	N Unit	S Unit	Normal
	----------- inches ----------				----------- inches ----------		
	2002				2003		
October	6.26	6.62	2.94	March	3.17	2.98	2.72
November	0.44	0.41	1.87	April	4.00	4.47	2.94
December	0.65	0.50	1.12	May	4.89	4.76	5.02
				June	2.85	2.85	4.39
	2003			July	0.86	0.55	3.71
January	0.11	0.09	0.69	August	4.28	4.78	3.99
February	1.29	1.41	0.93	September	3.84	4.55	2.93
Twelve-month total					32.64	33.97	33.25
Departure from 25-year normal at N. Unit					-0.61	0.72	

[1] Two experiments reported here were conducted at the North Unit: *Soybeans for Forage* and *Reduced Tillage and Crop Rotation Systems with Wheat, Grain Sorghum, Corn, and Soybeans*. All other experiments in this report were conducted at the South 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 seventh consecutive year. In most seasons, tillage in alternate years did not consistently affect no-till wheat after row crops. In 2003, however, prior tillage for row crop resulted in a 10.4 bu/a decrease in yield of no-till wheat after corn and sorghum, but not after soybeans. As in most years, crop-rotation effects on wheat yield were significant. Wheat in rotation with corn, grain sorghum, and soybeans averaged 65.0, 63.9, and 59.3 bu/a, whereas continuous wheat averaged 46.2 bu/a across all tillage systems. Continuous wheat with no-till yielded 56.6 bu/a versus 44.5 and 37.4 bu/a for chisel and burn systems. Row crop yields reflected serious drouth effects. Tillage system did not affect corn or soybeans. No-till enhanced the yield of sorghum after wheat by 8.1 bu/a, but had little or no effect on continuous sorghum. Unlike most years, crop rotation and planting date had little influence on sorghum production. Nevertheless, long-term averages continued to show a 15.7 bu/a advantage for sorghum rotation with wheat and a 4.5 bu/a advantage for May versus June planting.

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 drouth 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, thereby providing an opportunity for soil moisture replenishment, as well as a wider window of time within which to plant the succeeding wheat crop. This study was initiated at Hesston on Ladysmith silty clay loam to evaluate the consistency of corn and soybean production versus grain sorghum in an annual rotation with winter wheat and to compare these rotations with 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:

<u>Wheat after Corn</u>

WC-NTV = No-till after V-blade (V-blade, sweep-treader, mulch treader) for corn

WC-NTNT = No-till after No-till corn

<u>Wheat after Sorghum</u>

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

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

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 Roundup Ultra Max + 2,4-D_A + Banvel + Array (1.2 pt + 1 pt + 4 oz + 1.35 lb/a) on July 15. Additional fallow application of Roundup Ultra Max + 2,4-D_A + Placement Propak at 1.25 pt + 4 oz/a + 1% v/v was made on September 6. Wheat variety 2137 was planted on October 17 in 8-inch rows at 90 lb/a with a CrustBuster no-till drill equipped with double disk openers. Wheat was fertilized with 121 lb N/a and 35 lb P_2O_5/a as preplant, broadcast ammonium nitrate and in-furrow diammonium phosphate at planting. WW-NT and WW-C plots were sprayed for cheat control with Maverick 75 DF at 0.66 oz/a + 0.5% nonionic surfactant (NIS) on April 11. WC-NTNT and WG-NTNT were spot sprayed on the same day for cheat control with Everest 70 DF at 0.6 oz/a + 0.25% NIS. (Everest is labeled for use by wheat growers in the northern plains, but is not sold in Kansas.) No herbicides were used on wheat in the remaining tillage and cropping systems. Wheat was harvested on June 27, 2003.

No-till corn after wheat plots received the same herbicide treatments as WW-NT during the summer, plus a late November application of AAtrex 90 DF + 2,4-D_{LVE} 6EC+ crop oil concentrate (COC) at 1.67 lb + 0.67 pt + 1 qt/a. No additional preplant weed control was required. Weeds were controlled during the summer and fall fallow period in CW-V plots with three tillage operations. Two spring tillage operations were necessary for final weed control and seedbed preparation. 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 Pioneer 35N05 corn at approximately 18,700 seeds/a on April 11, 2003. Corn plots were sprayed shortly after planting with Dual II Magnum alone at 1.67 pt/a (CW-NT) or with Dual II Magnum + AAtrex 4L at 1.33 pt + 1.5 pt/a (CW-V) for preemergence weed control. Row cultivation was not used. Corn was harvested on August 28.

No-till sorghum after wheat plots received the same summer and fall fallow herbicide treatments as no-till corn. Continuous NT sorghum plots were treated with AAtrex 90 DF + 2,4-D_{LVE} 6EC + Banvel + COC (1.67 lb + 0.67 pt + 4 oz + 1 qt/a) in late November. $GG\text{-}NT_{May}$ areas received a preplant application of Roundup Ultra Max + Placement Propak (1 pt/a + 1%). $GG\text{-}NT_{June}$ plots received a mid-April application of AAtrex 4L + 2,4-D_{LVE} 6EC + COC (1.5 qt + 0.67 pt + 1 qt/a), later followed by Roundup Ultra Max + AMS (26 oz + 1.7 lb/a) one day before planting. GW-V plots were managed like CW-V areas during the fallow period between wheat harvest and planting. Between crops, all GG-C plots were tilled once in the fall (chisel) and twice in the spring (mulch treader and sweep-treader). Sorghum was fertilized like corn, but with 116 lb/a total N. Pioneer 8500 sorghum, treated with Concep III safener and Gaucho insecticide, was planted at 42,000 seeds/a in 30-inch rows on May 9, 2003. A second set of continuous sorghum plots was planted on June 17. Post-plant preemergence herbicides for sorghum in rotation with wheat consisted of Dual II Magnum at 1.67 pt/a (GW-NT) or Dual II Magnum at 1.33 pt/a + AAtrex 4L at 1.5 pt/a (GW-V). Continuous sorghum was treated with Dual II Magnum + AAtrex 4L at 1.33 pt + 1.5 pt/a (GG-NT_{May}) or at 1.33 pt + 1 qt/a (GG-C_{May}, GG-C_{June}) or Dual II Magnum alone at 1.33 pt/a (GG-NT_{June}) shortly after planting. Sorghum was not row cultivated. May- and June-planted sorghum were harvested on August 28 and October 30, respectively.

Fallow weed control procedures for no-till soybeans after wheat were the same as for CW-NT and GW-NT, except that the late fall herbicide application consisted of Roundup Ultra Max + 2,4-D $_{LVE}$ 6EC + Banvel + Placement Propak (6.4 oz + 2.67 oz + 2 oz/a + 1%). Roundup Ultra Max + Placement Propak (1 pt/a + 1%) controlled emerged weeds just before planting. SW-V tillage and herbicide treatments were the same as those indicated for GW-V. After planting, weeds were controlled with preemergence Dual II Magnum + Scepter 70 DG (1.33 pt + 2.8 oz/a). Iowa 3010 soybeans were planted at 7 seeds/ft in 30-inch rows on May 12 and harvested on October 22, 2003.

Results

Wheat

Summer drouth left the soil very dry, but October rains before and after wheat planting favorably set the stage for wheat germination and emergence. Fall wheat development was good despite very little additional rainfall. Late winter and early-spring precipitation was at or above normal. Cool spring temperatures permitted a prolonged grain-filling period and high yields.

Crop residue cover in wheat after corn, sorghum, and soybeans averaged 76, 78, and 48%, respectively (Table 2). WW-B, WW-C, and WW-NT averaged 9, 57, and 85% residue cover after planting, respectively. Wheat stands averaged 99% complete and were not affected by tillage or cropping system, except for WW-NT, with a slightly reduced average stand (96%). Cheat control was excellent. Plant N concentration in wheat at late boot-early heading stage was highest in rotation with corn (2.21%) and continuous cropping (2.08%). Differences in plant N for continuous wheat versus wheat after sorghum or soybeans were not significant. Greater amounts of N in wheat after corn can be attributed to residual N after low antecedent corn yields. The main effect of tillage system on wheat plant N content was significant in row-crop rotations, with V-blade in alternate years resulting in 0.14% greater N than continuous no-till. Wheat heading date occurred one day earlier in wheat after soybeans than in wheat after corn or sorghum and three days earlier than the average date for all continuous wheat. Tillage system effect on heading date was not significant in wheat rotations with corn and soybeans, but tended to be slightly delayed by NT in rotation with grain sorghum. In continuous wheat, chisel and NT systems delayed heading by two and four days, respectively, in comparison with the burn system.

Wheat yields were highest in rotation with corn and sorghum, averaging 65.0 and 63.9 bu/a, respectively. Yield of wheat after soybeans was slightly lower at 59.3 bu/a, whereas continuous wheat averaged 46.2 bu/a across all tillage systems. Tillage-system effects on wheat yield differed with crop rotation. In wheat after corn and sorghum, continuous NT averaged 10.4 bu/a more than NT/V-blade, whereas in wheat after soybeans, prior tillage had no effect on yield. NT continuous wheat performed surprisingly well at 56.6 bu/a, which was 12.1 bu/a better than WW-C and 19.2 bu/a more than WW-B. The poor performance of WW-B was attributable to premature termination of grain filling as a result of poor internal soil drainage and water ponding after abundant rainfall in mid-May.

Crop-rotation effect on test weights generally was not significant, with best values and comparable results for wheat in all rotations with row crops and in continuous cropping NT. Tillage-system main effect on test weight was significant for wheat rotated with row crops. In these systems, NT/NT averaged 1.2 lb/bu more than NT/V-blade, whereas, in continuous wheat, test weight for NT was 3.0 and 9.0 lb/bu greater than for chisel and burn systems.

Row Crops

Corn, sorghum, and soybeans following wheat had an average of 49, 59, and 36%, respectively, crop-residue cover after planting in V-blade systems (Table 3). Where these row-crops were planted NT after wheat, crop residue cover averaged 88%, with little difference among rotations. The chisel system in continuous sorghum resulted in ground cover comparable to the V-blade system in sorghum after wheat. But NT sorghum after wheat averaged 16 and 37% more ground cover than May- and June-planted NT continuous sorghum.

Drouth stress caused low yields in all row crops. Tillage systems had no significant effect on any of the crop response parameters measured in corn and soybeans. In grain sorghum, tillage-system effects on maturity and yield were observed, but these effects varied with crop rotation and planting date. No-till treatment increased by an average of one to two days the length of time to reach half bloom and, in sorghum after wheat, increased grain yield by 8.1 bu/a. Yield response to NT was small in May-planted continuous sorghum and was non-existent in June-planted continuous sorghum. Unlike most years, crop rotation and planting date had little effect on sorghum yield. But long-term average yields continued to show an advantage of 15.7 bu/a for sorghum after wheat versus continuous sorghum and an advantage of 4.5 bu/a for May versus June planting.

Table 2. Effects of row crop rotation and tillage on wheat, 2003, Harvey County Experiment Field, Hesston, Kansas.

Crop Sequence[1]	Tillage System	Crop Residue Cover [2]	Yield[3] 2003	Yield[3] 7-Yr	Test Wt	Stand[4]	Heading[5]	Plant N[6]	Cheat Control[7]
		%	bu/a		lb/bu	%	date	%	---%---
Wheat-corn (No-till)	V-blade	74	59.6	54.8	58.9	99	8	2.25	100
	No-till	78	70.4	56.5	59.7	100	8	2.17	100
Wheat-sorghum (No-till)	V-blade	73	58.9	45.0	58.9	100	9	2.03	98
	No-till	84	68.8	44.5	60.1	100	8	1.90	100
Wheat-soybeans (No-till)	V-blade	39	59.4	55.4	58.7	100	7	2.14	100
	No-till	57	59.2	58.7	60.2	99	7	1.93	100
Continuous wheat	Burn	9	37.4	47.1	51.6	99	8	2.04	100
	Chisel	57	44.5	44.6	57.6	99	10	2.10	100
	No-till	85	56.6	45.1	60.6	96	12	2.06	99
LSD .05		8	12.7	9.4	3.1	1.1	0.9	NS	NS
LSD .10		7	10.5	7.9	2.6	0.9	0.8	NS	NS
Main effect means:									
Crop Sequence									
Wheat-corn		76	65.0	55.6	59.3	99	8	2.21	100
Wheat-sorghum		78	63.9	44.7	59.5	100	8	1.97	99
Wheat-soybeans		48	59.3	57.0	59.4	100	7	2.03	100
Continuous wheat		71	50.5	44.8	59.1	97	11	2.08	100
LSD .05		6	5.3	9.4	NS	0.8	0.7	0.16	NS
Rotation Tillage system									
No-till/V-blade		62	59.3	51.7	58.8	100	8	2.14	99
No-till/no-till		73	66.1	53.2	60.0	100	8	2.00	100
LSD .05		5	3.0	NS	0.5	NS	NS	0.10	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 April 2.
[5] Date in May on which 50% heading occurred.
[6] Whole-plant N content at late-boot to early-heading stage.
[7] Visual rating of cheat control just before harvest.

Table 3. Effects of wheat rotation and reduced tillage on corn, grain sorghum, and soybeans, 2003, Harvey County Experiment Field, Hesston, Kansas.

Crop Sequence	Tillage System	Crop Residue Cover [1]	Yield[2] 2003	Yield[2] Multi-Yr	Test Wt	Stand	Maturity[3]	Ears or Heads/ Plant	Leaf N[4]
		%	---- bu/a -----		lb/bu	1000s/a	days		%
Corn-wheat	V-blade	49	37.3	61.2	57.6	19.2	84	0.80	----
	No-till	89	37.8	56.7	57.7	19.6	84	0.78	----
LSD .05		12	NS	NS	NS	NS	NS	NS	
Sorghum-wheat	V-blade	59	43.4	82.8	58.9	32.1	72	1.19	1.95
	No-till	90	51.5	86.4	58.6	34.2	74	1.29	2.16
Contin. sorghum (May)	Chisel	38	42.4	69.1	58.2	35.8	75	0.98	2.08
	No-till	74	44.7	68.6	58.5	33.1	76	1.03	1.91
Contin. sorghum (June)	Chisel	24	45.7	62.8	58.3	37.5	61	0.87	2.06
	No-till	53	45.4	66.0	58.4	36.7	62	0.84	1.98
LSD .05[5]		10	5.6	17.2	NS	2.9	2.8	0.08	NS
Soybeans-wheat	V-blade	36	7.8	24.5	—	—	—	—	—
	No-till	84	7.8	24.1	—	—	—	—	—
LSD .05		13	NS	NS	—	—	—	—	—
Main effect means for sorghum:									
Crop sequence									
Sorghum-wheat		74	47.5	84.6	58.7	33.1	73	1.24	2.05
Contin. sorghum (May)		56	43.6	68.9	58.3	34.5	75	1.01	1.99
Contin. sorghum (June)		38	45.5	64.4	58.3	37.1	61	0.86	2.02
LSD .05		7	NS	12.1	NS	2.0	1.9	0.06	NS
Tillage system									
V-blade/chisel		40	43.8	71.6	58.4	35.1	69	1.02	2.03
No-till/no-till		72	47.2	73.7	58.5	34.7	71	1.05	2.02
LSD .05		5	3.2	NS	NS	NS	1.6	NS	NS

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

[2] Means of four replications adjusted to 12.5% moisture (corn, sorghum) or 13% moisture (soybeans). Multiple-year averages: 1997-1999, 2001-2003 for corn and 1997-2003 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; soybeans - number of days from planting to occurrence of 95% mature pod color.

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

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

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

M.M. Claassen

Summary

Wheat following sorghum that had been fertilized with 120 lb/a of nitrogen (N) yielded an average of 6 bu/a more than wheat following sorghum that had received only 60 lb/a of N. The favorable residual effect of higher sorghum N rate was greater at low wheat N rates, but decreased to zero with 120 lb/a of N. Yields increased significantly with each 40 lb/a increment of fertilizer N. When averaged across seeding rates, highest yields of 65 bu/a were obtained with 120 lb/a of N. Plant height and plant N concentration also increased with N rate. Grain protein increased more with yield when wheat received 120 lb/a of N following 120 lb/a on sorghum than when it followed sorghum that had received the lower N rate. Wheat yields were not significantly affected by seeding rate, presumably because of abundant early-fall precipitation.

Introduction

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

Procedures

The experiment site was located on a Geary silt loam soil with pH 6.4, organic matter of 2.4%, 20 lb/a of available phosphorus (P), and 493 lb/a of exchangeable potassium. Grain sorghum had been grown continuously on the site for a period of years before the initiation of this experiment in 1998. A split-plot design was used with main plots of 60 and 120 lb/a N rates on the preceding sorghum crop and subplots of 0, 40, 80, and 120 lb/a of N on wheat, in a factorial combination with seeding rates of 60, 90, and 120 lb/a. In this third cycle of the sorghum/wheat rotation with its treatment variables, Pioneer 8500 grain sorghum was planted at 42,000 seeds/a in 30-in. rows on May 21 and harvested on September 5, 2002. Nitrogen rates were applied as ammonium nitrate on October 16-17. Wheat planting was delayed somewhat by substantial early October rains. Wheat variety 2137 was planted on October 18, 2002, into undisturbed sorghum stubble with a no-till drill equipped with double-disk openers on 8-in. spacing. P_2O_5 at 35 lb/a was banded in the seed furrow. Whole-plant wheat samples were collected at heading stage for determination of N and P concentrations. Wheat was harvested on June 25, 2003. Grain subsamples were analyzed for N content.

Results

Antecedent grain sorghum yields, averaged across previous wheat N rates and seeding rates, were 93 and 96 bu/a with 60 and 120 lb/a of N, respectively. Rainfall totaled 2.58 in. during the first 12 days after planting, but November and December were much dryer than usual. Although average October temperatures were 9ºF below normal and November also was somewhat cooler than usual, stand establishment and fall wheat development were good. Winter precipitation was below normal in January, but above normal during the other winter months. Rainfall was about 1.5 inches above normal in April and only slightly below normal in May and the first half of June. April temperatures were equal to long-term averages, whereas May and June averaged about 4ºF below normal. This combination of moisture and temperatures resulted in a favorable grain-filling period that culminated in good wheat yields and excellent test weights. Residual effect of sorghum N rate was seen in the succeeding wheat crop (Table 4). When averaged across wheat N rates and seeding rates, the high versus low sorghum N rate significantly increased wheat whole-plant nutrient content by 0.17% N and increased yield by 6 bu/a.

N rate significantly affected most wheat response variables measured. Yields increased with each 40 lb/a increment of fertilizer. Overall average yields of 65 bu/a were obtained with 120 lb/a of N. Plant height and plant N concentration also increased with N rate. Grain protein decreased with N rate, especially at intermediate amounts of N fertilizer. Plant P concentration also was greatest at the zero N rate, reflecting the dilution effect of greater plant growth that resulted from fertilizer application.

A significant interaction between sorghum N rate and wheat N rate occurred in wheat yield, plant height, and grain protein. When wheat followed sorghum that had been fertilized at 60 lb/a of N, the wheat yield increased more with increasing N rate than did yield of wheat that followed sorghum fertilized at 120 lb/a of N. But yields converged at the highest rates of fertilizer on wheat. Plant heights increased with N rate, but with zero fertilizer N, plant height was greater in wheat that followed sorghum fertilized at 120 lb/a of N than in wheat that followed sorghum fertilized at 60 lb/a of N. Grain protein was highest with zero fertilizer N in wheat that followed sorghum fertilized at 60 lb/a of N and in wheat with 120 lb/a of N that followed sorghum fertilized at 120 lb/a of N . At intermediate N rates, protein contents tended to be less than at the zero rate. Protein increased more with yield when wheat receiving 120 lb/a of N followed sorghum that had received 120 lb/a N than when it followed sorghum that received the lower N rate.

Seeding rate main effect on wheat was generally not significant, most likely because of abundant moisture during the establishment phase of the crop. Plant P concentration declined slightly at the highest seeding rate.

Table 4. Effects of nitrogen and seeding rate on no-till winter wheat after grain sorghum, 2003, Hesston, Kansas.

Sorghum N Rate[1]	Wheat N Rate	Seeding Rate	Yield	Bushel Wt	Plant Ht	Plant N[2]	Plant P[2]	Grain Protein[3]
lb/a			bu/a	lb	inches	%		
60	0	60	14.1	62.3	21	1.19	0.28	10.2
		90	13.2	62.5	20	1.16	0.27	10.4
		120	15.9	62.3	19	1.13	0.26	10.1
	40	60	32.1	62.0	26	1.14	0.23	8.9
		90	33.5	61.9	27	1.14	0.22	8.9
		120	32.4	61.6	26	1.14	0.22	8.9
	80	60	51.4	62.0	30	1.32	0.21	8.8
		90	52.4	61.6	30	1.31	0.22	8.6
		120	52.6	61.9	30	1.36	0.22	8.9
	120	60	64.9	62.0	31	1.71	0.23	9.2
		90	64.8	62.1	32	1.62	0.21	9.2
		120	64.5	62.3	31	1.60	0.21	9.5
120	0	60	22.2	62.2	25	1.26	0.26	9.9
		90	24.7	62.3	24	1.20	0.26	9.6
		120	23.7	62.2	23	1.29	0.24	9.6
	40	60	41.3	62.2	28	1.32	0.23	9.2
		90	43.6	62.1	28	1.36	0.22	9.3
		120	42.2	62.1	27	1.28	0.21	9.0
	80	60	57.4	62.0	30	1.60	0.22	9.5
		90	55.8	62.1	30	1.55	0.22	9.3
		120	57.6	62.2	30	1.55	0.21	9.3
	120	60	65.2	62.2	31	1.91	0.22	10.1
		90	63.8	62.4	30	1.80	0.21	10.2
		120	66.0	62.5	31	1.79	0.21	10.0
LSD .05	Means at same Sor. N		4.9	0.38	2.3	0.16	0.02	0.45
	Means at diff. Sor. N		5.6	0.82	2.6	0.19	0.03	0.59
Means: Sorghum N Rate								
60			41.0	62.0	27	1.32	0.23	9.3
120			47.0	62.2	28	1.49	0.23	9.6
LSD .05			3.3	NS	NS	0.12	NS	NS
LSD .15			----	NS	1.0	----	NS	NS
	N Rate							
	0		19.0	62.3	22	1.20	0.26	10.0
	40		37.5	61.9	27	1.23	0.22	9.0
	80		54.5	62.0	30	1.45	0.22	9.1
	120		64.9	62.2	31	1.74	0.21	9.7
	LSD .05		2.0	0.16	0.9	0.06	0.01	0.18
		Seed Rate						
		60	43.6	62.1	28	1.43	0.23	9.5
		90	44.0	62.1	28	1.39	0.23	9.5
		120	44.4	62.1	27	1.39	0.22	9.4
		LSD .05	NS	NS	NS	NS	0.01	NS

[1] N applied to preceding sorghum crop.
[2] Whole-plant nutrient content at heading stage.
[3] Protein calculated as %N x 5.7.

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

M.M. Claassen

Summary

Late-maturing Roundup Ready® soybeans and sunn hemp drilled in wheat stubble at 59 and 10 lb/a, respectively, produced an average of 3.91 and 3.52 ton/a of above-ground dry matter. Corresponding nitrogen (N) yields of 146 and119 lb/a were potentially available to the succeeding grain sorghum crop. When averaged across N fertilizer rates, soybeans and sunn hemp significantly increased sorghum leaf nutrient contents by 0.24% N and 0.29% N, respectively. Sorghum leaf N concentration indicated no interaction between cover crop and N rate. Cover crops shortened the period from planting to half bloom by 2 days. Sunn hemp increased grain sorghum yields by 10.6 bu/a, whereas soybeans did not significantly benefit sorghum under existing conditions. Sorghum test weights decreased by an average of 1.2 lb/bu with either cover crop. Nitrogen rates of 60 lb/a or more tended to increase leaf N in comparison with lower rates. No other N rate effects were measured.

Introduction

Research at the KSU Harvey County Experiment Field over a recent 8-year period explored the use of hairy vetch as a winter cover crop following wheat in a winter wheat- sorghum rotation. Results of long-term experiments showed that, between September and May, hairy vetch can produce a large amount of dry matter with an N content on the order of 100 lb/a. But significant disadvantages also exist in the use of hairy vetch as a cover crop, including 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 that has shown the positive effect these crops can have on the overall productivity of no-till systems. In a 2002 pilot project at Hesston, a Group VI maturity soybeans grown as a summer cover crop after wheat produced 2.25 ton/a of above-ground dry matter and an N yield of 87 lb/a potentially available to the succeeding crop. Soybean cover crop did not affect grain sorghum yield in the following growing season but, when averaged over N rate, resulted in 0.15% N increase in flag leaves. In the current experiment, late-maturing soybeans and sunn hemp, a tropical legume, were evaluated as summer cover crops for their impact on no-till sorghum grown in the spring following wheat harvest.

Procedures

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

After wheat harvest in 2002, weeds were controlled with Roundup Ultra Max® herbicide. Hartz H8001 Roundup Ready® soybean and sunn hemp seed were treated with respective rhizobium inoculants and were no-till planted in 8-inch rows with a CrustBuster stubble drill on July 5 at 59 lb/a and 10 lb/a, respectively. Sunn hemp began flowering in late September and was terminated at that time by a combination of rolling with a roller harrow and application of 26 oz/a of Roundup Ultra Max®. Soybeans were rolled after initial frost in mid October. Forage yield of each cover crop was determined by harvesting a 3.28 feet^2 area in each plot just before termination. Samples were subsequently analyzed for N content.

Weeds were controlled during the fallow period and row-crop season with Roundup Ultra Max®, atrazine, and Dual II Magnum®. Pioneer 8505 grain sorghum, treated with Concep® safener and Gaucho® insecticide, was planted at approximately 42,000 seeds/a on June 12, 2003.

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 July 9, 2003. Grain sorghum was combine harvested on October 24.

Results

Modest but timely rains three days before and five days after soybean and sunn hemp planting resulted in good cover-crop stand establishment. Although July and August rainfall in 2002 was below normal, both crops developed well. Late-maturing soybeans reached an average height of 35 inches, showed limited pod development, and produced 3.91 ton/a of above-ground dry matter with an N content of 1.86%, or 146 lb/a (Table 5). Sunn hemp averaged 82 inches in height and produced 3.52 ton/a of dry matter with 1.71% N, or 119 lb/a of N. It was noted, however, that sunn hemp roots had little or no nodulation, evidence that the inoculant was ineffective. Soybeans and sunn hemp effectively suppressed volunteer wheat and, in the fall, reduced the density of henbit in comparison with areas having no cover crop.

Grain sorghum emerged on June 17, with final stands averaging 39,340 plants/a. Extreme drouth stress characterized the period from late June until late August, during which little rain fell and temperatures on 21 days reached or exceeded 100°F. Cover crops had no effect on sorghum population, but shortened the period from planting to half bloom by an average of two days. Both cover crops significantly increased leaf N concentration. Across N rates, these increases averaged 0.24% N and 0.29% N, respectively, for soybeans and sunn hemp.

The positive effect of cover crops on sorghum leaf N concentration was significant at each rate of fertilizer N except the 60 lb/a rate. Cover crops did not affect the number of heads/plant. Sunn hemp, however, increased grain sorghum yields by 10.6 bu/a, whereas soybeans did not significantly benefit sorghum under existing conditions. Sorghum test weights decreased by an average of 1.2 lb/bu with either cover crop.

Nitrogen rates of 60 and 90 lb/a versus 0 and 30 lb/a resulted in an average of 0.12% N increase in sorghum leaves, significant at $p=0.06$. No other meaningful effects of N rate on grain sorghum were observed or measured.

Table 5. Effects of soybean and sunn hemp summer cover crops and nitrogen rate on no-till grain sorghum after wheat, 2003, Hesston, Kansas.

Cover Crop	N Rate[1]	Cover Crop Yield[2]		Grain Sorghum					
		Forage	N	Grain Yield	Bushel Wt	Stand	Half[3] Bloom	Heads/ Plant	Leaf N[4]
	lb/a	ton/a	lb/a	bu/a	lb	1000' s/a	days	no.	%
None	0	----	----	49.2	57.5	38.5	61	0.67	1.98
	30	----	----	48.2	57.9	39.4	62	0.66	1.94
	60	----	----	48.8	56.1	39.3	61	0.69	2.20
	90	----	----	45.8	56.8	39.0	61	0.67	2.08
LSD .05				NS	NS	NS	NS	NS	0.16
Soybeans	0	3.54	130	47.9	56.0	40.3	59	0.66	2.27
	30	3.99	133	48.3	56.2	39.4	59	0.67	2.26
	60	3.88	152	56.2	55.7	38.9	59	0.69	2.32
	90	4.23	170	50.7	55.9	39.1	59	0.66	2.31
LSD .05		----	----	NS	NS	NS	NS	NS	NS
Sunn hemp	0	3.93	128	58.8	56.7	40.0	59	0.65	2.24
	30	3.44	122	53.0	55.3	39.2	59	0.69	2.31
	60	3.28	111	59.9	55.9	39.4	60	0.67	2.34
	90	3.42	114	62.6	55.8	39.7	59	0.68	2.48
LSD .05		----	----	NS	0.88	NS	NS	NS	NS
LSD .05 across systems		NS	38	10.0	0.97	NS	1.1	NS	0.21
Means: Cover Crop/ Termination									
None									
Soybeans		----	----	48.0	57.1	39.0	61	0.67	2.05
Sunn hemp		3.91	146	50.8	55.9	39.4	59	0.67	2.29
LSD .05		3.52	119	58.6	55.9	39.6	59	0.67	2.34
		NS	19	5.0	0.49	NS	0.5	NS	0.11
N Rate									
0		3.74	129	51.9	56.7	39.6	60	0.66	2.17
30		3.72	128	49.9	56.5	39.3	60	0.68	2.17
60		3.58	132	55.0	55.9	39.2	60	0.68	2.29
90		3.82	142	53.0	56.2	39.3	60	0.67	2.29
LSD .05		NS	NS	NS	0.56	NS	NS	NS	NS

[1] N applied as 28-0-0 on July 9, 2003.
[2] Oven dry weight and N content on October 16, 2002.
[3] Days from planting (June 12, 2003) to half bloom.
[4] Flag leaf at late-boot to early-heading stage.

DRYLAND CORN HYBRID AND PLANT-POPULATION INTERACTIONS

M.M. Claassen and D.L. Fjell

Summary

Two corn hybrids, NC+ 5790B and NC+ 5878B, respectively representing fixed-ear (D) and flex-ear types (F), were grown in a wheat rotation under no-till conditions at plant populations ranging from 14,000 to 26,000 plants/a. Yields were low because of drought stress. Highest yields occurred with 14,000 or 18,000 plants/a, decreasing by an average of 23% at 22,000 and 33% at 26,000 plants/a. As in the previous years of this experiment, these hybrids were similar in their yield response to population. Number of ears/plant tended to decrease at the highest populations in NC+ 5878B, but not in NC+ 5790B. Grain test weight was not affected by the number of plants/a. Lodging was generally low and not meaningfully related to plant population.

Introduction

The Kansas Corn Performance Tests historically have been planted at a constant population across all hybrids at a given location. Optimal populations are generally based on current K-State Research and Extension recommendations, as well as consideration of soil type, typical rainfall, fertility, and planting date. Seed companies often recommend a specific population range for each hybrid on the basis of in-house research. These recommendations are based on the observed reaction of each hybrid to changes in population. Typically, flex-ear hybrids are characterized as handling low populations better and not responding well to higher populations. Fixed-ear (determinate) hybrids are characterized as performing best in higher populations. As a result, some seed company representatives have questioned our policy of using a constant population for all hybrids at a given location.

This experiment was initiated in 2001 to determine if hybrid types (flex-ear vs. determinate) respond differently to plant population under existing dryland conditions and to provide a basis for either 1) the validation of current Kansas crop performance test practices or 2) additional studies on a broader scale to evaluate hybrid response characteristics.

Procedures

The 2003 experiment was conducted on a Geary silt loam with pH 6.7, organic matter of 1.9%, and soil tests that were high in available phosphorus and exchangeable potassium. In 2002, winter wheat was grown on the site, which was subsequently maintained without tillage. Corn was fertilized with 37 lb/a of P_2O_5 and 125 lb/a of N as 18-46-0 banded at planting and as 28-0-0 injected in a band 10 inches on either side of each row. The experiment design was a randomized complete block, with factorial combinations of two hybrids and four plant populations in four replications. A fixed-ear (D) hybrid, NC+ 5790B, and a flex-ear (F) hybrid, NC+ 5878B, were planted at 31,000 seeds/a into moist soil on April 15, 2003. Weeds were controlled in a preplant burndown with a tank mix containing 26 oz/a Roundup Ultra Max + 0.67 pt/a 2,4-D_{LVE} 6SC + 1.5 oz/a Banvel + 1% v/v Placement ProPak applied April 5. A subsequent postplanting herbicide treatment consisted of 1.5 pt/a atrazine 4L + 1.33pt/a Dual II Magnum + 1 qt/a COC broadcast on April 17. Corn emerged on May 1 and was subsequently hand thinned to specified populations of 14,000, 18,000, 22,000, and 26,000 plants/a. Evaluations included maturity, lodging, ear number, yield, and grain test weight. Plots were combine harvested on August 27.

Results

Moisture conditions were favorable for corn in April and most of May. From that time onward, below-normal rainfall began to have a cumulatively negative effect on corn. Serious stress already was evident during silking, and subsequent high temperatures exacerbated the situation during the grain-filling period. Length of time to reach half-silking stage increased slightly in both hybrids at the highest plant populations (Table 6). Corn yields were low, and stress effects on yield were accentuated where stands were highest. Maximum yields occurred with 14,000 or 18,000 plants/a. Yields for these populations averaged across hybrids decreased by 23% at 22,000 and by 33% at 26,000 plants/a. NC+ 5790B (D) produced 25.2 bu/a more than NC+ 5878B (F). But these hybrids had similar yield trends in relation to plant population. Test weight was not affected by number of plants/a. Number of ears/plant tended to decrease at the highest populations in NC+ 5878B, but not in NC+ 5790B. Lodging was generally limited and not consistently related to plant population.

Table 6. Dryland corn hybrid response to plant populations, 2003, Harvey County Experiment Field, Hesston, Kansas.

Hybrid[1]	Plant Population	Grain Yield[2] 2003	2002	2001	Avg	Bu Wt	Ears/ Plant	Days to Silk[3]	Lodging
	no./a	-----------bu/a-------------				lb/bu			%
NC+ 5790B (D)	14,000	62	66	48	59	54.3	0.61	78	3
NC+ 5790B (D)	18,000	52	70	44	55	54.4	0.66	79	1
NC+ 5790B (D)	22,000	54	57	40	50	53.9	0.75	79	1
NC+ 5790B (D)	26,000	47	64	36	49	54.3	0.70	80	1
NC+ 5878B (F)	14,000	36	58	28	41	54.3	0.58	79	12
NC+ 5878B (F)	18,000	42	62	24	42	55.0	0.64	79	3
NC+ 5878B (F)	22,000	20	52	15	29	55.6	0.42	80	1
NC+ 5878B (F)	26,000	17	53	14	28	50.1	0.34	81	1
LSD .05		16.5	6.9	8.4	9.6	NS	0.17	1.0	5
Hybrid*Plant Population [4]		NS	NS	NS	NS	NS	NS	NS	0.02*
Main effect means:									
Hybrid									
NC+ 5790B (D)		54	64	42	53	54.2	0.68	79	1
NC+ 5878B (F)		29	56	20	35	53.7	0.50	80	4
LSD .05		8.2	3.5	4.2	4.8	NS	0.08	0.5	2
Plant Population									
14,000		49	62	38	50	54.3	0.59	79	7
18,000		47	66	34	49	54.7	0.65	79	2
22,000		37	54	27	39	54.7	0.58	80	1
26,000		32	58	25	39	52.2	0.52	81	1
LSD .05		11.6	4.9	5.9	6.8	NS	NS	0.7	3

[1] (D) = fixed-ear hybrid ; (F) = flex-ear hybrid.
[2] Average of 4 replications, adjusted to 56 lb/bu and 15.5% moisture.
[3] Days from planting to 50% silking.
[4] Probability of significant differential hybrid response to plant population; NS = not significant.

SOYBEANS FOR FORAGE

M.M. Claassen

Summary

Four grain-type soybean varieties from maturity groups III to VII and four forage-type varieties from maturity groups V to VII were planted in early May to evaluate their utility for forage production. Seasonal drouth impacted soybean development. Grain-type soybeans were shorter in stature than forage-type soybeans. In the group III soybeans, this resulted in 0.30 ton/a less dry matter production. Among later maturing varieties, however, grain-type soybeans produced dry matter yields comparable to the forage types, averaging 1.32 ton/a. N concentration was highest in the earliest maturing grain-type variety, but total N yield in the forage was comparable for all varieties.

Introduction

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

Procedures

The experiment site was located on Ladysmith silty clay loam and had been cropped to soybeans in 2002. Four grain-type soybean varieties from maturity groups III to VII and four forage-type soybean varieties from maturity groups V to VII were no-till planted in four, 30-inch rows per plot on May 7 at 140,000 seeds/a. Weeds were controlled with 26 oz/a Roundup Ultra Max plus 4 oz/a Sencor 75 DF plus 1.66 pt/a Dual II Magnum just after planting. Soybeans emerged May 15. To determine forage yield, subplot areas were hand harvested at a height of three inches above the soil surface when the most mature pods were approximately one inch long. Late-maturing varieties were harvested somewhat earlier than this growth stage, however, because of drouth stress and impending loss of lower leaves. Actual harvest dates were July 29 (Iowa 3010), August 12 (KS4702 sp and Laredo), and August 26 (all remaining varieties).

Results

Final stands ranged from 85,700 to 110,400 plants per acre and differed significantly among varieties (Table 7), but variation in stands did not affect forage yield beyond the effect attributed to varieties. The period from planting to bloom initiation ranged from 64 to 91 days, with significant differences between varieties. Plant heights ranged from 18 inches for Iowa 3010 to 32 inches for Laredo. Notably, grain-type varieties in maturity groups IV through VII averaged four inches shorter than the forage varieties. Forage yields only differed significantly between Iowa 3010 and the remaining varieties, with an average advantage of 0.30 ton/a of dry matter for the later maturing soybeans. Moisture content of Iowa 3010 at harvest was 12% greater than for the remaining varieties, which averaged 59%. Forage N concentrations were similar among all varieties except Iowa 3010, with an average of 0.52% more N. This was attributable to a lower forage yield and somewhat greater pod development by Iowa 3010. Offsetting differences in dry matter yield and N concentrations resulted in no significant differences among varieties in total N/a harvested in the forage.

Table 7. Soybean variety forage production, 2003, Harvey County Experiment Field, Hesston, Kansas.

Brand	Variety[1]	Maturity Group	Plant Population	Bloom[2] Initiation	Plant Ht	Forage Yield[3]	Forage Mois	Forage N	Forage N
			1000's	DAP	inches	ton/a	%	%	lb/a
Public	Iowa 3010	III	110.4	64	18	1.01	71	3.11	63
Public	KS 4702 sp	IV	85.7	69	28	1.34	62	2.61	70
Public	Hutcheson	V	106.0	77	25	1.30	57	2.71	70
Hartz	H7242 RR	VII	98.7	91	24	1.27	59	2.65	67
Public	Derry	VI	82.8	88	28	1.25	56	2.56	63
Public	Donegal	V	88.6	70	31	1.43	58	2.52	71
Public	Laredo	---	110.4	71	32	1.29	65	2.64	68
Public	Tyrone	VII	110.4	91	29	1.30	57	2.41	62
LSD .05			18.7	0.7	2.0	NS	2.4	0.39	NS
LSD .10			15.5	0.6	1.7	0.20	2.0	0.32	NS
Main effect means for soybean type:									
Grain			100.2	75	24	1.23	62	2.77	67
Forage			98.0	80	30	1.32	59	2.53	66
LSD .05			NS	NS	2.4	NS	NS	0.21	NS
LSD .10			NS	NS	2.0	NS	3.0	0.17	NS

[1] Derry, Donegal, Laredo, and Tyrone are forage soybeans.
[2] Days from planting to first bloom.
[3] Dry matter yield.

HERBICIDES FOR WEED CONTROL IN GRAIN SORGHUM

M.M. Claassen and D.L. Regehr

Summary

Twenty-two herbicide treatments were evaluated for crop tolerance and weed-control efficacy in grain sorghum. Weed competition consisted of light large-crabgrass and moderate sunflower populations, as well as dense stands of Palmer amaranth. Most treatments provided excellent control of large crabgrass. Exceptions were Paramount + AAtrex + COC and Guardsman + COC postemergence, which had very limited activity on large crabgrass up to 2 inches tall. Palmer amaranth control was excellent with the full rate of Lasso, alone and with all preemergence treatments involving atrazine or early-postemergence atrazine. Among postemergence treatments, Peak plus AAtrex or Banvel as well as Ally plus AAtrex and/or 2,4-D following Dual II Magnum preemergence were very effective on Palmer amaranth. Similar results were obtained with Permit plus 2,4-D or with Yukon following Lasso preemergence. Sunflowers were completely controlled by postemergence treatments involving AAtrex, Peak plus AAtrex or Banvel, Ally plus AAtrex and/or 2,4-D, Permit plus 2,4-D, and Yukon, but the AAtrex plus Aim tank mix was ineffective on sunflowers. Guardsman Max was the only preemergence treatment with good sunflower control. Sorghum was significantly injured by treatments containing Banvel or Ally plus 2,4-D, which caused plants and tillers to lean and eventually lodge. Delayed application timing accentuated this effect, which ultimately caused yield reduction. Highest grain yields were achieved with Dual II Magnum preemergence followed by Peak plus AAtrex postemergence and with Bicep II Magnum preemergence. But various other treatments had similar yields. Comparisons of treatment effects on yield were diminished by drouth-induced site variability.

Introduction

This experiment evaluated grass herbicides, standard premix preemergence treatments, and alternative post-emergence herbicides and herbicide combinations that may provide greater flexibility for growers with regard to grain sorghum rotation and cost.

Procedures

Winter wheat was grown on the experiment site in 2002. Soil was a Geary silt loam with pH 6.3 and organic matter of 2.0%. A reduced-tillage system with v-blade, sweep-treader, and field cultivator was used to control weeds and prepare the seedbed. Sorghum was fertilized with 120 lb N and 37 lb P_2O_5/a. Palmer amaranth and large crabgrass seed was broadcast over the area to enhance the uniformity of weed populations. Also, domestic sunflowers were planted in four 30-inch rows across all plots. Pioneer 8505, with Concep III safener and Gaucho insecticide seed treatment, was planted at approximately 42,000 seeds/a in 30-inch rows on June 10, 2003. Seedbed condition was excellent. All herbicides were broadcast in 15 gal/a of water, with three replications per treatment (Table 8). Preemergence (PRE) applications were made shortly after planting with AI TeeJet 110025-VS nozzles at 30 psi. Postemergence treatments were applied with Greenleaf TurboDrop TDXL025 venturies, in combination with Turbo Tee 11005 nozzles at 30 psi on June 30 (EPOST) or July 1 (POST). Postemergence herbicides were applied to 0.5- to 5-inch Palmer amaranth, 4- to 6-inch domestic sunflowers, and 0.5- to 2-inch large crabgrass in 8- to10-inch sorghum. Plots were not cultivated. Crop injury and weed control were rated several times during the growing season. Sorghum was harvested October 30.

Results

Meaningful June rainfall consisted of 0.4, 0.7, and 0.43 inch at 6, 15, and 19 days, respectively, after planting and preemergence herbicide application. Early postemergence treatments were delayed somewhat by weather conditions, resulting in little difference in timing between these and subsequent postemergence treatments. July and August were characterized by hot, dry conditions with little precipitation of consequence. Drouth was broken by copious rains at the end of August. Sorghum recuperated somewhat, but only managed to produce relatively poor and variable yields.

Sorghum was significantly injured by treatments containing Banvel or Ally plus 2,4-D, which caused plants and tillers to lean and eventually lodge. This effect was exacerbated by the somewhat advanced stage of sorghum development at the time of application.

Most treatments gave excellent or perfect control of large crabgrass. Exceptions were postemergence Guardsman and Paramount plus AAtrex, which provided little or no control of large crabgrass.

Palmer amaranth control was excellent or complete with the full rate of Lasso alone and with all preemergence treatments containing atrazine or early postemergence atrazine. Control of Palmer amaranth also was excellent with postemergence Peak plus AAtrex or Banvel as well as with Ally plus AAtrex and/or 2,4-D following Dual II Magnum preemergence. Similar results were obtained with Permit plus 2,4-D or with Yukon following Lasso preemergence. Lesser, but fair to good control of Palmar amaranth occurred with several remaining treatments. These included the normal rates of preemergence Dual II Magnum and Outlook alone, as well as with the low rate of Lasso, and postemergence treatments containing Aim plus AAtrex or Peak. Poorest control occurred with the low rates of Dual II Magnum and Outlook.

Sunflower control was complete with postemergence treatments containing AAtrex, Peak plus AAtrex or Banvel, Ally plus AAtrex and/or 2,4-D, Permit plus 2,4-D, and Yukon. When AAtrex was tank mixed with Aim, however, sunflower control was very poor. Among preemergence treatments, Guardsman Max provided good control, whereas the remaining treatments containing atrazine gave poor to fair control of sunflowers.

Highest grain yields were achieved with Dual II Magnum preemergence followed by Peak plus AAtrex postemergence and with Bicep II Magnum preemergence. Various other treatments had similar yields that were not statistically different from the untreated check because of drouth-induced site variability. Treatments causing the greatest crop injury produced yields that were numerically equal to or less than the untreated check.

Table 8. Weed control in grain sorghum, 2003, Harvey County Experiment Field, Hesston, Kansas.

Herbicide Treatment[1]	Product			Timing[2]	Injury 7/30	Lacg[3] Control 7/30	Paam[4] Control 7/30	Dosf[5] Control 7/30	Yield	Cost[6]
	Form	Rate/a	Unit							
					%	%	%	%	bu/a	$/a
1 Dual II Magnum	7.64 EC	0.44	Pt	PRE	0	100	64	0	21	8.50
2 Dual II Magnum	7.64 EC	1.33	Pt	PRE	0	100	84	0	44	18.61
3 Outlook	6 EC	5	Fl Oz	PRE	0	100	79	0	40	7.68
4 Outlook	6 EC	15	Fl Oz	PRE	0	100	87	0	37	16.05
5 Lasso	4 EC	1.66	Pt	PRE	0	100	85	0	34	7.27
6 Lasso	4 EC	2.5	Qt	PRE	0	100	100	0	30	14.86
7 Bicep II Magnum	5.5 SC	2.1	Qt	PRE	0	100	100	81	51	19.86
8 Bicep Lite II Magnum	6 F	1.5	Qt	PRE	0	100	100	72	45	20.02
9 Guardsman Max	5 F	2	Qt	PRE	0	100	100	90	37	19.08
10 Guardsman Max Lite	5F	1.5	Qt	PRE	0	100	100	81	42	17.72
11 Bullet	4 F	3.5	Qt	PRE	0	100	100	73	38	16.63
12 Guardsman Max +	5 F	1.75	Qt	EPOST	0	0	100	100	49	18.15
COC		1	Qt	EPOST						
13 Paramount +	75 DF	5.33	Oz	EPOST	0	7	96	100	47	19.84
AAtrex +	4 F	1.5	Pt	EPOST						
COC		1	Qt	EPOST						
14 Dual II Magnum	7.64 EC	0.44	Pt	PRE	0	99	99	100	57	19.84
Peak +	57 WG	0.5	Oz	POST						
AAtrex +	4 F	1.5	Pt	POST						
COC		1	Qt	POST						
15 Dual II Magnum	7.64 EC	0.44	Pt	PRE	19	100	96	100	25	20.11
Peak +	57 WG	0.5	Oz	POST						
Banvel +	4 EC	4	Fl Oz	POST						
NIS		0.25	% V/V	POST						
16 Dual II Magnum	7.64 EC	0.44	Pt	PRE	0	99	89	45	37	16.68
Aim +	40 WG	0.33	Oz	POST						
AAtrex +	4 F	1.5	Pt	POST						
NIS		0.25	% V/V	POST						
17 Dual II Magnum	7.64 EC	0.44	Pt	PRE	26	100	100	100	21	14.20
Ally +	60 DF	0.05	Oz	POST						
2,4-D $_{\text{Amine}}$ +	4 L	8	Fl Oz	POST						
NIS		0.25	% V/V	POST						

Table 8. Weed control in grain sorghum, 2003, Harvey County Experiment Field, Hesston, Kansas.

Herbicide Treatment[1]	Product			Timing[2]	Injury 7/30	Lacg[3] Control 7/30	Paam[4] Control 7/30	Dosf[5] Control 7/30	Yield	Cost[6]
	Form	Rate/a	Unit							
					%	%	%	%	bu/a	$/a
18 Dual II Magnum	7.64 EC	0.44	Pt	PRE	16	99	100	100	34	15.02
Ally +	60 DF	0.05	Oz	POST						
AAtrex +	4 F	1	Pt	POST						
2,4-D $_{LVE}$ +	6 EC	2.67	Fl Oz	POST						
NIS		0.25	% V/V	POST						
19 Dual II Magnum	7.64 EC	0.44	Pt	PRE	0	99	86	100	40	20.11
Peak +	57 WG	0.5	Oz	POST						
Aim +	40 WG	0.33	Oz	POST						
NIS		0.25	% V/V	POST						
20 Outlook	6 EC	5	Fl Oz	PRE	0	98	88	41	25	15.86
Aim +	40 WG	0.33	Oz	POST						
AAtrex +	4 F	1.5	Pt	POST						
NIS		0.25	% V/V	POST						
21 Lasso	4 EC	1.66	Pt	PRE	13	99	99	100	30	20.66
Permit +	75 DF	0.67	Oz	POST						
2,4-D $_{LVE}$ +	6 EC	2.67	Fl Oz	POST						
NIS		0.25	% V/V	POST						
22 Lasso	4 EC	1.66	Pt	PRE	1	99	92	100	45	21.73
Yukon +	67.5	5	Oz	POST						
NIS	WG	0.25	% V/V	POST						
23 No Treatment					0	0	0	0	34	
LSD .05					3	4	6	4	16	

[1] COC = Farmland Crop Oil Plus. NIS = Pen-A-Trate II nonionic surfactant.
[2] PRE= preemergence on June 4; EPOST = early postemergence 21 days after planting (DAP).;
POST = postemergence 23 DAP.
[3] Lacg =large crabgrass.
[4] Paam = Palmer amaranth. Weed population included some redroot pigweeds.
[5] Dosf = domestic sunflowers.
[6] Total herbicide cost based on prices from an area supplier and spraying cost of $3.50 per acre per application.

HERBICIDES FOR WEED CONTROL IN SOYBEANS

M.M. Claassen

Summary

Twenty herbicide treatments were evaluated for crop tolerance and weed control efficacy in soybeans. Dense Palmer amaranth and moderate sunflower populations developed along with moderate to light stands of large crabgrass. Control of large crabgrass was excellent with a number of treatments, but was unsatisfactory with Flexstar + Fusion. Palmer amaranth control was excellent with most treatments, but significantly less control of Palmer amaranth occurred with Prowl H2O preemergence followed by Raptor + Ultra Blazer or with a single application of Touchdown without prior preemergence herbicide. Touchdown, Roundup Ultra Max, Extreme, and Backdraft completely controlled sunflowers, whereas Flexstar plus Fusion, as well as Raptor plus Ultra Blazer, were ineffective. Drouth stress contributed to low and variable soybean yields. Nevertheless, most treatments significantly improved soybean production. Touchdown treatments applied late were among those with poorer soybean yields.

Introduction

Successful soybean production is dependent upon effective weed control. Growers may choose from a number of herbicide options that can accomplish this objective. These include the use of relatively new herbicides, alone or in combination with glyphosate. This experiment was conducted to evaluate various herbicides and herbicide combinations for weed control efficacy as well as soybean tolerance. Treatments in 2003 included Boundary, Authority, Canopy XL, or Domain preemergence followed by Flexstar plus Fusion or Touchdown; different Touchdown application timings; and several non-glyphosate postemergence herbicide options.

Procedures

Winter wheat was grown on the experiment site in 2002. The soil was a Smolan silt loam with pH 6.6 and organic matter of 1.9%. A reduced tillage system with v-blade, sweep-treader, and field cultivator was used to control weeds and prepare the seedbed. Palmer amaranth and large crabgrass seed was broadcast over the area to enhance the uniformity of weed populations. Also, domestic sunflowers were planted across all plots. Asgrow AG3302 Roundup Ready + STS soybeans were planted at 122,000 seeds/a in 30-inch rows on June 10, 2003. Seedbed condition was excellent. All herbicide treatments were broadcast in 15 gal/a of water, with three replications per treatment. Preemergence (PRE) applications were made shortly after planting with AI TeeJet 110025-VS nozzles at 30 psi (Table 9). Postemergence treatments were applied with Greenleaf TurboDrop TDXL025 venturies, in combination with Turbo Tee 11005 nozzles at 30 psi on July 1 (POST3), July 9 (POST4), July 16, (POST5), and July 23 (POST6 and SEQ). POST3 treatments were applied to 1- to 6-inch Palmer amaranth, 5- to 7-inch domestic sunflowers, and 0.5- to 3-inch large crabgrass in 7-inch soybeans with 2 trifoliate leaves. POST4 herbicides were applied to 1- to15-inch Palmer amaranth, 9- to16-inch sunflowers, and 1- to 8-inch large crabgrass in 10-inch soybeans. POST5 herbicides were applied to 5- to 24-inch Palmer amaranth, 18- to 26-inch sunflowers, and 3- to 10-inch large crabgrass in 14-inch soybeans. POST6 and SEQ treatments were applied to 3- to 32-inch

Palmer amaranth, 24- to 37-inch sunflowers, and 4- to 12-inch large crabgrass in 15-inch soybeans. Crop injury and weed control were evaluated several times during the growing season. Soybeans were harvested October 25.

Results

Meaningful June rainfall consisted of 0.4, 0.7, and 0.43 inch at 6, 15, and 19 days after planting and preemergence herbicide application. Dense Palmer amaranth stands and moderate domestic sunflower stands developed, along with moderate to light large-crabgrass populations. July and August were characterized by hot, dry conditions with little precipitation of consequence. Drouth was broken by copious rains at the end of August. Remarkably, soybeans survived to produce relatively low, but significant yields.

Preemergence treatments caused slight soybean injury in the form of minor stunting or leaf wrinkling. Raptor plus Ultra Blazer caused more significant injury as chlorotic or necrotic spots on soybean leaves. Flexstar plus Fusion caused similar, but somewhat less severe, symptoms.

Most treatments gave excellent or perfect control of large crabgrass. Boundary at both application rates was very effective. A single application of Touchdown at 4 weeks after planting (WAP) was significantly less effective than other Touchdown treatments. Environmental conditions or crabgrass variability may have contributed to the poorer performance of this treatment versus those at 5 or 6 WAP. Flexstar plus Fusion gave no meaningful control of large crabgrass.

Palmer amaranth control was excellent or complete with most treatments. Boundary again was effective at both rates. But single applications of Touchdown tended to give significantly less control. Prowl H2O followed by Raptor plus Ultra Blazer also provided only fair control. Flexstar plus Fusion was ineffective on Palmer amaranth.

Sunflower control was complete with all Touchdown treatments, as well as with Roundup Ultra Max, Extreme, and Backdraft. Flexstar plus Fusion, as well as Raptor plus Ultra Blazer, were ineffective on sunflowers. Boundary or Prowl H2O preemergence generally added little or nothing to the efficacy of treatments that included subsequent postemergence herbicides.

Most treatments significantly improved soybean yield versus the untreated check. Highest yields were attained with Canopy XL preemergence followed by Touchdown and by Prowl H2O followed by Extreme. Similar yields occurred with nine other treatments. Late-applied Touchdown treatments were among those with poorer yields. Drouth-accentuated site variability contributed to the fact that injury and weed control ratings were not consistently related to yield.

Table 9. Weed control in soybeans, 2003, Harvey County Experiment Field, Hesston, Kansas.

Herbicide Treatment[1]	Product			Timing[2]	Injury 7/15	Lacg[3] Control 8/22	Paam[4] Control 8/22	Dosf[5] Control 8/22	Yield	Cost[6]
	Form	Rate/a	Unit							
					%	%	%	%	bu/a	$/a
1 Boundary	6.5 EC	1.5	Pt	PRE	0	99	98	0	11	16.35
2 Boundary	6.5 EC	2.25	Pt	PRE	0	100	100	0	11	22.78
3 Boundary	6.5 EC	1.5	Pt	PRE	15	100	99	63	17	43.07
Flexstar +	1.88 L	16	Fl Oz	POST4						
Fusion +	2.56 EC	10	Fl Oz	POST4						
COC +		1	% V/V	POST4						
UAN		2.5	% V/V	POST4						
4 Boundary	6.5 EC	1.5	Pt	PRE	15	100	100	78	16	45.84
Flexstar +	1.88 L	20	Fl Oz	POST4						
Fusion +	2.56 EC	10	Fl Oz	POST4						
COC +		1	% V/V	POST4						
UAN		2.5	% V/V	POST4						
5 Flexstar +	1.88 L	20	Fl Oz	POST4	13	45	47	57	10	29.49
Fusion +	2.56 EC	10	Fl Oz	POST4						
COC +		1	% V/V	POST4						
UAN		2.5	% V/V	POST4						
6 Boundary	6.5 EC	1.5	Pt	PRE	0	100	100	100	15	26.40
Touchdown +	4 L	2	Pt	POST4						
AMS		2.5	Lb	POST4						
7 Domain	60 DF	10	Oz	PRE	0	100	100	100	17	19.90
Touchdown +	4 L	2	Pt	POST4						
AMS		2.5	Lb	POST4						
8 Authority	75 DF	3	Oz	PRE	0	99	99	100	18	17.79
Touchdown +	4L	2	Pt	POST4						
AMS		2.5	Lb	POST4						
9 Canopy XL	56.3 DF	3.5	Oz	PRE	0	97	99	100	20	19.32
Touchdown +	4 L	2	Pt	POST4						
AMS		2.5	Lb	POST4						
10 Touchdown +	4 L	2	Pt	POST4	0	79	82	100	17	10.05
AMS		2.5	Lb	POST4						
11 Boundary	6.5 EC	1.5	Pt	PRE	0	100	100	100	16	26.40
Touchdown +	4 L	2	Pt	POST5						
AMS		2.5	Lb	POST5						
12 Touchdown +	4 L	2	Pt	POST5	0	98	93	100	9	10.05
AMS		2.5	Lb	POST5						
13 Boundary	6.5 EC	1.5	Pt	PRE	0	100	100	100	15	26.40
Touchdown +	4 L	2	Pt	POST6						
AMS		2.5	Lb	POST6						
14 Touchdown +	4 L	2	Pt	POST6	0	100	83	100	11	10.05
AMS		2.5	Lb	POST6						

Table 9. Weed control in soybeans, 2003, Harvey County Experiment Field, Hesston, Kansas.

Herbicide Treatment[1]	Product Form	Product Rate/a	Product Unit	Timing[2]	Injury 7/15	Lacg[3] Control 8/22	Paam[4] Control 8/22	Dosf[5] Control 8/22	Yield	Cost[6]
					%	%	%	%	bu/a	$/a
15 Touchdown +	4 L	2	Pt	POST3	0	100	100	100	18	20.10
AMS		2.5	Lb	POST3						
Touchdown +	4 L	2	Pt	SEQ6						
AMS		2.5	Lb	SEQ6						
16 Touchdown +	4 L	1.5	Pt	POST3	0	100	100	100	18	15.44
AMS		2.5	Lb	POST3						
Touchdown +	4 L	1	Pt	SEQ6						
AMS		2.5	Lb	SEQ6						
17 Roundup UltraMax +	5 L	26	Fl Oz	POST3	0	100	100	100	15	22.28
AMS		2.5	Lb	POST3						
Roundup UltraMax +	5 L	26	Fl Oz	SEQ6						
AMS		2.5	Lb	SEQ6						
18 Prowl H2O	3.9 SL	2	Pt	PRE	0	100	97	100	20	24.11
Extreme +	2.16 L	3	Pt	POST4						
NIS +		0.125	% V/V	POST4						
AMS		2.25	Lb	POST4						
19 Prowl H2O	3.9 SL	2	Pt	PRE	0	100	96	100	19	24.51
Backdraft +	1.7 L	5	Pt	POST4						
NIS +		0.25	% V/V	POST4						
AMS		2.25	Lb	POST4						
20 Prowl H2O	3.9 SL	2	Pt	PRE	19	99	80	68	17	35.77
Raptor +	1 L	4	Fl Oz	POST4						
Ultra Blazer +	2 L	12	Fl Oz	POST4						
MSO +		1	% V/V	POST4						
AMS		2.5	Lb	POST4						
21 No Treatment					0	0	0	0	6	
LSD .05					1	3	3	5	4	

[1] COC = Prime Oil crop oil concentrate; AMS = sprayable ammonium sulfate. MSO = Destiny methylated seed oil; NIS = Pen-A-Trate II nonionic surfactant; UAN = urea ammonium nitrate fertilizer (28% N).

[2] PRE= preemergence to soybeans and weeds on June 10; POST3 = postemergence 3WAP; POST4 = postemergence 4 WAP;
POST5 = postemergence 4 WAP; POST3 = postemergence 6 WAP; SEQ6 = sequential postemergence 6 WAP;

[3] Lacg =large crabgrass.

[4] Paam = Palmer amaranth.

[5] Dosf = domestic sunflowers.

[6] Total herbicide cost based on prices from an area supplier and spraying cost of $3.50 per acre per application.

IRRIGATION AND NORTH CENTRAL KANSAS EXPERIMENT FIELDS

Introduction

The 1952 Kansas legislature provided a special appropriation to establish the Irrigation Experiment Field to serve expanding irrigation development in north central Kansas. The original 35-acre field was located 9 miles northwest of Concordia. In 1958, the field was relocated to its present site on a 160-acre tract near Scandia in the Kansas-Bostwick Irrigation District. Water is supplied by the Miller Canal and stored in Lovewell 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 2 miles south of the present Irrigation Experiment 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 soybeans.

Soil Description

Predominant soil type on both fields is 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. 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 inch of water per inch of soil.

2003 Weather Information

Table 1. Climatic data for the North Central Kansas Experiment Fields, Scandia and Belleville, Kansas.

	Rainfall, inches			Temperature ^{0}F		Growth Units	
	Scandia 2003	Belleville 2003	Average 30-year	Daily Mean 2003	Average Mean	2003	Average
April	3.7	2.8	2.3	54	52	288	224
May	5.7	5.2	3.8	61	63	375	429
June	10.8	8.9	4.6	70	73	585	686
July	0.1	0.3	3.4	80	78	809	808
August	5.6	5.3	3.4	78	77	780	778
Sept	7.5	6.5	3.5	63	68	443	528
Total	33.4	29.0	20.8			3280	3453

POTASSIUM FERTILIZATION OF CORN IN REDUCED-TILLAGE PRODUCTION SYSTEMS

W. Barney Gordon

Summary

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

The appearance of K deficiency in fields managed with conservation-tillage systems has been reported with greater frequency in recent years and has become a concern for producers. In these experiments, addition of K to starter fertilizers containing N and P improved early-season growth, nutrient uptake, earliness, and yield of corn grown in a long-term ridge-tillage production system on soils that were not deficient in available K.

Introduction

Conservation-tillage usage has increased in recent years because of its effectiveness in conserving soil and water. Potassium deficiency can be a problem on soils that have been managed with reduced-tillage practices. The large amount of residue left on the soil surface can depress soil temperature early in the growing season. Low soil temperature can interfere with plant root growth, nutrient availability in soil, and crop nutrient uptake. Soil temperature influences K uptake by roots and K diffusion through the soil. Limited soil water content or zones of soil compaction can reduce K availability. Potassium uptake in corn is greatest early in the growing season and K accumulates in plant parts at a relatively faster rate than dry matter, N, or P. Cool spring temperatures can limit early-season root growth and K uptake by corn.

In plant physiology, K is the most important cation, not only in concentration in tissues but also with respect to physiological functions. Potassium deficiency affects such important physiological processes as respiration, photosynthesis, chlorophyll development, and regulation of stomatal activity. Plants suffering from K deficiency have shown a decrease in turgor, making resistance to drought poor. The main function of K in biochemistry is its function in activating many different enzyme systems involved in plant growth and development. Potassium influences crop maturity and plays a role in reducing disease and stalk lodging in corn. Potassium deficiency in fields managed with conservation-tillage systems has been reported with greater frequency in recent years and is a concern for producers. Starter fertilizer applications have proven effective in enhancing nutrient uptake and yield of corn even on soils that are not deficient in available nutrients. The objective of these studies was to determine if K applied as a starter at planting could improve K uptake and corn yield on soils managed in a ridge-tillage production system. Two separate studies were conducted at the North Central Kansas Experiment Field. Both experiments were conducted on a Crete silt loam soil in areas that had been ridge-tilled since 1984. Both sites were furrow irrigated. Potassium deficiencies had been observed in these two areas before initiation of the studies. Ear-leaf K concentrations proved to be less than published sufficiency ranges.

Procedures

Experiment 1

This field experiment was conducted for three crop years, 2000 through 2002. Soil test results showed that initial pH was 6.2, organic matter was 2.4%, and Bray-1 P and exchangeable K in the top 6 inches of soil were 40 and 420 ppm, respectively.

Treatments consisted of liquid starter fertilizer N-P_2O_5-K_2O combinations 30-15-5, 15-30-5, 30-30-0, and 30-30-5. A no-starter check was included. Starter fertilizers were made by using 28% UAN, ammonium polyphosphate (10-43-0), and potassium thiosulfate (KTS) (0-0-25-17). Nitrogen was balanced so that all plots received 220 lbs/a N, regardless of starter treatment. Plots receiving no K as KTS included ammonium sulfate to eliminate sulfur as a variable. Starter fertilizer was applied 2 inches to the side and 2 inches below seed at planting.

Experiment 2

This experiment was conducted during the 2002 and 2003 growing seasons on a site that had less soil-test K than the site in Experiment 1. Analysis showed that initial soil pH was 6.9; organic matter was 2.5%; Bray-1 P was 35 ppm, and exchangeable K was 150 ppm. Treatments consisted of liquid starter fertilizer rates of 0, 5, 15, or 25 lbs/a K_2O, applied in combination with 30 lb N, 15 lb P_2O_5, and 5 lb/a S. A 30-15-15-0 treatment was included to separate the effects of K and S. The K source used in this treatment was KCL. The K source used in all other treatments was potassium thiosulfate. Starter fertilizer was applied 2 inches to the side and 2 inches below seed at planting. Nitrogen was balanced on all plots to a total of 220 lbs/a. Both experiments were furrow irrigated.

Results

Experiment 1

The 30-30-5 starter treatment increased corn 6-leaf stage dry matter and tissue K content, decreased the number of days from emergence to mid-silk, and increased grain yield, compared with the 30-30-0 treatment (Table 1). On this soil, which had good soil-test K, a small amount of K applied as a starter resulted in better growth, better nutrient uptake, and 12 bu/a greater yield than application of starter fertilizer that did not include K. In all instances, the 30-30-5 starter was superior to the 15-30-5 treatment, indicating that N is an important element of starter-fertilizer composition. All starter treatments improved growth and yield over the no-starter check.

Experiment 2

Grain yield was maximized with application of 15 lbs of K_2O in the starter fertilizer (Table 2). Addition of 15 lbs/a K_2O to the starter increased grain yield by 13 bu/a over the starter containing only N and P. No response to sulfur was seen at this site. All combinations improved yields over the no-starter check.

Even though soil-test K was in the high range, addition of K in the starter fertilizer increased early-season growth and yield of corn. At this site, 15 lbs/a K_2O was required to reach maximum yield. In Experiment 1, on a soil having much more available K, 5 lb/a K was needed to maximize yields.

Conclusions

Nutrient management in conservation tillage systems can be challenging. Increased amounts of crop residue in these systems can cause early-season nutrient deficiency problems that the plant may not be able to overcome later in the growing season. Early-season P and K nutrition is essential for maximizing corn yield. In these experiments, addition of K to starters containing N and P resulted in improved early-season growth, nutrient uptake, earliness, and yield of corn grown in a long-term ridge-tillage production system.

Table 1. Effects of starter fertilizer combinations on corn, Experiment 1, 2000 through 2003, North Central Kansas Experiment Field, Belleville, Kansas.

Treatments $N-P_2O_5-K_2O$	V6 Dry Weight	V6 K Uptake	Days to Mid-Silk	Grain Yield
lb/a	- - - - - - - - lb/a	- - - - - - - -		bu/a
0-0-0 Check	210	6.2	79	162
30-15-0	382	10.9	71	185
15-30-5	355	15.2	71	173
30-30-0	395	11.2	71	184
30-30-5	460	15.2	68	195
LSD(0.05)	28	1.5	2	10

Table 2. Effects of starter fertilizer combinations on corn, Experiment 2, 2002 and 2003, North Central Kansas Experiment Field, Belleville, Kansas.

Treatments $N-P_2O_5-K_2O$	V6 Dry Weight	V6 K Uptake	Days to Mid-Silk	Grain Yield
lb/a	- - - - - - - - lb/a	- - - - - - - -		bu/a
0-0-0-0 Check	208	6.9	82	161
30-15- 5-5	312	12.8	76	189
30-15-15-5	395	16.2	72	198
30-15-25-5	398	16.9	72	197
30-15-0	290	8.8	76	185
30-15-15-0	398	16.1	72	198
LSD(0.05)	31	1.9	2	11

MAXIMIZING IRRIGATED-CORN YIELDS IN THE GREAT PLAINS

W. Barney Gordon

Summary

This experiment was conducted in 2000 through 2002 on a producer's field in the Republican River Valley, on a Carr sandy loam soil, and in 2003 on the North Central Kansas Experiment Field, on a Crete silt loam soil. Treatments consisted of two plant populations (28,000 and 42,000 plants/a) and nine fertility treatments consisting of three N rates (160, 230, and 300 lb/a), in combination with rates of P, K and S. Results of the experiment show clear interaction between plant density and fertility management. At 42,000 plants/a, yields at the optimum N rate increased from 159 bu/a to 223 bu/a with the addition of P in combination with K and S. At the low P rate, yields decreased by 3 bu/a when population was increased from 28,000 to 42,000 plants/a. On the sandy Carr soil, yield increases were achieved with addition of both K and S, whereas on the silt loam, yield increases were seen with the addition of K but not S. This experiment illustrates the importance of using a systems approach when attempting to increase yield, because factors interact with one another.

Introduction

With advances in genetic improvement of corn, yields continue to rise. New hybrids suffer less yield reduction under conditions of water and temperature stress. Hybrids no longer lose yield to insect infestations. Newer hybrids have the ability to increase yields in response to larger plant populations. For many reasons, both environmental and agronomic, reduced-tillage production systems are becoming more popular with producers. The large amount of surface residue present in reduced tillage systems can reduce seed zone temperatures, which may interfere with plant growth and development and with nutrient uptake. Crops may respond to addition of fertilizer, even though soil-test values are not low. Increasing plant population may increase yields and create a greater demand for crop nutrients. This research was designed to assess whether larger amounts of crop nutrients are needed in systems managed for maximum yields.

Procedures

This experiment was conducted in 2000 through 2002 on a producer's field located near the North Central Kansas Experiment Field, near Scandia, Kansas, on a Carr sandy loam soil. Analysis by the Kansas State University Soil Testing Laboratory showed that initial soil pH was 6.8, organic matter was 2.0%, Bray 1-P was 20 ppm, exchangeable K was 240 ppm, and SO_4-S was 6 ppm. In 2003, the experiment was conducted on a Crete silt loam soil. Soil test values for this site were: pH, 6.5; organic matter, 2.6 %; Bray-1 P, 30 ppm; exchangeable K, 170 ppm; and S, 15 ppm. Treatments included two plant populations (28,000 and 42,000 plants/a) and nine fertility treatments. Fertility treatments consisted of three nitrogen rates (160, 230, and 300 lb/a) applied in combination with 1) current soil test recommendations for P, K, and S (this would consist of only 30 lb/a P_2O_5 at this site); 2) 100 lb/a P_2O_5+80 lb/a K_2O+40 lb/a SO_4 applied preplant, and N applied in two split applications; and 3) 100 lb/a P_2O_5+ 80 lb/a K_2O+40 lb/a SO_4 applied preplant, in combination with N applied in four split applications (preplant, V4, V8, and tassel). A complete description of treatments is given in Table 3. Preplant applications were made 14 to 18 days before planting. Fertilizer sources used were ammonium nitrate, diammonium phosphate, ammonium sulfate, and potassium chloride. The experiment was fully irrigated.

Results

At 42,000 plants/a on the Carr sandy loam soil, yields at 230 lb/a N rate increased from 159 bu/a to 223 bu/a with the addition of P in combination with K and S (Table 4). At the low P rate, yields decreased by 3 bu/a when population was increased from 28,000 to 42,000 plants/a. At the optimum N rate and with the addition of P, K and S, yields were increased by 18 bu/a by increasing population density from 28,000 to 48,000 plants/a. On the Carr soil, significant yield increases were achieved with the addition of both K and S (Table 5).

Results in 2003 on the Crete soil were similar to that on the Carr soil in previous years. At the 230 lb/a N rate, with the addition of higher rates of P in combination with K and S, yields were 45 bu/a greater when population density was increased from 28,000 to 42,000 plants/a (Table 6). On the Crete silt loam soil, no response to S was seen (Table 7). No yield advantage was gained by splitting N fertilizer into four applications on either soil.

Results of this experiment have shown a clear interaction between plant density and fertility management, thus illustrating the importance of using a systems approach when attempting to increase yield.

Table 3. Treatments, irrigated-corn experiments, 2000 through 2003, Republican River Valley and North Central Kansas Experiment Field, Scandia, Kansas.

A. Population

28,000 plants/a and 42,000 plants/a

B. Fertility

P in the first 3 treatments was applied preplant.

N was applied as a split application (½ preplant and ½ at the V4 stage).

1. 160 lb/a N, 30 lb P_2O_5.
2. 230 lb/a N, 30 lb P_2O_5.
3. 300 lb/a N, 30 lb P_2O_5.

For treatments 4,5, and 6, P, K, and S were applied preplant.

N was applied as a split application (½ preplant and ½ at V4 stage).

4. 160 lb/a N, 100 lb/a P_2O_5, 80 lb/a K_2O, 40 lb/a S
5. 230 lb/a N, 100 lb/a P_2O_5, 80 lb/a K_2O, 40 lb/a S.
6. 300 lb/a N, 100 lb/a P_2O_5, 80 lb/a K_2O, 40 lb/a S.

For treatments 7,8, and 9, P, K and S were applied preplant.

N was applied in 4 split applications (preplant, V 4, V8, and tassel).

7. 160 lb/a N, 100 lb/a P_2O_5, 80 lb/a K_2O, 40 lb/a S
8 .230 lb/a N, 100 lb/a P_2O_5, 80 lb/a K_20, 40 lb/a S.
9. 300 lb/a N ,100 lb/a P_2O_5, 80 lb/a K_20, 40 lb/a S.

Table 4. Effects of plant population and fertilizer rates and timing on irrigated corn grown on a Carr sandy loam soil, 2000 through 2002, Scandia, Kansas.

		……………..*Timing of N Application*…………		
		Pre+V4	Pre+V4	Pre+V4+V8+Tassel
		……………………*Elements*…………………...		
		P_2O_5	P_2O_5-K_2O-S	P_2O_5+K_2O+S
		…………………*Rates, lb/a*………………….		
		30	100-80-40	100-80-40
Population	N Rate		Yield	
plants/a	lb/a	- - - - - - - - - - - - - - - - - bu/a - - - - - - - - - - - - - - -		
28,000	160	143	180	185
	230	162	205	206
	300	164	205	206
	N Rate Avg	**156**	**197**	**199**
42,000	160	137	185	191
	230	159	223	222
	300	163	223	222
	N Rate Avg	**153**	**210**	**212**
Pop Avg	bu/a			
28,000	184			
42,000	192			
LSD(0.05)	7			
N-Rate Avg				
160	170			
230	196			
300	197			
LSD(0.05)	5			

Table 5. Nutrient effects on corn on a Carr sandy loam soil, 2001 and 2002, Scandia, Kansas.

Nutrient and Rate	Yield
lb/a	bu/a
0-0-0-0-0 Check	80
300 N	151
300 N+100 P_2O_5	179
300 N+100 P_2O_5+80 K_2O	221
300 N+100 P_2O_5+80 K_2O+40 S	239
LSD(0.05)	10

Table 6. Effects of plant population and fertilizer rates and timing on irrigated corn on a Crete silt loam soil, 2003, Scandia, Kansas.

		……………..*Timing of N Application*…………		
		Pre+V4	Pre+V4	Pre+V4+V8+Tassel
		……………………*Elements*…………………...		
		P_2O_5	P_2O_5-K_2O-S	P_2O_5+K_2O+S
		…………………*Rates, lb/a*………………….		
		30	100-80-40	100-80-40
Population	N Rate		Yield	
plants/a	lb/a	- - - - - - - - - - - - - - -	bu/a	- - - - - - - - - - - - - -
28,000	160	152	196	215
	230	176	202	220
	300	183	205	223
	N Rate Avg	**170**	**201**	**219**
42,000	160	144	220	233
	230	174	247	251
	300	193	250	251
	N Rate Avg	**171**	**239**	**245**
Pop Avg	bu/a			
28,000	197			
42,000	218			
LSD(0.05)	9			
N-Rate Avg				
160	194			
230	212			
300	218			
LSD(0.05)	9			

Table 7. Nutrient effects on corn on a Crete silt loam soil, 2003, Scandia, Kansas.

Nutrient and Rate	Grain Yield
lb/a	bu/a
0-0-0-0-0 Check	114
300 N	154
300 N + 100 P_2O_5	229
300 N + 100 P_2O_5 + 40 K_2O	243
300 N + 100 P_2O_5 + 40 K_2O + 40 S	244
LSD(0.05)	11

CONTROLLED RELEASED UREA FOR IRRIGATED CORN PRODUCTION

W. Barney Gordon

Summary

No-tillage production systems are being used by an increasing number of producers in the central Great Plains because of several advantages that include reduction of soil erosion, increased soil water-use efficiency, and improved soil quality. But 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 coarse-textured soils when N is applied in one preplant application. Slow-release, polymer-coated urea products are available for agricultural use. Polymer coating allows urea to be released at a slower rate than uncoated urea. This experiment compares urea, controlled-release polymer-coated urea (CRU), and ammonium nitrate at 3 N rates (80, 160, and 240 lb/a). Split applications (1/2 preplant + 1/2 at V4 stage) at the 160 lb/a N rate also were included. The study was conducted on a farmer's field on a Carr sandy loam soil. Field was furrow-irrigated. Plots treated with the CRU product yielded more than plots treated with urea at all N rates. Ammonium nitrate and CRU had essentially the same effect on yield. Maximum yield with CRU came at 160 lb N/a, whereas yields of plots receiving urea continued to increase with increasing N rate up to 240 lb/a. Splitting N application improved yields when urea was applied but not when CRU was the N source. Polymer-coated urea has the potential to make surface application of N in no-tillage systems more efficient.

Introduction

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

Procedures

This experiment was conducted on a farmer's field in the Republican River Valley on a Carr sandy loam soil. Soil pH was 6.9, organic matter was 1.8%, Bray-1 P was 25 ppm, and exchangeable K was 150 ppm. Pioneer 33P67 hybrid corn was planted without tillage into corn stubble on May 1, 2003, at the rate of 28,000 seeds/a. Nitrogen was applied on the soil surface immediately after planting. Split applications consisted of 1/2 of the N applied immediately after planting and 1/2 applied at the V4 stage. Treatments consisted of controlled-release polymer-coated urea (CRU), urea, and ammonium nitrate applied at three rates (80, 160, and 240 lb/a). A no-N check plot also was included. Additional treatments were split applications of CRU, urea, ammonium nitrate, and UAN at the 160 lb/a N rate. The experimental area was adequately irrigated throughout the growing season. Plots were hand harvested on Oct 30, 2003.

Results

The CRU product gave greater corn yield than urea at all rates of N (Table 8). Yields achieved with CRU application were equal to those of ammonium nitrate. The lesser yields with urea indicate that volatilization of N may have been a significant problem. Splitting applications of N with CRU and ammonium nitrate did not improve corn yields. When urea was the N source, yields increased from 139 bu to 156 bu/a by splitting N application. Maximum yield occurred with 160 lb N/a when CRU was used as the N source, but maximum yield was produced with 240 lb N/a when urea was used as the N source.

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

Table 8. Effects of nitrogen source and rate on corn grain yield and ear-leaf N, 2003, Scandia, Kansas.

N Source	N Rate	Yield	Earleaf N
	lb/a	bu/a	%
	0-N check	89	1.66
CRU	80	151	2.16
	160	175	2.83
	240	178	2.31
Urea	80	123	1.97
	160	139	2.11
	240	160	2.20
Ammonium nitrate	80	154	2.19
	160	175	2.25
	240	177	2.28
CRU	80+ 80 split	177	2.28
Urea	80+80 split	156	2.17
Ammonium nitrate	80+80 split	178	2.28
28% UAN	80+ 80 split	164	2.18
LSD (0.05)		14	0.14

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

W. Barney Gordon

Summary

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

The appearance of K deficiency in fields managed with conservation-tillage systems has been reported with greater frequency in recent years and has become a concern for producers. In this experiment, preplant broadcast application of potassium thiosulfate (KTS) was compared with a planting-time starter application of KTS and foliar application of Trisert-K+(5-0-20-13) at two growth stages of soybeans. The experimental area had been in a ridge-tillage production system since 1984. All treatments improved soybean seed yield over the untreated check plot except the broadcast application. Yields were maximized with either planting-time application of KTS in combination with foliar application of Trisert-K+ at early pod stage or with two foliar applications of Trisert-K+, at early vegetative stage and again at early pod stage.

Introduction

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

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

Procedures

This field experiment was conducted in 2003 on a Crete silt loam soil. The experimental area had been managed in a ridge-tillage system since 1984. Potassium deficiencies were observed in this area before the initiation of the study. Soil test results showed that initial pH was 6.5, organic matter was 2.5%, Bray-1 P and exchangeable K in the top 6 inches of soil were 35 and 170 ppm, respectively. Treatments consisted of the liquid fertilizer Trisert-K+ applied at 2.5 gal/a at the V3 (early vegetative) or R3 (early pod) stage of growth, Trisert-K+ applied at 5 gal/a at the early pod stage, 2.5 gal/a of Trisert-K+ applied at the early vegetative and early pod stage of growth, starter-applied potassium thiosulfate plus 28%UAN (5-0-12.5-8.5), starter KTS plus UAN in combination with 2.5 gal/a Trisert-K+ applied at early pod, and KTS plus 28% UAN applied preplant broadcast. An untreated check plot was included. Trisert-K+ is a chlorine-free, clear liquid solution containing 5% N, 20% K_2O, and 13% S. Each gallon of Trisert-K+ contains 0.58 lb N, 2.34 lb K_2O, and 1.55 lb S. Starter fertilizer was applied 2 inches to the side and 2 inches below the seed at planting. Foliar fertilizer was applied with a back-pack sprayer using a total spray volume of 20 gal/a. Broadcast applications were made 5 days before planting. The experiment was furrow-irrigated. Soybean variety Asgrow 3302 was planted on May 15, 2003 at the rate of 12 seed/ft. The plots were machine harvested on October 8, 2003.

Results

All K fertilizer treatments improved soybean yields and whole plant K concentration over the untreated check plot except the broadcast application (Table 9). Seed yields were maximized with either starter application of KTS in combination with foliar application of Trisert-K+ applied at early pod stage or with two foliar applications of Trisert-K+ at 2.5 gal/a applied at early vegetation stage and again at early pod. Seed yield was 4 bu/a greater when starter KTS was combined with a single foliar application of Trisert-K+ at the early pod stage than when starter KTS was applied alone. Yield achieved with two foliar applications of Trisert-K+ was statistically equal to yield with starter-applied KTS in combination with a single foliar application of Trisert-K at the early pod stage. Broadcast application of K containing fertilizer was not as effective as starter or foliar-applied fertilizer.

Table 9. Effects of potassium fertilizer application on soybean yield, 2003, Scandia, Kansas.

Treatment	Yield	Whole Plant K at Full Bloom
	bu/a	%
Trisert-K+ 2.5 gal/a at V3	68.7	2.61
Trisert-K+- 2.5 gal/a at R5	72.4	2.85
Trisert-K+- 5.0 gal/a at R5	72.8	2.82
Trisert-K+- 2.5 gal/a at V3+R5	76.0	3.10
Starter KTS	74.9	2.89
Starter KTS plus Trisert-K+- 2.5 gal/a at R5	78.9	3.11
Preplant Broadcast KTS	68.9	1.68
Untreated check	68.7	1.62
LSD(0.05)	3.1	0.12

USE OF STRIP-TILLAGE FOR CORN PRODUCTION IN KANSAS

W. Barney Gordon, R.E. Lamond and L.J. Ferdinand

Summary

Conservation-tillage production systems are being used by an increasing number of producers. Early-season plant growth and nutrient uptake can be poorer in no-tillage than in conventional tillage systems. Strip-tillage may offer many soil-saving advantages of the no-tillage system, while establishing a seed-bed that is similar to conventional tillage. Field studies were conducted at Belleville and Manhattan, Kansas, to compare the effectiveness of strip tillage with that of no-tillage and to assess the effects of fall versus spring applications of N-P-K-S fertilizer on growth nutrient uptake and yield of corn. The 2002 growing season was characterized by much less rainfall than normal at both locations. Corn yields were severely reduced by the hot, dry conditions. Even though grain yields were poor, strip-tillage improved early season growth and nutrient uptake of corn at both locations. Grain yields of strip-tilled corn were significantly greater than yields of no-tillage corn at Belleville, but not at Manhattan. At the Belleville location, strip-tillage shortened the time from emergence to mid-silk by 7 days and also reduced grain moisture content at harvest. In 2003, the growing season was again very dry at the Belleville location. Yields were poor, but the use of strip-tillage increased yields by 15 bu/a over yield of no-tillage corn. Yields were excellent at Manhattan in 2003, and strip-tillage proved to be superior to no-tillage. Soil temperature was consistently warmer in strip-tillage than in no-tillage at both locations. Early-season growth was greatly improved in strip-tillage when compared with no-tillage. Fall fertilization was as effective as spring fertilization at both Belleville and Manhattan. Strip-tillage seems to be an attractive alternative to no-tillage for Great Plains producers.

Introduction

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

Procedures

Studies were conducted at the North Agronomy Farm at Manhattan, Kansas, and at the North Central Kansas Experiment Farm near Belleville to compare strip-tillage and no-tillage systems for dryland corn production. Fertilizer treatments consisted of 40, 80, or 120 lb N/a with 30 lb P_2O_5, 5 lb K_2O, and 5 lb S/a. An unfertilized check plot was included. In the strip-tillage system, fertilizer was either applied in the fall at the time of strip-tilling or in the spring at planting. Fertilizer was applied in the spring at planting in the no-till system. At Manhattan, strip-tillage was done in soybean stubble in early March in 2002 and into grain-sorghum stubble in late October in 2003. At Belleville, strip-tillage was done in wheat stubble in early October in both years of the study. The zone receiving tillage was 5-6 inches in width. Spring-applied fertilizer was placed 2 inches to the side and 2 inches below the seed at planting. Nutrients were supplied as 28% UAN, ammonium polyphosphate (10-34-0), and potassium thiosulfate. Corn was planted in early April at both sites, both years. Soil test phosphorus, potassium, and sulfur were in the high category at both sites.

Results

Because of a very dry growing season in 2002, grain yields at both sites were very poor, and response to applied N was variable. When averaged over fertilizer treatment at Manhattan, strip-tillage improved early-season plant growth and uptake of N, P, and K, compared with no-tillage (Table 10). Even though strip-tillage was done a month before planting, the tilled zone provided a better environment for plant growth and development than no-till plots. There was no significant difference in grain yields between the strip-tillage and no-tillage plots.

At Belleville, strip-tillage improved early-season growth, nutrient uptake, and grain yield of corn, compared with no-tillage (Table 11). When averaged over fertility treatment, strip-tilled plots reached mid-silk 7 days earlier than no-tillage plots. The early-season growth advantage seen in strip-tilled plots carried over to harvest. Grain moisture in strip-tilled plots was 2.8 % less than in no-till plots. In this very dry year, yield advantage may have been the result of the increased rate of development in the strip-till system. Corn plants reached the critical pollination period sooner in strip-tilled plots, while some stored soil water was still available. The soil water reserve was depleted 1 week later when plants in no-tillage plots reached mid-silk.

Soil temperature in the early growing season was warmer in the strip-tillage system than in the no-tillage system (Figures 1 and 2).

In 2003, corn grain yields at Manhattan were excellent. Yields in the strip-tillage system were greater than in no-tillage at all rates of fertilizer (Table 12). Grain yields were poor at Belleville in 2003 because of very hot and dry conditions in July and August. Even at low yield levels, strip-tillage proved to be more effective than no-tillage (Table 13).

Under Kansas conditions, fall-applied fertilizer was as effective as spring-applied fertilizer (Table 14 and Table 15).

Strip-tillage does provide a better early-season environment for plant growth and development, while still preserving a large amount of residue on the soil surface. This system may solve some of the major problems associated with conservation tillage, thus making it more acceptable to producers.

Table 10. Early-season growth, nutrient uptake, and yield of corn, averaged over fertility treatments, 2002, Manhattan, Kansas.

Treatment	V-6 Whole Plant				Yield
	Dry Weight	N	P	K	
		- - - - - - - - - - - lb/a		- - - - - - - - - - -	bu/a
Strip-Tillage	490	17	2.0	13	58
No-Tillage	379	13	1.5	10	55

Table 11. Effects of tillage system on corn, averaged over fertility treatments, 2002, Belleville, Kansas.

Treatment	V-6 Dry Weight	Days from Emergence to Mid-Silk	Harvest Moisture	Yield
	lb/a		%	bu/a
Strip-Tillage	456	58	13.8	49
No-Tillage	296	65	16.6	37

Table 12. Corn grain yield as affected by tillage and spring-applied fertilizer, 2003, Manhattan, Kansas.

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

Table 13. Corn grain yield as affected by tillage and spring-applied fertilizer , 2003, Belleville, Kansas.

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

Table14. Corn grain yield as affected by fall- or spring-applied fertilizer in the strip-tillage system, 2003, Manhattan, Kansas.

	Grain Yield	
Fertilizer Treatment	Fall-Applied	Spring-Applied
lb/a	- - - - - - - - - - - - - - - bu/a	- - - - - - - - - - - - - -
40-30-5-5	182	185
80-30-5-5	192	187
120-30-5-5	205	187
Average	193	186

Table 15. Corn grain yield as affected by fall- or spring-applied fertilizer in the strip-tillage system, 2003, Belleville, Kansas.

	Grain Yield	
Treatment	Fall-Applied	Spring-Applied
lb/a	- - - - - - - - - - - - - - bu/a	- - - - - - - - - - - - - -
40-30-5-5	56	52
80-30-5-5	58	60
120-30-5-5	68	71
Average	61	61

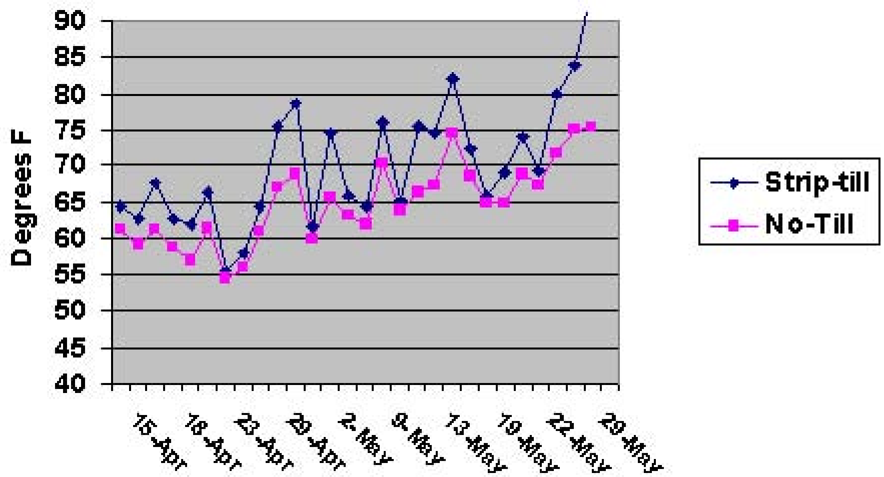

Figure 1. Soil temperature at planting depth, 2003, Manhattan, Kansas.

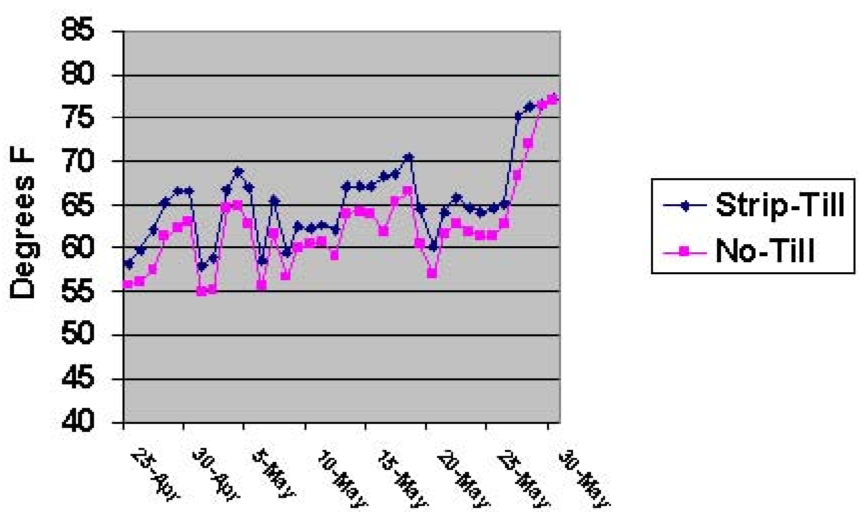

Figure 2. Soil temperature at planting depth, 2003, Belleville, Kansas.

KANSAS RIVER VALLEY EXPERIMENT FIELD

Introduction

The Kansas River Valley Experiments Field were established to study how to manage and use irrigation resources effectively for crop production in the Kansas River Valley. The Paramore Unit consists of 80 acres located 3.5 miles east of Silver Lake on US 24, then 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.

Soil Description

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

2003 Weather Information

The frost-free season was 191 days at the Paramore Unit and 190 days at the Rossville Unit (173 days average). The last 32° F frosts in the spring were on April 9 at the Rossville Unit and on April 10 at the Paramore Unit (average, April 21). The first frost in the fall was on October 17 at both fields (average, October 11). Precipitation was below normal at both fields (Table 1). Irrigated corn yields were excellent and soybean yields were fair. Take-all disease was a problem in soybeans.

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

Month	Rossville Unit		Paramore Unit	
	2002-2003	30-Yr. Avg.	2002-2003	30-Yr. Avg.
	Inches		Inches	
Oct.	5.55	0.95	5.40	0.95
Nov.	0.19	0.89	0.20	1.04
Dec.	0.01	2.42	0.05	2.46
Jan.	0.31	3.18	0.25	3.08
Feb.	1.18	4.88	1.19	4.45
Mar.	0.76	5.46	0.81	5.54
Apr.	4.78	3.67	5.92	3.59
May	2.51	3.44	3.70	3.89
June	6.01	4.64	3.71	3.81
July	1.31	2.97	0.70	3.06
Aug.	4.31	1.90	6.26	1.93
Sep.	1.96	1.24	2.97	1.43
Total	28.88	35.64	31.16	35.23

CORN HERBICIDE PERFORMANCE TEST

Larry D. Maddux

Summary

Two studies were conducted at the Rossville Unit. Timeliness of herbicide application is a major factor in determining effective weed control. These two studies evaluated several pre-emergence and post-emergence treatments, both as stand-alone treatments and in combinations. Most treatments gave good-to-excellent control of large crabgrass, palmer amaranth, and the common sunflower. The early post-emergent treatment of Option + Hornet gave poor control of palmer amaranth. Acceptable control of ivyleaf morningglory required a post-emergent herbicide application in most instances.

Introduction

Chemical weed control and cultivation have been used in row crops to reduce weed competition, which can reduce yields. Results of seventeen selected treatments from a weed-control test, including thirty-four pre-emergence and/or post-emergence herbicide treatments are presented here. The weeds evaluated were large crabgrass (lacg), palmer amaranth (paam), common sunflower (cosf), and ivyleaf morningglory (ilmg)

Procedures

Two tests were conducted on a Eudora silt loam soil previously cropped to soybeans. Test 1 included mainly pre-emergence (PRE) treatments; Test 2 included mostly PRE + post-emergent or all post-emergent treatments. The test site had a pH of 6.9 and an organic matter content of 1.1%. Garst 8544RR hybrid corn was planted April 29 at 30,000 seeds/a in 30-inch rows. Anhydrous ammonia at 150 lbs N/a was applied preplant, and 120 lbs/a of 10-34-0 fertilizer was banded at planting. Herbicides were broadcast in 15 gal. water/a, with 8003XR flat fan nozzles at 17 psi, and three replications per treatment. Pre-emergence (PRE) applications were made April 29. Early post-emergence (EP) treatments were applied May 29 to 6-leaf corn, seedling to 1-inch lacg), 1- to 2-inch paam, 1- to 6-inch cosf, and 1- to 2-inch ilmg. The late post-emergence (LP) treatments were applied June 10 to 7-leaf corn, 2- to 5-inch paam, a few 2- to 8-inch cosf, and seedling ilmg. Populations of all four weed species were moderate to heavy. But weed populations were generally fairly light at post-emergence time in plots receiving a pre-emergence treatment, and lacg was not present at LP. Plots were not cultivated. The crop-injury and weed-control ratings reported were made June 23 and July 7, respectively. The first significant rainfall after PRE herbicide application was on May 8 (0.47 inches). The first sprinkler irrigation occurred on June 19. The test was harvested September 23 with a modified John Deere 3300 plot combine.

Results

Light rains of 0.13 and 0.16 inch occurred 2 and 8 days after planting, respectively, with a significant rainfall of 0.47 inch occurring 10 days after planting. Crop injury was observed from treatments containing isoxaflutol (Epic & Balance Pro) in Test 1 (Table 2). This injury was severe enough to result in yield reductions. Injury from isoxaflutol can be a problem, especially on lighter-textured soils such as this test site. Planting corn at a depth of 1.5 or greater can help, and little injury from isoxaflutol was observed in 2004 when corn was planted deeper. In Test 2, slight injury was observed from some treatments (Table 3), but had no significant effect on grain yield. Good to excellent control of lacg, paam, and cosf was obtained with most treatments in both tests. Poor paam control was obtained with the EP treatment of Option + Hornet. Control of ilmg was less with most PRE treatments. A post-emergent treatment generally was required to obtain satisfactory control of ilmg.

Table 2. Effects of post-emergence herbicides on injury, weed control, and grain yield of corn, Kansas River Valley Experiment Field, Rossville, Kansas, 2003

Treatment	Rate	Appl Time[2]	Corn Injury[1]	Weed Control[1,3] lacg	paam	cosf	ilmg	Grain Yield
	product/a		---%---	---------------%---------------				bu/a
Untreated check		---	0	0	0	0	0	105
Lumax	2.5 qt	PRE	0	100	100	100	73	208
Lumax + Aatrex	2.5 qt + 1.0 qt	PRE	0	98	100	95	78	203
Lumax + Princep 90	2.5 qt + 1.11 lb	PRE	0	97	98	100	72	202
Bicep II Magnum	2.1 qt	PRE	0	93	100	92	72	209
Harness Xtra 5.6	2.44 qt	PRE	0	100	100	87	43	193
Epic	12.0 oz	PRE	43	97	92	100	50	138
Keystone	2.65 qt	PRE	0	97	100	88	72	208
Keystone + Hornet	2.65 qt + 3.0 oz	PRE	0	97	100	100	72	194
Keystone + Balance Pro	1.3 qt + 2.25 oz	PRE	27	95	100	100	67	152
Guardsman Max	2.0 qt	PRE	0	97	100	97	45	183
Camix	2.0 qt	PRE	0	98	100	95	65	195
Camix + Princep 90	2.0 qt + 1.11 lb	PRE	0	100	100	93	80	210
Harness Xtra 5.6 + Balance Pro	2.0 qt + 1.2 oz	PRE	3	95	100	88	53	181
Define + Atrazine	14.4 oz + 1.5 qt	PRE	0	98	98	90	65	205
Balance Pro + Define + Atrazine	1.2 oz + 12.0 oz + 1.25 qt	PRE	8	98	93	98	68	177
Balance Pro + Define + Atrazine	1.2 oz + 14.4 oz + 1.25 qt	PRE	15	97	95	98	68	156
Fultime + Hornet	3.35 qt + 3.0 oz	PRE	0	92	100	100	63	195
Surpass fb Hornet +Callisto + Atrazine 90	2.5 pt 3.0 oz + 0.75 oz + 0.28 lb	PRE EP	0	98	100	100	72	187
Fultime fb Hornet + Atrazine 90	3.35 pt 3.0 oz + 0.83 lb	PRE EP	5	88	100	100	82	174
LSD(.05)			8	8	6	9	31	30

[1] Corn injury - 6/23/03; weed control - 7/10/03.

[2] PRE = pre-emergence; SP = spike; EP = early post-emergence. EP treatments had surfactants added (NIS, COC, UAN, and/or AMS) according to label recommendations.

[3] lacg = large crabgrass; paam = palmer amaranth; cosf = common sunflower; ilmg = ivyleaf morningglory.

Table 3. Effects of pre-emergence plus post-emergence herbicides on injury, weed control, and grain yield of corn, Kansas River Valley Experiment Field, Rossville, Kansas, 2003

Treatment	Rate	Appl Time[2]	Corn Injury[1]	Weed Control[1,3] lacg	paam	cosf	ilmg	Grain Yield
	product/a		---%---	----------------	%	--------------		bu/a
Untreated check	---	---	0	0	0	0	0	85
Lumax	2.5 qt	PRE	0	100	98	100	82	196
Lumax + AAtrex	2.5 qt + 1.0 qt	PRE	0	100	100	100	82	201
Bicep II Magnum *fb*	2.1 qt	PRE	2	100	100	100	92	198
Callisto + AAtrex	3.0 oz + 0.5 qt	EP						
Degree Xtra *fb*	3.2 qt	PRE	0	98	98	100	90	196
Yukon	4.0 oz	EP						
Outlook *fb*	0.56 qt	PRE	7	95	100	100	92	193
Marksman	1.5 qt	EP						
Guardsman Max *fb*	2.0 qt	PRE	0	100	100	100	83	204
Distinct	4.0 oz	EP						
Keystone *fb*	2.6 qt	PRE	0	97	97	100	87	191
Hornet	3.0 oz	EP						
Cinch ATZ *fb*	0.75 qt	PRE	13	100	100	100	82	212
Steadfast + Aatrex	0.75 oz + 1.0 qt	EP						
Harness Xtra 5.6 *fb*	1.0 qt	PRE	0	100	100	100	78	225
Roundup WeatherMax	0.665 qt	EP						
Roundup WeatherMax *fb*	0.665 qt	EP	3	100	100	100	90	203
Roundup WeatherMax	0.5 qt	LP						
Basis Gold + Clarity	14.0 oz + 4.0 oz	EP	0	85	87	100	87	180
Celebrity Plus	4.7 oz	EP	2	83	98	100	80	211
Steadfast + Aatrex + Callisto	0.75 oz + 0.5 qt + 3.0 oz	EP	12	100	98	100	87	197
Steadfast + Aatrex + Clarity	0.75 oz + 1.0 qt + 2.0 oz	EP	0	98	97	100	90	189
Option + Hornet	1.5 oz + 3.0 oz	EP	0	98	60	100	77	186
Cinch ATZ *fb*	2.0 pt	PRE	0	100	100	100	88	220
Steadfast + Callisto + Atrazine	0.75 oz + 2.0 oz + 16.0 oz	EP						
Cinch ATZ *fb*	2.0 pt	PRE	2	100	97	100	85	193
Steadfast + Distinct	0.75 oz + 2.0 oz	EP						
Cinch ATZ *fb*	2.0 pt	PRE	0	100	100	100	78	220
Rimsulfuron + Roundup WeatherMax	0.75 oz + 26.0 oz	EP						
Rimsulfuron + Roundup WeatherMax	0.75 oz + 26.0 oz	EP	2	100	92	100	80	200
Roundup WeatherMax	26.0 oz	EP	0	100	98	100	47	208
Fultime *fb*	2.25 qt	PRE	0	100	100	100	80	206
Glyphomax Plus	2.0 pt	EP						
Keystone *fb*	1.75 qt	PRE	0	100	100	100	82	219
Glyphomax Plus	2.0 pt	EP						
LDS(.05)			7	5	13	NS	19	31

[1] Corn injury - 6/23 /03; weed control - 7/10/03.

[2] PRE = pre-emergence; SP = spike; EP = early post-emergence; LP = late post-emergence. EP and LP treatments had surfactants added (NIS, COC, UAN, and/or AMS) according to label recommendations.

[3] lacg = large crabgrass; paam = palmer amaranth; cosf = common sunflower; ilmg = ivyleaf morningglory.

SOYBEAN HERBICIDE PERFORMANCE TEST

Larry D. Maddux

Introduction

Chemical weed control and cultivation have been used in row crops to reduce weed competition, which can reduce yields. Results of sixteen selected treatments from a weed-control test, including twenty-seven pre-emergence and/or post-emergence herbicide treatments, are presented here. The weeds evaluated in these tests were large crabgrass (lacg), palmer amaranth (paam), common sunflower (cosf), and ivyleaf morningglory (ilmg)

Procedures

This test was conducted on a Eudora silt loam soil previously cropped to corn. The test site had a pH of 6.9 and an organic matter content of 1.2%. Garst 399N soybean was planted May 2 at 144,000 seeds/a in 30-inch rows, and 10-34-0 fertilizer was banded at 120 lbs/a. Herbicides were broadcast in 15 gal. water/a, with 8003XR flat fan nozzles at 17 psi, and three replications per treatment. Pre-emergence (PRE) applications were made May 2. P3 (3 weeks after planting) treatments were applied June to 1-trifoliate soybean, seedling lacg, 1- to 2-inch paam, 1- to 4-inch cosf, and seedling ilmg. P4 (4 weeks after planting) were applied June 3 to 2-trifoliate soybean, seedling to 1-inch lacg, 1- to 2-inch paam, 1- to 5-inch cosf, and 1- to 2-inch ilmg. P5 (5 weeks after planting) treatments were applied June 9 to 3-trifoliate soybean, 1- to 2-inch lacg, 1- to 5-inch paam, 4- to 12-inch cosf, and 1- to 3-inch ilmg. P6 (6 weeks after planting) treatments were applied June 16 to 4-trifoliate soybean, 1- to 3-inch lacg, 2- to 8-inch paam, 6- to 14-inch cosf, and 1- to 2-inch ilmg. Populations of lacg, paam, and cosf were heavy; populations of ilmg were light to moderate, and variable. Plots were not cultivated. Weed-control ratings reported were made on July 25. The first significant rainfall after PRE herbicide application was on May 8 (0.47 inches). The first sprinkler irrigation occurred on June 27. The test was harvested October 8 with a modified John Deere 3300 plot combine.

Results

A light rain of 0.16 inches occurred on May 6, with the first significant rainfall of 0.47" occurring on May 8. Rainfall was below normal during May and June. Significant crop injury was observed with treatments containing Flexstar, but the injury had no effect on grain yield (Table 4).

The PRE-only treatments of Boundary resulted in poor control of cosf and ilmg. The P5 treatment of Flexstar + Fusion resulted in fairly poor control of paam, which was reflected in a lower grain yield. Most of the other treatments gave fairly good weed control. It is interesting to note that Touchdown IQ at 1.5 pt/a (P3) followed by (*fb*) Touchdown IQ at 1.0 pt/a resulted in equivalent weed control to that obtained with the higher application rates of 2.0 pt/a *fb* 2.0 pt/a. But weeds were small at both times of application. Control of ilmg with glyphosate-only treatments was better this year than has been observed in other years. Control of ilmg can be poor with glyphosate, especially if ilmg are a little larger than they were in this test. One application of glyphosate, especially without a PRE herbicide, has usually not been sufficient to achieve acceptable weed control. The use of reduced rates of PRE herbicide(s), followed by glyphosate, results in good weed control while being cost comparative, and provides the producer more flexibility in timing of the glyphosate application. Yields in this test were fairly variable, as indicated by the large LSD of 16 bu/a. Herbicide use decisions from this data should be determined more by the weed-control ratings than by yield.

Table 4. Effects of pre-emergence and post-emergence herbicides on injury, weed control, and grain yield of soybean, Kansas River Valley Experiment Field, Rossville, Kansas, 2003.

Treatment[1]	Rate	Appl Time[2]	Injury	Weed Control[3], 7/25 lacg	paam	cosf	ilmg	Grain Yield
	product/a		---------------	--------------- %	---------------	---------------		bu/a
Untreated check		---	0	0	0	0	0	0
Boundary	1.5 pt	PRE	0	100	97	50	73	0
Boundary	2.25 pt	PRE	0	93	100	67	60	8
Boundary *fb*	1.5 pt	PRE	20	100	100	98	92	41
Flexstar + Fusion	1.0 pt + 0.625 pt	P5						
Boundary *fb*	1.25 pt	PRE	18	98	100	98	95	40
Flexstar + Fusion	1.25 pt + 0.625 pt	P5						
Flexstar + Fusion	1.25 pt + 0.625 pt	P5	22	87	73	100	97	23
Boundary *fb*	1.5 pt	PRE	0	93	85	98	80	37
Touchdown IQ	2.0 pt	P4						
Domain *fb*	10.0 oz	PRE	2	98	80	100	82	27
Touchdown IQ	2.0 pt	P4						
Authority *fb*	3.0 oz	PRE	0	83	97	97	100	42
Touchdown IQ	2.0 pt	P4						
Canopy XL *fb*	3.5 oz	PRE	0	83	92	100	98	35
Touchdown IQ	2.0 pt	P4						
Touchdown IQ	2.0 pt	P4	0	90	82	85	83	32
Boundary *fb*	1.5 pt	PRE	0	93	100	98	88	31
Touchdown IQ	2.0 pt	P5						
Touchdown IQ	2.0 pt	P5	0	83	95	100	93	32
Boundary *fb*	1.5 pt	PRE	0	93	92	100	95	41
Touchdown IQ	2.0 pt	P6						
Touchdown IQ	2.0 pt	P6	0	87	87	100	100	34
Touchdown IQ *fb*	2.0 pt	P3	0	90	95	100	88	40
Touchdown IQ	2.0 pt	P6						
Touchdown IQ *fb*	1.5 pt	P3	0	93	95	100	92	39
Touchdown IQ	1.0 pt	P6						
Roundup Ultra Max *fb*	25.6 oz	P3	0	95	97	100	87	52
Roundup Ultra Max	25.6 oz	P6						
FirstRate + Valor + Pendimax	0.6 oz+3.0 oz+3.0 pt	PRE	0	92	92	100	93	36
Pendimax *fb*	3.0 pt	PRE	15	97	88	100	97	40
FirstRate + Flexstar	0.3 oz + 12.0 oz	P5						
FirstRate + Valor *fb*	0.3 oz + 1.5 oz	PRE	0	100	100	100	93	43
Glyphomax Plus	1.5 pt	P6						
FirstRate + Valor *fb*	0.4 oz + 2.0 oz	PRE	0	98	98	100	100	44
Glyphomax Plus	1.5 pt	P6						
Python + Valor *fb*	0.66 oz + 1.50 oz	PRE	0	95	97	100	95	36
Glyphomax Plus	1.5 pt	P6						
FirstRate fb	0.3 oz	PRE	0	97	100	100	92	35
Glyphomax Plus	1.5 pt	P5						
LSD(.05)			3	12	13	13	23	16

[1] P3, P4, P5, and P6 treatments had surfactants added (NIS, COC, UAN, &/or AMS) according to label recommendations.
[2] PRE = preemergence; P3, P4, P5, P6 = 3, 4, 5, 6 weeks after planting.
[3] lacg = large crabgrass; paam = palmer amaranth; cosf = common sunflower; ilmg = ivyleaf morningglory.

EFFECTS OF REDUCED TILLAGE ON CORN-SOYBEAN CROPPING SEQUENCES

Larry D. Maddux

Summary

Three tillage systems (conventional, reduced, and no-till) were evaluated in a corn/soybean rotation and continuous monocultures from 1984 to 2002. In contrast to some other studies, corn following soybeans did not consistently yield more than continuous corn. But soybeans following corn consistently yielded more than continuous soybeans, for an average yield increase of 7.0 bu/a. The no-till and reduced-tillage corn yielded less than conventional corn in the later years of the study. In contrast, no-till soybeans had significantly less yield than conventional and reduced tillage only in the first 5 years of the study. Weed control has been more difficult to attain in the no-till plots, especially in the monocultures.

Introduction

Research has shown that both corn and soybeans benefit from a corn-soybean cropping sequence. The objective of this study was to evaluate the long-term effects of conventional tillage, reduced tillage, and no-till on a corn-soybean cropping sequence and on continuous corn and soybeans.

Procedures

The study was initiated in 1983, when the cropping sequences were started on a conventionally tilled field. The tillage treatments were started that fall. Tillage treatments consisted of: (1) conventional till - CT (fall tillage with an offset disk and chisel plus spring tillage with a disk or field cultivator); (2) reduced till - RT (1983 to 1991: fall tillage with an offset disk and spring tillage with a disk or field cultivator after corn in the cropping sequence, or every other year with continuous corn or soybeans; 1992 to 2002 - disk once in the spring every year); (3) no-till - NT (plant on the ridge). All plots were cultivated and furrowed for irrigation.

Anhydrous ammonia was applied preplant on 30-inch centers (between plant rows) on corn plots at rates of 175 lbs N/a on continuous corn and 150 lbs N/a on corn following soybeans. Starter fertilizer was banded at planting at a rate of 130 lb/a of 8-32-16 (1983 to 1991) and 110 lb/a (10 gpa) of 10-34-0 (1992 to 2002). Chemical weed control was used for weed control, with the herbicides being varied from year to year in an attempt to get the best weed control possible.

Adapted hybrids of corn were planted in 30-inch rows in mid-April at 26,200 sds/a from 1983 to 1997 and at 30,000 sds/a from 1998 to 2002. Various soybean varieties were planted in 30-inch rows in mid-May at 174,000 sds/a from 1983 to 1992 and at 140,000 sds/a from 1993 to 2002. A hail storm on Oct. 2 resulted in the loss of soybean yields for 1991, and a severe wind storm on July 1 resulted in stalk breakage and loss of corn yields for 1994. Each year a plot combine was used to harvest corn in early to mid-September and soybeans in early to mid-October.

Results

Corn Yield

No significant differences in corn yield were observed during the first 5 years of the study (Table 1). During the second 5 years, the corn/soybean rotation yielded an average of 9 bu/a more than the continuous corn. This trend was still present during the third 5 years (6 bu/a), but was not statistically significant.

No significant response of corn yield to tillage was observed during the first 10 years of the test. During the third 5 years of the test, no-till yielded an average of 11 to 12 bu/a less than did the conventional tilled plots. Average corn yields the last 4 years of the test were 12 bu/a less with reduced tillage than with conventional tillage and 18 bu/a less with no-till. Part of the lower yields with no-till likely was because of a lower plant population. It was difficult to get the planter adjusted and get a good stand on the no-till plots planted on the ridges.

Soybean Yield

A significant yield increase for soybeans following corn over that of continuous soybeans was observed for the duration of the study (Table 2). The average yield advantages for the rotation were: 9.1 bu/a the first 5 years; 3.6 bu/a the second 5 years, 9.2 bu/a the third 5 years, and 4.9 bu/a for the last 4 years of the study. The average yield increase for the rotation over the continuous soybeans was 7.0 bu/a.

Only in the first 5 years of the study was a soybean yield response to tillage treatment observed. The no-till 5-year average yield was about 10 bu/a less than that obtained with conventional or reduced tillage. As with corn, it has been difficult to obtain good stands on the ridge tops with no-till, but the soybeans have compensated for poorer stands more effectively than corn has. Weed control in the no-till plots has been more difficult to attain, especially in the continuous monoculture.

Table 5. Long-term Effects of Cropping Sequence and Tillage on Corn Yields, 1984 to 2002.

Crop		Yield Averages[2]				Yield
Sequence	Tillage[1]	1984-88	1989-93	1995-98	1999-02	18-yr Avg.
Continuous	Conventional	172	168	179	192	176
	Reduced	175	166	185	186	179
	No-Till	167	154	165	175	171
Corn-Soybean	Conventional	170	173	172	179	172
	Reduced	169	171	167	172	165
	No-Till	170	174	172	170	170
Interaction LSD(0.05)		NS	NS	NS	NS	NS
CROPPING SEQUENCE MEANS:						
Continuous		171	163	170	180	171
Corn-Soybean		170	172	176	178	174
LSD(0.05)		NS	6	NS	NS	NS
TILLAGE MEANS:						
	Conventional	171	171	182	189	177
	Reduced	172	168	169	177	171
	No-Till	168	164	170	171	168
LSD(0.05)		NS	NS	9	12	8

[1] Conventional: Fall disk and chisel, spring disk or field cultivate
Reduced: 1984 to 1991 - Disk fall and spring every other year or after corn in sequence;
1992 to 2002 - Disk in spring every year
No-Till: Plant on top of old row
[2] No yield was collected in 1994.

Table 6. Long-term Effects of Cropping Sequence and Tillage on Soybean Yields, 1984 to 1999.

Crop		Yield Averages				Yield
Sequence	Tillage[1]	1984-88	1989-93[2]	1994-98	1999-02	18 yr Avg.
Continuous	Conventional	51.5	63.3	54.0	47.5	53.9
	Reduced	59.2	68.1	65.6	51.2	61.2
	No-Till	51.4	64.0	56.8	44.6	54.2
Corn-Soybean	Conventional	58.3	68.2	64.8	54.2	61.4
	Reduced	38.6	66.4	56.1	48.4	51.8
	No-Till	51.5	68.3	64.0	49.6	58.3
Interaction LSD(0.05)		3.2[3]	NS	NS	4.6	NS
CROPPING SEQUENCE MEANS:						
Continuous		47.2	64.6	55.6	46.8	53.3
Corn-Soybean		56.3	68.2	64.8	51.7	60.3
LSD(0.05)		2.2	2.1	2.5	2.6	1.5
TILLAGE MEANS:						
	Conventional	55.3	65.7	59.8	49.4	57.6
	Reduced	54.9	66.1	60.8	49.4	57.8
	No-Till	45.1	67.3	60.1	49.0	55.0
LSD(0.05)		2.7	NS	NS	NS	1.8

[1] Conventional: Fall disk and chisel, spring disk or field cultivate
Reduced: 1984 - 1991 - Disk fall & spring every other year or after corn in sequence;
1992 - 2002 - Disk in spring every year
No-Till: Plant on top of old row

[2] 1991 not included in this average.

[3] Significant at the 10% level of probability.

QUANTIFYING NITRATE LEACHING IN SANDY SOILS AS AFFECTED BY N AND WATER MANAGEMENT

Ron J. Gehl*, John P. Schmidt, Loyd R. Stone, and Larry D. Maddux

Summary

Efficient use of nitrogen (N) fertilizer for corn production is important for maximizing economic return and minimizing NO_3 leaching to groundwater, especially on irrigated, sandy soils. Grain yield and soil NO_3-N (before and after the growing season) to a depth of 94 inches were determined for all plots. Yield results indicated that a split application of 165 lb N/a was sufficient to achieve maximum corn yield at every location. Water samples collected throughout the growing season indicated that, after July 15, soil water NO_3-N concentration at the 6-inch depth increased 2 to 3 times more with the single pre-plant N applications than with the split N applications. Total N fluxes at the 6-inch depth exceeded 90 lb N/a when water and N were applied in excess of that required for maximum yield, particularly with the single, pre-plant N applications.

Introduction

In recent years, research evidence has implicated irrigated agriculture as a contributor to the contamination of surface and groundwater through excessive inputs of both fertilizers and water. Timing of N fertilizer application is central to minimizing NO_3 leaching, particularly on sandy-textured soils that are susceptible to rapid downward movement of water. When N fertilizer is applied before planting, the period before rapid plant growth (late April to late May) combines high soil NO_3 concentration and high rainfall, so NO_3 leaching potential can be relatively great. The Kansas Department of Agriculture and the United States Geological Survey have identified groundwater wells (as many as 15 %) in the Lower Arkansas River Basin with NO_3-N concentrations exceeding 10 ppm – the US EPA threshold for drinking water quality. Common to this same area are sandy-textured soils supporting irrigated corn production.

As little as 1 inch of irrigation or rainfall can move soil NO_3 6 to 8 inches in a loamy sand. Average May rainfall (1999 through 2003) in Barton Co, Kansas, is 3.9 inches, so the depth to which NO_3 could potentially move early in the growing season is almost as great as the average corn rooting depth (54 inches). Maximum corn rooting depth does not occur until about tasseling, by which time only 60 % of total N uptake has occurred. Any rainfall/irrigation in May in excess of average rainfall increases the potential for NO_3 leaching to a depth that exceeds the average corn rooting depth.

Combining N and water management practices that minimize NO_3 leaching potential in corn production along environmentally sensitive tributaries in Kansas will be essential to maximizing economic return for producers and minimizing adverse effects on groundwater quality (a benefit to all downstream water users). Objectives of this study include (i) in a sandy soil typical to Kansas' tributaries, quantify NO_3 leaching under current and alternative N and water-management strategies for corn, and (ii) evaluate yield response to alternative N and water-management practices for irrigated corn production.

Procedures

Corn was grown in 2001 and 2002 at six Kansas locations along the Republican (Scandia), Kansas (Manhattan, Rossville), and Lower Arkansas (Ellinwood, Pretty Prairie, St. John) rivers. Soils at the locations ranged in textural class from silt loam to fine sand. Continuous corn is the crop rotation at every site except Scandia, which was in a corn-soybean rotation before this study. Each field is sprinkler-irrigated. All P and K fertilizer, corn variety selection, herbicide application, and water management were determined by individual producers and were typical for these areas.

Plots at each field site were arranged in a randomized complete-block design (RCBD), with four blocks of six N treatments. Nitrogen was surface applied as NH_4NO_3; treatments included 270 lb N/a applied pre-plant; 220 lb N/a applied pre-plant; 220 lb N/a applied pre-plant (½) and sidedress (½); 165 lb N/a applied pre-plant (⅓) and sidedress (⅔); 110 lb N/a applied pre-plant ($^1/_5$) and sidedress ($^2/_5$, $^2/_5$); and 0 lb N/a. Treatments were adjusted at Pretty Prairie and St. John to accommodate producer management practices, so that total N applied was similar to intended rates. St. John received 30 lb N/a applied as a starter at planting. Pretty Prairie East and West received 10 lb N/a applied as starter, as well as 45 and 60 lb N/a applied through the irrigation system, respectively. The N treatments at the Ellinwood site were duplicated for each of two irrigation treatments (optimal water rate and 25 % greater than optimal water rate). Plot locations were identical between years.

Three porous-cup tensiometers and one solution sampler were installed at Ellinwood in each replication of the four highest-N treatments. Tensiometers were placed at depths of 12, 54, and 64 inches and solution samplers were placed at 60 inches. Irrigation and rainfall were measured with 8 non-evaporative rain gauges in each irrigation treatment and 1 rain gauge at the field edge (outside the sprinkler range). Tensiometer measurements were collected at 7- to10-day intervals during the growing season, and soil solution was collected every 10 to 14 days.

Water flux at Ellinwood was determined by using a drainage plot located centrally to the entire plot area. A 15’ x 15’ area was flooded to obtain saturated flow throughout the soil profile. As the soil profile drained, water tension and water content (using neutron probes) were monitored. Change in water content in the drainage plot was used to determine hydraulic conductivity as a function of water tension. This relationship was then used to determine water flux in the plot area.

Soil samples were collected three times during the study year for NO_3-N analysis. Samples were collected at planting and after harvest to a depth of 96 inches, in 6-inch increments. At Ellinwood, two cores were collected and combined in each plot by using a hydraulic probe with a 2-inch i.d. core. At the other sites, pre-plant soil samples were collected only from the highest (270 lb N/a) and the control (0 lb N/a) treatments. Soil samples were collected before fertilizer application at the V-6 to V-8 growth stage to a 24-inch depth, in 6-inch increments. Six 1-inch cores were taken in each plot at all sites. After-harvest soil samples consisted of one 1-inch i.d. core taken from each plot at all sites except Ellinwood. All soil samples were dried at 50^o C and ground to pass a 2-mm sieve. Soil NO_3-N was determined by flow injection analysis of 1 *M* KCl extracts.

Grain yield was determined by hand harvesting a 20’ length of each of the middle two rows from each plot. The middle two rows of each plot at Rossville were harvested with a combine modified for plot work.

Statistical analyses were performed according to General Linear Procedures. F-tests for analyses of variances were considered significant at the 0.10 probability level. PROC GLM was used to analyze treatment differences in grain yield, soil water NO_3-N concentrations, and post-harvest soil NO_3-N concentrations.

Results

A split application of 165 lb N/a was sufficient to achieve maximum corn yield at every location (Fig. 1), and, in some instances, a split application of 110 lb N/a was sufficient. Optimum N rates observed in this study were generally less than corresponding N recommendation from

Kansas State University (KSU). Using KSU's (2003) formula for each location produced N recommendations that ranged between 160 and 290 lb N/a. The difference between these recommendations and actual performance ranged from near optimum to 125 lb N/a in excess of that required to achieve maximum grain yield. Although split applications may provide some measure of N use efficiency not accounted for in KSU's formula, a single pre-plant application of 220 lb N/a, 60 lb N/a less than the maximum recommendation, was sufficient to achieve maximum corn yield on these irrigated sands.

Soil water NO_3-N concentration (150-cm depth) early in the growing season at Ellinwood ranged from 37 to 53 ppm N in 2001 and from 13 to 20 ppm N in 2002 (Fig. 2). As early as June 26, 2001, however,

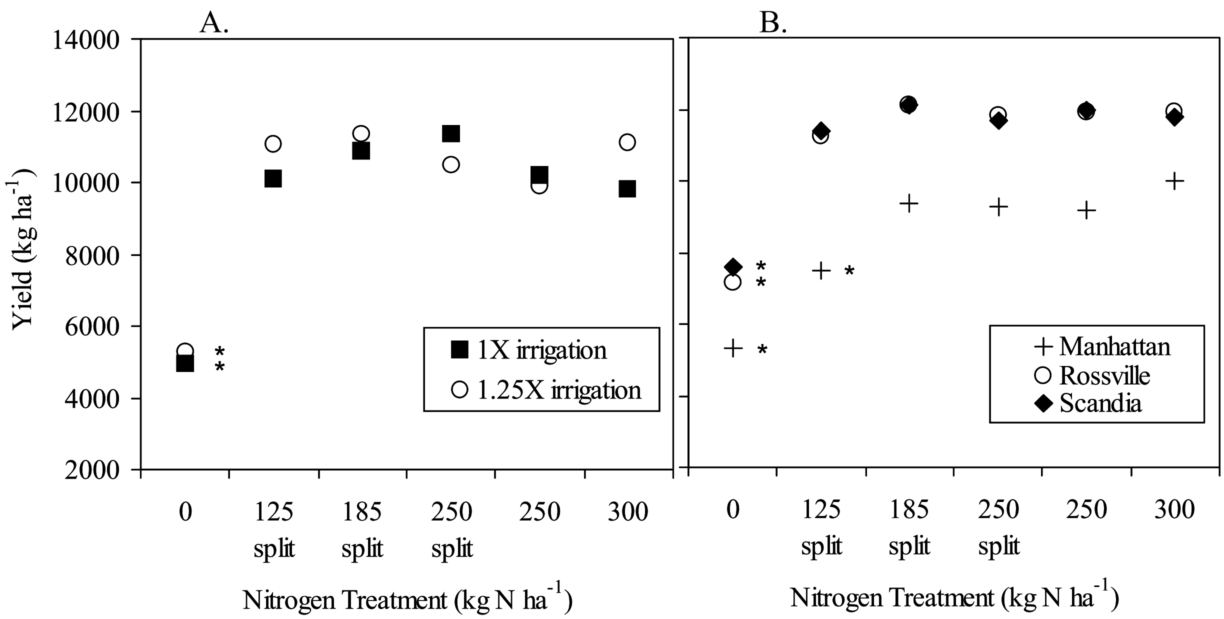

Figure 1. Average grain-yield (2001 and 2002) response to N treatments for two irrigation treatments at Ellinwood (A) and at Manhattan, Rossville, and Scandia (B). * indicates that yield for an N treatment is significantly less than the next adjacent treatment (to the right).

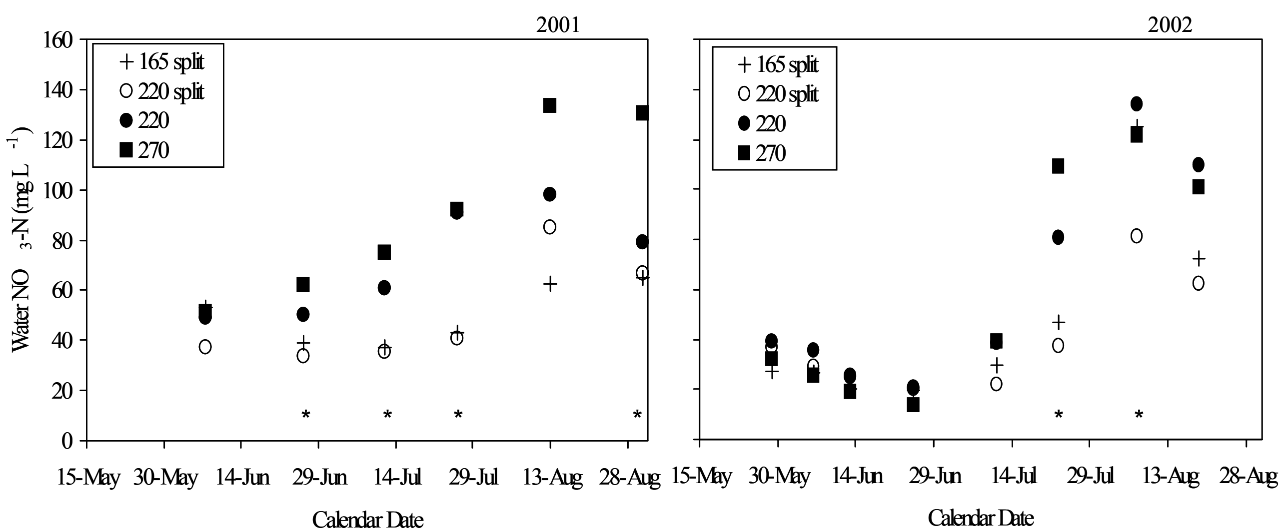

Figure 2. Water NO_3-N concentration at the 150-cm depth at Ellinwood. * indicates a significant N treatment effect on a specific sampling date.

there was a significant difference in water NO_3-N concentration among N treatments. Single pre-plant N applications resulted in consistently greater NO_3-N concentration at the 60-inch depth, compared with split N applications. This trend was consistent throughout the growing season in both years; by late July and early August, NO_3-N concentrations were exceeding 100 ppm N for the single pre-plant N applications.

Alhough the water NO_3-N concentration with the 1.25 X irrigation treatment was generally greater than with the 1.0 X irrigation treatment, averaging 23 and 13 ppm greater across all sampling dates in 2001 and 2002, respectively, the results depicted in Fig. 3 illustrate the most dramatic interaction observed between the N and irrigation treatments. With 25 % more irrigation water, the water NO_3-N concentration (60-cm depth) was 3 to 4 times greater for the single pre-plant N applications, reaching almost 200 ppm N. Increasing soil water NO_3-N concentrations down the soil profile, as a result of additional water and the single pre-plant N applications, translates to greater potential for NO_3 leaching during the growing season.

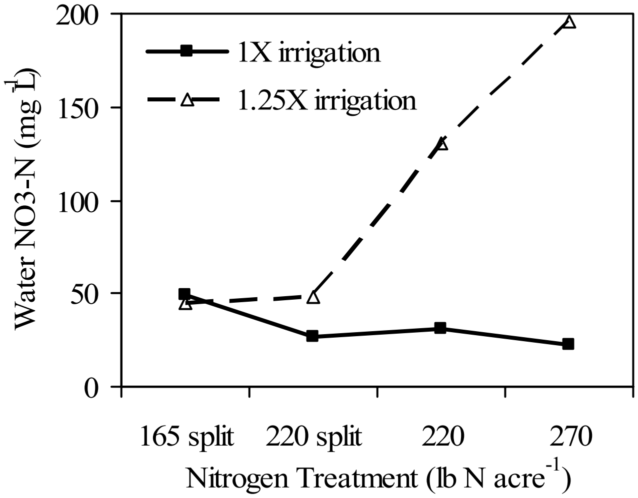

Figure 3. Water NO_3-N concentration at the 60-inch depth on July 23, 2002 at Ellinwood. The irrigation by N treatment interaction was significant.

Irrigation amounts at Ellinwood for the 1.25 X and 1.0 X irrigation treatments were 12.2 and 9.4 inches (2001) and 9.0 and 7.5 inches (2002), respectively. An additional 11.8 and 7.9 inches of rainfall occurred in 2001 and 2002, respectively. Average water flux during the growing season for each irrigation treatment was always in the downward direction (Fig. 4).

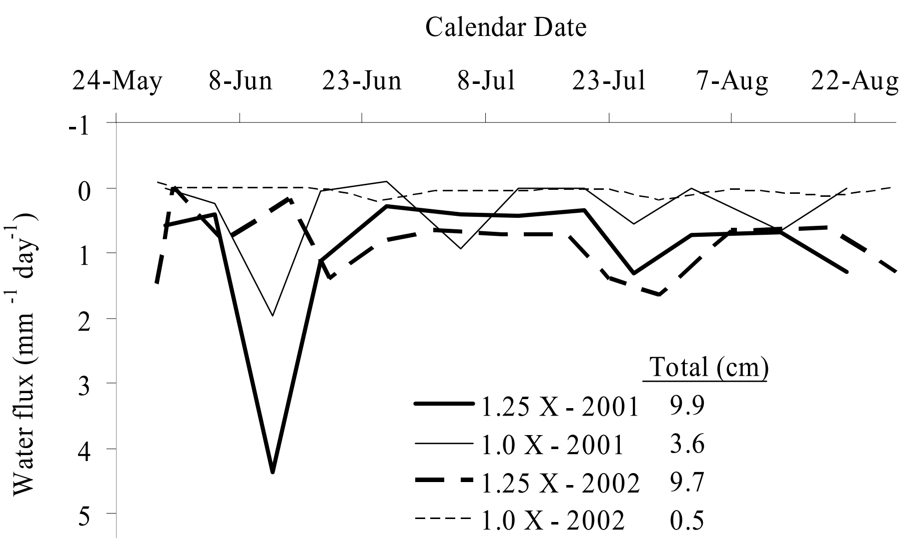

Figure 4. Water flux at the 60-inch depth, Ellinwood site.

Although generally less than 1.5 mm d^{-1}, after two consecutive early-season rainfalls (2.2 and 1.6 inches) within a week in 2001, the water flux spiked to greater than 4.0 mm d^{-1}. Total drainage with the 1.25 X irrigation treatment exceeded drainage in the 1.0 X treatment by 2.5 and 3.6 inches in 2001 and 2002, respectively. Despite receiving considerably less water during 2002, yield was the same or slightly greater than in 2001. The additional water did not increase grain yield on this Pratt loamy fine sand, but resulted in additional water drainage.

When N fertilizer was applied in excess of that required for maximum grain yield (Fig. 1) at Ellinwood, and as a single application before planting, soil water NO_3-N concentrations (60-inch depth) increased substantially (Fig. 2). Water flux at the 60-inch depth was continually in the downward direction throughout the growing season, and when slightly more water was applied (Fig. 4), total N flux at the 60-inch depth was exacerbated (Fig. 5). The 1.25 X irrigation treatments resulted in the greatest NO_3-N fluxes in both years, always exceeding 35 lb N/a. Nitrate-N fluxes were equal to or exceeded 90 lb N/a when N was applied pre-plant and at rates more than required for maximum yield. Although the 1.0 X irrigation treatment resulted in NO_3-N fluxes less than 20 lb N/a, regardless of N treatment, these results reflect observations recorded only during the growing season. Nitrate-N remaining in the soil as a result of N rates in excess of crop requirements will be susceptible to leaching as illustrated here for the 1.25 X irrigation treatment.

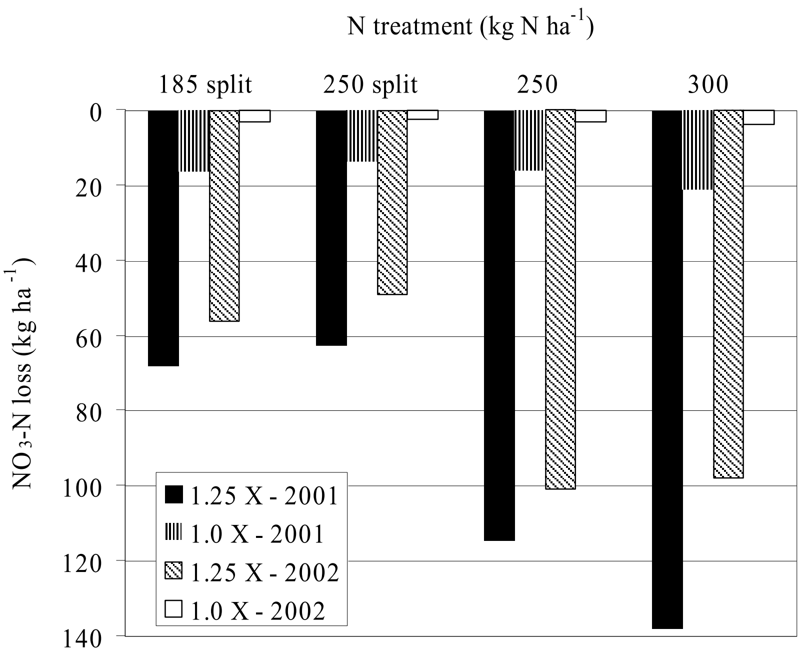

Figure 5. Total NO_3-N flux at the 60-inch depth during the growing season. Determined by multiplying NO_3-N concentration by average water flux between sampling dates.

SOUTH CENTRAL KANSAS EXPERIMENT FIELD

Hutchinson

Introduction

The South Central Kansas Experiment Field was established in 1951 on the US Coast Guard Radio Receiving Station located southwest of Hutchinson. The first research data were collected with the harvest of 1952. Before 1952, data for the South Central area of Kansas were collected at three locations (Kingman, Wichita, 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 by using sound environmental practices. The principal objective is achieved through investigations of fertilizer use, weed and insect control, tillage methods, seeding techniques, cover crop and crop rotation, variety improvement, and selection of hybrids and varieties adapted to the area.

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

Soil Description

A new soil survey was completed for Reno County and has renamed some of the soils on the Field. The new survey overlooks some of the soil types present in the older survey, and it is believed that the descriptions of the soils 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 Counties. 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.

2002/2003 Weather Information

From 1997 to 2000, precipitation was above average. In 2001, a below-normal amount of precipitation was recorded at the Field. The precipitation for 2002 was slightly (0.946 inches) above normal. The U.S. Department of Commerce National Oceanic and Atmospheric Administration National Weather Service rain gauge (Hutchinson 10 S.W. 14-3930-8) collected 28.94 inches of precipitation in 2003, 1.06 inches less than the 30-year (most recent) average of 30.0 inches. It should be noted, however, that the average has been increasing in the past few years.

As with all years, distribution is the determining factor in the usefulness of the precipitation. Six months–February, March, April, August, October, and December–received above normal precipitation: 0.41, 1.75, 0.64, 2.06, 1.14 and 0.47 inches respectively. The August precipitation came at two times, the first two days and the last three days of the month. The March rain also came during a three-day period. Because of timing of the spring rains and cool temperatures, the wheat crop did well. This was not the true for the summer crops, however, as can be seen in Table 1.

A frost-free growing season of 183 days (April 17 to October 16, 2003) was recorded, one day more than the average frost-free season of 182 days (April 19 to October 17).

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

Month	Rainfall (inches)	30-yr avg* (inches)	Month	Rainfall (inches)	30-yr avg (inches)
2002			April	3.55	2.91
September	0.83	3.04	May	3.50	4.15
October	6.22	2.34	June	3.21	4.10
November	0.38	1.47	July	0.50	3.44
December	0.68	1.00	August	5.15	3.09
2003			September	1.83	3.00
January	0.04	0.75	October	3.65	2.51
February	1.51	1.10	November	0.05	1.39
March	4.51	2.76	December	1.44	0.97
			2003 Total	28.94	30.00

* Most recent 30 years.

CROP PERFORMANCE TESTS AT THE SOUTH CENTRAL FIELD

William F. Heer and Kraig 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. Results of these tests can be found in the following publications, which are available at the local county extension office or online at http://www.ksu.edu/kscpt.

2003 Kansas Performance Tests with Winter Wheat Varieties. KAES Report of Progress 912.
2003 National Winter Canola Variety Trial. KAES Report of Progress 924.
2003 Kansas Performance Tests with Grain Sorghum Hybrids. KAES Report of Progress 915.
2003 Kansas Performance Tests with Sunflower Hybrids. KAES Report of Progress 922 .
2003 Kansas Performance Tests with Alfalfa Varieties. KAES Report of Progress 918.

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

William F. Heer

Summary

The predominant cropping systems in South Central Kansas have been continuous wheat and wheat-grain sorghum-fallow. With continuous wheat, tillage is preformed to control diseases and weeds. In the wheat-sorghum-fallow system, only two crops are produced every three years. Other crops (corn, soybean, sunflower, winter cover crops, and canola) can be placed in these cropping systems.

To determine how winter-wheat (and alternative-crop) yields are affected by these alternative cropping systems, winter wheat was planted in rotations following the alternative crops. Yields were compared with yields of continuous winter wheat under conventional (CT) and no-till (NT) practices. Initially, the CT continuous wheat yields were greater than those from the other systems.

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

Cropping systems with winter wheat following several alternative crops would provide improved weed control through additional herbicide options and provide reduced disease incidence by interrupting disease cycles, as well as allow producers several options under the 1995 Farm Bill. But the fertilizer nitrogen (N) requirement for many crops is often greater under NT than 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 rotation (established in 1990) has winter wheat following soybeans. 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 five times in a randomized block design with a split-plot arrangement. The main plot was crop, and the subplot was six N levels (0, 25, 50, 75, 100, and 125 lbs/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 are 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. The conventional tillage treatments are plowed immediately after harvest, then worked with a disk as necessary to control weed growth. The fertilizer is applied with a Barber metered screw spreader before the last tillage (field cultivation) on the CT and before seeding of the NT plots. The plots are cross-seeded in mid-October to winter wheat. Because of an infestation of cheat in the 1993 crop, the plots were planted to oats in the spring of 1994. The fertility rates were maintained, and the oats were harvested in July. Winter wheat has been planted in the plots in mid-October each year since the fall of 1994. New herbicides have aided in the control of cheat in the no-till treatments.

Wheat after Corn/Grain Sorghum Fallow

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

Wheat after Soybean

Winter wheat is planted after the soybeans have 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 is 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 delayed 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 Rotation

Winter wheat is planted into stubble of grain sorghum harvested the previous fall. Thus, the soil 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 lbs/a with the Barber metered screw spreader in the same manner as for the continuous wheat.

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

Results

Continuous Wheat

Grain yield data from the plots for continuous winter wheat are summarized by tillage and N rate in Table 3. Data for years before 1996 can be found in Field Research 2000, KAES Report of Progress 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 smaller grain-yield differences between the conventional and no-till treatments within N rates. Conditions in the springs of 1998 and 1999 were excellent for grain filling in wheat, but the differences in yield between conventional and no-till wheat still expressed themselves (Table 2). In 2000, the differences were larger up to the 100 lb/a N rate. At that point, the differences were similar to those of previous years. The wet winter and late spring of 2002/2003 harvest year allowed for excellent tillering and grain fill and yields.

Wheat after Soybean

Wheat yields after soybeans 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 the N rates between 0 and 75 lb in 1993 and between 0 and 125 lb in 1994 (Table 3). Yields in 1995 reflect the added N from the previous soybean crop, with yield by N-rate increases similar to those of 1994. The 1996 yields for spring wheat reflect the lack of response to nitrogen fertilizer for the spring wheat. Yields for 1997 and 1998 both show the yield 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 soybeans to express the differences in N rate up to the 100 lb N/ac rate. In the past, those differences stopped at the 75 lb N/ac treatment. When compared with the yields in the continuous wheat, the rotational wheat is starting to reflect the presence of the third crop (grain sorghum) in the rotation. Wheat yields were less in 2000 than in 1999. This is attributed to the lack of timely moisture in April and May and the hot days at the end of May. This heat caused the plants to mature early and also caused low test weights. In 2003, there seemed to be more cheat in the plots, and this affected the yields in Table 3. But the yields were much better than that of continuous wheat, no-till or conventional. 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 lbs/a where wheat follows soybeans.

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 wheat yields from 1997 to 2003 are in Table 4. During these four years, there does not seem to be a definite effect of the cover crop (CC) on yield. This is most likely due to the variance in CC growth within a given year. In years like 1998 and 1999 , in which sufficient moisture and warm winter temperatures produced good CC growth, the additional N from the CC seems to carry through to the wheat yields. With the fallow period after the sorghum in this rotation, the wheat crop has a moisture advantage over the wheat after soybeans. Cheat was the limiting factor in this rotation. More aggressive herbicide control of cheat in the cover crops has been started. This rotation has also resulted in an infestation of cheat grass. Management of the grasses in the cover crops seems to be the key factor in controlling the cheat grass.

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 soybeans. Corn will have the potential to produce grain in favorable years (cool and moist) and produce silage in unfavorable (hot and dry) years. In extremely dry summers, extremely poor grain sorghum yields can occur. The major weed-control problem in the wheat-after-corn system is grasses. This was expected, and work is being done to determine the best herbicides and time of application to control grasses.

Soybean and Grain Sorghum In Rotations

Soybeans were added to intensify the cropping system in the South Central area of Kansas. They also have the ability, being a legume, to add nitrogen to the soil system. For this reason, the 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 use the added N and the yields for the crop can be compared with yields in other production systems. Yield data for the soybeans following grain sorghum in the rotation are given in Table 5. The soybean yields are more affected by the weather for the given year than by the previous crop. In three out of the five years, there was no yield difference for different N rates applied to the wheat and grain sorghum crops in the rotation. In the two years that N application rate did affect yield, it was only at the lesser N rates. This is a similar effect that is seen in a given crop. The yield data for the grain sorghum after wheat in the soybean-wheat-grain sorghum rotation are in Table 6. As with the soybeans, weather is the main factor affecting yield. The addition of a cash crop (soybeans), thus intensifying the rotation (cropping system), will reduce the yield of grain sorghum in the rotation; compare soybean-wheat-grain sorghum vs. wheat-cover crop-grain sorghum in Tables 6 and 7. More uniform yields are obtained in the soybean-wheat-grain sorghum rotation (Table 6) than in the wheat-cover crop-grain sorghum rotation (Table 7).

It is hoped that these rotations will be continued after Field personnel are removed from the Field and it becomes a satellite Field. Other systems studies at the Field are a wheat-cover crop (winter pea)-grain sorghum rotation with N rates (data presented in Report of Progress 854, 2000) and a date-of-planting, date-of-termination cover-crop rotation with small grains (oat) and grain sorghum.

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

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

[1] Nitrogen rate in lb/a.
[2] CT conventional; NT no-tillage.
* 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 3. Wheat yields after soybeans in a soybean-wheat-grain sorghum rotation, Hutchinson, Kansas.

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

[1]Spring wheat yields.
[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 after grain sorghum in a wheat-cover crop-grain sorghum rotation, Hutchinson, Kansas.

	Yield						
Treatment	1997	1998	1999	2000	2001	2002[1]	2003
	bu/a						
0 lb/a N	17	25	26	4	45	10	9
Hairy vetch	43	50	39	16	45	10	5
50 lb/a N	59	52	50	21	41	8	4
Winter pea	43	51	66	21	41	9	8
100 lb/a N	52	56	69	26	39	5	5
Sweet clover	53	54	70	22	42	6	6
LSD*$_{(0.01)}$	21	12	5	5	5	3	NS
CV $_{(\%)}$	26	14	6	16	6	20	70

[1]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 5. Soybean yields after grain sorghum in soybean-wheat-grain sorghum rotation, Hutchinson, Kansas.

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

[1]N rates are not applied to the soybean plots in the rotation.
* 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, Hutchinson, Kansas.

	Yield							
N Rate	1996	1997	1998	1999	2000	2001	2002	2003
lb/a	bu/a							
0	32	13	57	52	55	15	34	10
25	76	29	63	67	56	15	41	10
50	93	40	61	82	54	13	43	9
75	107	41	60	84	49	9	43	8
100	106	65	55	77	50	7	46	8
125	101	54	55	82	49	7	47	9
$LSD^{*}_{(0.01)}$	8	13	NS	13	NS	NS	8	NS
$CV_{(\%)}$	5	18	10	9	10	58	11	24

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

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

	Yield							
Treatment	1996	1997	1998	1999	2000	2001	2002[1]	2003
	bu/a							
0 lb/a N	73	26	69	81	68	17	22	21
Hairy vetch	99	36	70	106	54	17	21	16
50 lb/a N	111	52	73	109	66	13	25	15
Winter pea	93	35	72	95	51	19	23	17
100 lb/a N	109	54	67	103	45	12	25	14
Sweet clover	94	21	72	92	51	19	19	19
$LSD^{*}_{(0.01)}$	13	14	NS	21	16	6	NS	5
$CV_{(\%)}$	8	22	13	12	16	21	20	22

[2]Yields affected by hot, dry conditions in July and by bird damage.

* 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.

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

William F. Heer and Rhonda R. Janke

Summary

Effects of the cover crop most likely were not expressed in the first year (1996) grain-sorghum harvest (Table 8). Limited growth of the cover crop (winter peas), due to weather conditions, produced limited amounts of organic nitrogen. Therefore, effects of the cover crop were limited and varied when compared with fertilizer nitrogen (N). The winter pea plots were planted after the wheat crop for 1998 was harvested in June, and were terminated the following spring. The N rate treatments were applied and the grain sorghum was planted on June 11, 1999. Winter wheat was again planted on the plots in October of 2000 and was harvested in June of 2001. Winter peas were planted in September of 2001 and were terminated in April and May of 2002. Grain sorghum was planted in June and harvested in October, 2002. In 2003, this area was in sorghum fallow, and plots were fertilized and planted to wheat in October of 2003 for harvest in 2004.

Introduction

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

Procedures

The research is being conducted at the KSU Research and Extension South Central Experiment Field, Hutchinson. The soil in the experimental area was an Ost loam. The site had been in wheat before starting the cover-crop cropping system. The research used a randomized block design and was replicated four times. Cover-crop treatments consisted of fall-planted winter peas with projected termination dates in April and May, and no cover crop (fallow). The winter peas are planted into wheat stubble in early September at a rate of 35 lb/a in 10-inch rows with a double disk opener grain drill. Before termination of the cover crop, above-ground biomass samples are taken from a one-square-meter area. These samples are used to determine forage yield (winter pea and other) and forage nitrogen and phosphate content for the winter pea portion. Fertilizer treatments consist of four fertilizer N amounts (0, 30, 60, and 90 lb N/a). Nitrogen treatments are broadcast-applied as NH_4NO_3 (34-0-0) before planting of grain sorghum. Phosphate is applied at a rate of 40 lbs P_2O_5 in the row at planting. Grain sorghum plots are harvested to determine grain yield, moisture, test weight, and nitrogen and phosphate content. The sorghum plots are fallowed until the plot area is planted to wheat in the fall of the following year. The fertilizer treatments are also applied before planting of wheat. Wheat was planted in this rotation in October of 2003 for harvest in 2004.

Results

Winter Pea/Grain Sorghum

Winter pea cover crop and grain sorghum results were summarized in the Field Research 2000 Report of Progress 854, pages 139-142. Grain sorghum yields were similar to wheat yields in the long-term N rate study. The first increment of N resulted in the greatest change in yield. Yields tended to peak at the 60-lb N rate treatment regardless of presence, or lack of, winter peas. Grain sorghum yields for 2002 are presented in Table 8. These yields reflect the later planting date (June 22). The growing season in 2002 favored the later-planted summer crops. The crops emerged after the June 15 hail storm and were not as mature for the August wind storm; thus, they had less lodging and stock damage, resulting in less secondary tillering and sucker heads, and allowing the main head to fill and produce quality grain.

Winter Wheat

The fall of 2000 was wet, after a very hot, dry August and September. Thus, the planting of wheat was delayed until November 24, 2000. With the wet fall, the temperatures were also warm, allowing the wheat to tiller into late December. January and February both had above normal precipitation, which carried the wheat through a dry March. April, May, and June had slightly below normal precipitation and temperature. The wheat plots were harvested on June 29, 2001. Wheat yields reflect the presence of the winter pea treatments, as well as the reduced yields in the grain sorghum for the no-pea treatment plots. Test weight of the grain was not affected by pea or fertilizer treatment, but was affected by the rainfall at harvest time. This is also true for the percent nitrogen in the seed at harvest. A concern with the rotation is weed pressure. The April-termination pea plus 90 lbs/a N treatment had significantly more weeds in it than any of the other treatments. Except for this treatment, there were no differences noted for weed pressure. Grain yield data are presented in Table 8. With the earlier planting for 2004 crop, the wheat should have had a better chance to tiller, but the fall was wet and cold, limiting fall growth.

As this rotation continues and the soil system adjust, the true effects of the winter cover crop in the rotation should become clear. In the dry (normal) years, the soil water (precipitation) during the growing season most likely will not be as favorable as it was in 1999, and the water use by the cover crop will be the main influence on the yield of succeeding crop.

Table 8. Winter pea cover crop and termination-date effects on grain sorghum yield in a winter wheat-cover crop-sorghum rotation, Hutchinson Kansas.

		Flag Leaf		Grain								
Termination		1996		1996			1999			2002		
Date	N Rate[1]	N	P	N	P	Yield	N	P	Yield	N	P	Yield
	lb/a	- - - % - - -		- - - % - - -		bu/a	- - - % - - -		bu/a	- - - % - - -		bu/a
April[2] N/pea	0	2.5	0.38	1.6	0.26	86.5	1.1	0.32	72.6	1.5	0.38	78.4
	30	2.7	0.44	1.6	0.27	93.9	1.2	0.29	90.9	1.6	0.40	87.5
	60	2.8	0.43	1.7	0.27	82.6	1.5	0.32	106.4	1.8	0.40	82.8
	90	2.8	0.44	1.7	0.25	90.4	1.7	0.34	101.8	1.8	0.35	92.5
April[2] /pea	0	2.4	0.40	1.5	0.29	80.2	1.3	0.31	93.5	1.6	0.37	79.9
	30	2.7	0.39	1.6	0.26	85.7	1.3	0.32	97.4	1.7	0.38	91.1
	60	2.7	0.38	1.7	0.27	90.0	1.5	0.33	105.1	1.8	0.40	87.5
	90	2.9	0.41	1.8	0.23	83.8	1.8	0.32	97.9	2.0	0.37	77.2
May[3] N/pea	0	2.1	0.39	1.4	0.30	81.4	1.1	0.34	40.5	1.6	0.41	56.4
	30	2.4	0.39	1.5	0.28	88.1	1.1	0.32	66.6	1.7	0.40	71.6
	60	2.6	0.40	1.6	0.27	90.7	1.2	0.30	93.3	1.8	0.40	71.4
	90	2.6	0.40	1.6	0.26	89.6	1.4	0.31	105.9	1.9	0.40	82.6
May[3] /pea	0	2.3	0.40	1.4	0.29	85.0	1.2	0.31	92.4	1.7	0.39	74.8
	30	2.5	0.40	1.5	0.31	92.4	1.3	0.31	97.7	1.8	0.38	81.5
	60	2.6	0.38	1.6	0.26	92.9	1.5	0.30	112.3	1.9	0.36	86.8
	90	2.7	0.41	1.6	0.25	90.5	1.5	0.32	108.7	1.8	0.39	90.3
LSD (P=0.05)		0.2	0.02	0.1	NS	8.9	0.2	0.04	16.0	0.14	0.05	14.0

[1] Nitrogen applied as 34-0-0 after pea termination and before planting grain sorghum on June 17, 1996, June 11, 1999, and June 22, 2002.
[2] Early April termination. Actual termination May 16, 1996, April 21, 1999, and April 13, 2002.
[3] Early May termination. Actual termination June 4, 1996, May 19, 1999, and May 25, 2002 .

RESEARCH AT OTHER LOCATIONS

REDUCING THE IMPACT OF PHYTOPHTHORA ROOT ROT IN SOYBEANS

Scott Staggenborg, Gary Cross, and Chris Rost

Introduction

Fungi that live in the soil and infect plants during wet periods in the growing season cause Phytophthora root rot. Symptoms in seedlings will often appear as damping off, whereas older plants may turn yellow and have wilted leaves. Management practices to reduce the impact of the disease include planting varieties with improved resistance to the pest, the use of seed treatments and planting-time fungicides, and by improving drainage. The field selected in Doniphan County had exhibited serious phytophthera problems in previous years.

Procedures

To assess the impact of seed and planting treatments on Phytophthera root rot, a soybean variety that was susceptible to Phytophthera (Taylor 388, Taylor Seed Farm, White Cloud, KS) was planted May 20, 2002, and May 16, 2003. Four seed-applied fungicides and two soil-applied fungicide treatments were evaluated (Table 1). These treatments included: Ridomil (Syngenta) at two rates, ApronMaxx (Syngenta), ApronMaxx+ApronXl, Soyguard (Gustafson), and Soyguard+Allegiance. All plots were planted with a six-row John Deere 7200 MaxEmerge planter. Plots were 15 feet wide and 150 feet long in 2002 and 50 ft long in 2003. A randomized complete-block design was used, with 3 replications in 2002 and 4 replications in 2003. Soybean cyst nematodes (SCN) were present in 2002. To simultaneously assess the impact of seed treatments and SCN, a SCN-tolerant variety (TR374RR, Taylor Seed Farm, White Cloud, KS) was included in the study, both untreated and with the ApronMaxx + ApronXL treatment. Taylor 388, the soybean used in 2002 and in 2003 for the fungicide treatments, is SCN susceptible.

Approximately eight pounds of seed were used for each treatment. Seed lots were weighed and placed in plastic bags for the application of the seed treatments. Appropriate amounts of each treatment were placed in the bag with seed and gently mixed to provide uniform seed coverage. Seed lots were then placed on paper sacks until seed was completely dry.

Grain yield was determined by harvesting 20 feet of row out of each treatment in 2002. In 2003, the entire plot (6 rows wide and 50 ft long) was harvested with the producer's combine and weighed on an electronic balance. Grain yields were calculated and adjusted to 13% moisture. Analysis of variance was used to determine differences between treatments. In 2002 and 2003, to determine direct differences between the base seed-treatment fungicide (SoyGuard and ApronMax) and treatments with additional metalaxyl or mefenoxam (SoyGuard + Allegiance and ApronMax + ApronXL), single-degree-of-freedom contrasts were used. To determine the differences between the SCN tolerant and susceptible varieties in 2003, single-degree-of-freedom contrasts also were used.

Results

Below-average precipitation and above-average temperatures resulted in less than expected Phytophthera incidence in 2002 and 2003. No visual symptoms were observed in either year, compared with the previous years in this field and surrounding fields.

As a result of the low disease incidence in 2002, there were few differences in the treatments (Table 2). The only differences were between the ApronMaxx and ApronMaxx + ApronXL. The treatment with the additional ApronXL resulted in the highest-yielding treatment in 2002, but, this treatment was not different than the untreated control.

One interesting trend that will be tested again next year is that higher yields were achieved at the higher rates of either metalaxyl or mefenoxam. This is especially true when comparing the ApronMaxx with the ApronMaxx+ApronXL.

Similar results of fungicide treatments were found in 2003 (Table 3). There were differences, however, when the SCN-tolerant and -susceptible varieties are compared. The direct comparison of the two varieties indicated a 9.9-bushel advantage to the T374RR variety, compared with T388. Although the two varieties do not have identical genetics, they are of similar maturities.

Conclusions

Hot, dry conditions reduced the incidence of Phytophthera both years, and no treatment yields were different than the untreated control. In 2002, only two treatments were statistically different, ApronMaxx and ApronMaxx + ApronXL. The ApronMaxx + ApronXL produced the highest yields and illustrated a yield trend in the data. This trend was that yields were numerically higher at the higher rates of fungicides. Ridomil at 4 lb/a produced yields that were higher than Ridomil at 2 lb/a. Soyguard + Allegiance Fl produced yields that were numerically higher than Soyguard alone. These trends suggest that higher rates of metalaxyl or mefenoxam may produce higher yields.

In 2003, similar fungicide results were reported. At the low yields achieved, there were not differences between the untreated controls and any fungicide treatments. The difference between the SCN-tolerant and -susceptible varieties was approximately 10 bu/acre. These data suggest that SCN may be a serious problem in northeastern Kansas, and yield losses should be managed with a management program that includes SCN-resistant/tolerant soybean varieties.

Table 1. Fungicide treatments used in 2002 and 2003 in Doniphan County, Kansas, to assess the impact of planting time treatments on Phytophthera root rot.

Treatment	Active Ingredient	Rate of Formulated Material	Application Method
Ridomil Gold GR	Metalaxyl	2 lb/a	Soil Applied
Ridomil Gold GR	Metalaxyl	4 lb/a	Soil Applied
ApronMaxx	Mefenoxam + Fludioxonil	5 oz/cwt	Seed Treatment
ApronMaxx + ApronXL	Mefenoxam + Fludioxonil	5 oz/cwt + 0.55 oz cwt	Seed Treatment
Soyguard	Azoxystrobin + Metalaxyl	0.32 oz/cwt	Seed Treatment
Soyguard + Allegiance FL	Azoxystrobin + Metalaxyl	0.32 oz/cwt + 1.1 oz/cwt	Seed Treatment

Table 2. Soybean yields in Doniphan County, Kansas, in 2002 as a result of planting time fungicide applications.

Treatment	Rate	Application Method	Yield
			bu/a
Untreated	None	None	42.5 a[†]
Ridomil Gold GR	2 lb/a	Soil Applied	37.4 ab
Ridomil Gold GR	4 lb/a	Soil Applied	41.2 bc
ApronMaxx	5 oz/cwt	Seed Treatment	35.2 bc
ApronMaxx + ApronXL	5 oz/cwt + 0.55 oz/cwt	Seed Treatment	48.0 bc
Soyguard	0.32 oz/cwt	Seed Treatment	37.1 bc
Soyguard + Allegiance FL	0.32 oz/cwt + 1.1 oz/cwt	Seed Treatment	39.3. c
$LSD_{(0.05)}$			6.7

Contrasts for Metalaxyl or Mefenoxam	
SoyGuard vs. Apron Max	-1.9[ns]
Soyguard + Allegiance FL vs. ApronMaxx + ApronXL	8.7*

† Means followed by the same letter are not significantly different at the 0.10 level.

* indicates a significant difference at the 0.10 level

Table 3. Soybean yields in Doniphan County, Kansas, in 2003 as a result of planting time fungicide applications.

Treatment	Variety	Rate	Application Method	Yield
				bu/a
Untreated	388	None	None	23.5 bc
Ridomil Gold GR	388	2 lb/a	Soil Applied	24.6 bc
Ridomil Gold GR	388	4 lb/a	Soil Applied	24.8 bc
ApronMaxx	388	5 oz/cwt	Seed Treatment	26.0 bc
ApronMaxx + ApronXL	388	5 oz/cwt + 0.55 oz cwt	Seed Treatment	21.0 c
Soyguard	388	0.32 oz/cwt	Seed Treatment	21.0 c
Soyguard + Allegiance FL	388	0.32 oz/cwt + 1.1 oz/cwt	Seed Treatment	23.9 bc
Untreated	374RR	None	None	36.4 a
ApronMaxx + ApronXL	374RR	5 oz/cwt + 0.55 oz cwt	Seed Treatment	30.4 ab
$LSD_{(0.05)}$				8.0
Contrasts for Metalaxyl or Mefenoxam				
SoyGuard vs. ApronMax				1.6^{ns}
Soyguard + Allegiance FL vs. ApronMaxx + ApronXL				1.8^{ns}
Contrast for SCN				
SCN Susceptible vs. SCN Tolerant				9.9*

† Means followed by the same letter are not significantly different at the 0.10 level.

* indicates a significant difference at the 0.10 level.

EVALUATING TWIN-ROW CORN PLANTING SYSTEMS

Scott Staggenborg, W. Barney Gordon, and Larry Maddux

Summary

A study was conducted under dryland and irrigated conditions to evaluate three row-spacing configurations (30 in., 20 in., and twin row) at two plant densities. Low corn yields as a result of high temperature and drought stress resulted in few differences between the row spacings or the plant-density treatments at all five locations.

Introduction

Corn row spacing and configurations continue to be of interest in Kansas. The concept of twin row configurations recently has gained new interest as more precise seeding methods have been developed. Twin-row configuration consists of two rows planted close together (7.5 in.) and centered on a standard 30-in. spacing. This configuration allows for some row crop equipment to be used, especially standard corn harvesting equipment. Previous narrow-row corn research indicated that, in most parts of Kansas, row spacing narrower than 30 in. will not consistently increase corn yields.

Procedures

Three row-spacing configurations were tested under dryland at Manhattan, Kansas, on a Reading silt loam, at Belleville, Kansas, on a Crete silt loam, and at Powhattan, Kansas, on a Grundy silt loam and tested under irrigation at Scandia on a Crete Silt Loam and at Silver Lake, Kansas, on a Eudora silt loam. The row-spacing configurations consisted of 30 in., 20 in., and twin row. The twin-row configuration has two rows that are spaced 7.5 in. apart; each set of twin rows is spaced 30 in. apart. All plots were planted with John Deere 71-Flex planter units mounted on a two-bar planter. This configuration allowed for all possible row spacings to be planted in one pass through each plot by simply moving individual planter units to the appropriate location for each configuration. A randomized complete-block design with four replications was used at each location.

The corn hybrid Pioneer ‘35P12’ was used at all dryland locations, and corn hybrid Pioneer ‘33P67' was used at all irrigated locations. Plots were planted in Manhattan on June 8, 2003; at Belleville on April 15, 200; at Powhattan on May 13, 2003; at Scandia on April 23, 2003; and at Rossville on April 14, 2003. Plant populations of 24,000 and 28,000 plants/a were established at all dryland locations and 28,000 and 32,000 plants/a were established at the irrigated locations. All plots were over-planted and hand thinned to the desired population. Grain yield was determined by hand harvesting 30 row-feet from the center 5 feet of each plot.

Results

Corn yields were lower than expected in 2003 due to extreme heat and dry conditions throughout late June and the entire month of July. Corn yields averaged less than 100 bu/a at all dryland locations and, as a result, no differences between row spacings were found. Problems with the irrigation system at Silver Lake and with the planter at Scandia resulted in no useful data being collected at either site in 2003.

Table 1. Corn yields for three row configurations and two plant populations at three dryland and two irrigated locations in 2003.

		Location				
Row Spacing	Target Population	Manhattan	Belleville	Powhattan	Scandia	Silver Lake
		bu/a				
30 in.	High	57.0	72.3	80.2	–*	125.3
20 in.	High	57.0	65.0	81.2	197.5	129.2
Twin-row	High	55.1	51.1	84.7	203.8	123.9
30 in.	Low	57.3	38.4	84.8	--	113.9
20 in.	Low	57.3	57.6	85.1	190.9	126.7
Twin-row	Low	56.7	67.7	82.0	189.1	123.5
LSD(0.05)		NS	NS	NS	NS	NS
Population						
Low		57.1	54.6	84.0	190.0	121.4
High		56.4	62.8	82.3	200.7	126.1
LSD(0.05)		NS	NS	NS	NS	NS
Row Spacing						
30 in.		57.2	55.3	82.7	--	119.6
20 in.		57.1	61.3	83.2	194.2	128.0
Twin-row		55.9	59.4	83.3	196.5	123.7
LSD(0.05)		NS	NS	NS	NS	NS

*Planter malfuncation resulted in low stand establishment for 30-in. rows.

EVALUATING TWIN-ROW GRAIN SORGHUM PLANTING SYSTEMS

Scott Staggenborg and Larry Maddux

Summary

A study was conducted under dryland conditions to evaluate three row-spacing configurations (30 in., 20 in., and twin row) at two plant densities. Low sorghum yields as a result of high temperature and drought stress resulted in the lower yields in the twin rows, compared with the 30-in. and 20-in. rows. Panicles a^{-1} and panicle $plant^{-1}$ were determining factors in yields.

Introduction

Grain sorghum row spacings are often of interest as ways to improve yields within a given management system. The concept of twin row configurations recently has gained new interest as more precise seeding methods have been developed. Twin-row configuration consists of two rows planted close together (7.5 in.) and centered on a standard 30-in. spacing. This configuration allows for some row crop harvesting equipment to be used.

Procedures

Three row-spacing configurations were tested under dryland conditions at Powhattan, Kansas, on a Grundy silt loam. The row-spacing configurations consisted of 30 in., 20 in., and twin row. The twin row configuration has two rows that are spaced 7.5 in. apart; each set of twin rows are spaced 30 in. apart. All plots were planted with John Deere 71-Flex planter units mounted on a two-bar planter. This configuration allowed for all possible row spacings to be planted in one pass through each plot by simply moving individual planter units to the appropriate location for each configuration. A randomized complete-block design with four replications was used at each location.

Plots were planted at Powhattan on May 13, 2003. Plant populations of 45,000 and 60,000 plants a^{-1} were established. Grain yield was determined by hand-harvesting 30 row-feet from the center 5 feet of each plot.

Results

Grain sorghum yields were lower than expected in 2003 due to extreme heat and dry conditions in throughout late July and August. Yields averaged 50 bu $acre^{-1}$. The twin rows resulted in lower yields than the 30- or 20-in. rows. Panicles a^{-1} and panicles $plant^{-1}$ followed a trend similar to that of grain yields.

Table 1. Yield, plant density, and panicle number for three row configurations and two plant-population treatments at Powhattan, Kansas, in 2003.

Row Spacing	Target Population	Yield	Plant Population	Panicle Number	
		bu a^{-1}	Plants a^{-1}	Panicle a^{-1}	Panicle $plant^{-1}$
30 in.	High	54.3	58,588	59,024	1.0
20 in.	High	49.5	50,312	71,438	1.4
Twin-row	High	38.4	74,052	67,591	0.9
30 in.	Low	59.9	44,867	50,312	1.1
20 in.	Low	49.3	44,322	57,935	1.6
Twin-row	Low	46.5	47,698	52,780	1.1
Prob > F		0.78	0.37	0.77	0.96
$LSD_{(0.10)}$		NS	NS	NS	NS
Population					
Low		51.9	45,629	53,676	1.3
High		47.4	60,984	66,018	1.1
Prob > F		0.38	0.03	0.03	0.28
$LSD_{(0.10)}$		NS	13,426	7577	NS
Row Spacing					
30 in.		57.1	51,728	54,668	1.1
20 in.		49.4	47,317	64,687	1.5
Twin-row		42.5	60,875	60,185	1.0
Prob > F		0.08	0.28	0.10	0.02
$LSD_{(0.10)}$		10.6	NS	7632	0.35

NO-TILL SOYBEAN DRILL EVALUATION

Randal K. Taylor and Scott A. Staggenborg

Summary

Recommended seeding rates for drilled soybeans are typically greater than those for planted soybeans, which was not a major concern until the recent introduction of genetically modified seed caused an increase in seed cost. Furthermore, most of the research that contributed to these recommendations was developed in conventional or minimum-tillage cropping systems. This study was conducted to evaluate the soybean-seeding performance of three commercially available no-till drills relative to a row-crop planter operated by cooperating farmers. Results from the one-year study indicate that the seeding performance, as measured by emergence percentage and emergence rate index, of current model no-till drills is generally similar to that of farmer-operated row-crop planters.

Introduction

Establishing a uniform stand of soybeans has long been a goal for soybean growers. Selecting and operating the seeding device is paramount for success. Many researchers have evaluated the effect of row spacing and seeding rates on crop yields. The effect of these two items is environmentally sensitive, but it is also interactive.

Recommended seeding rates for drilled soybeans are typically 15% greater than those for soybeans planted in 30-in. rows in the same environment. The question that remains is whether the greater seeding rate is necessary to take advantage of the narrower row spacing or to account for lesser emergence. At the time of this research, it was expected that soybean emergence percentages on average would be 75 to 80% when planted with a drill into a conventionally tilled soil.

The objective of this study was to evaluate the in-field performance of no-till drills as measured by emergence percentage and emergence rate index.

Procedures

Soybeans were planted into standing residue from the previous crop on five fields in northeastern Kansas during the 2003 growing season. Intended seeding rates, planting date, previous crop residue, variety, and control seeder differed among the fields and are shown in Table 1. The locations and range of planting dates was intended to provide some variation in emergence conditions. The seeders evaluated were the control treatment, which consisted of the cooperating producer's row-crop planter, and three no-till drills (John Deere 1590, Great Plains 1510P, and Sunflower 9412). The control treatment seeders had differing widths, but all had rows spaced at 30 inches. The three no-till drills were 15 feet wide and had openers on 7.5-in. spacings. The treatments consisted of the control, each of the three drills on 7.5-in. spacing, and the Great Plains 1510P in a twin-row configuration. The twin-row configuration was achieved by blocking two adjacent rows while leaving the next two rows open and resulted in two rows that were 7.5 in. apart, with 22.5 inches to the next row. A Case-IH Soybean Special was included as a treatment at Field 1. This drill seeder consists of a row opening system similar to that of a row-crop planter and has a volumetric metering system. Row openers are on 15-in. row spacings.

A randomized complete-block design with four replications was used at each location. Plot sizes differed by field, but were generally 60 feet wide and at least 300 feet long. All field borders and features such as terraces and waterways were georeferenced with a differentially corrected GPS receiver. Plot plans were created based on the field dimensions and features (figure 1). Consideration of harvest direction played a role in plot locations and plots were oriented with terraces at three fields. Each planter tractor was equipped with a DGPS and a method for logging position during planting. All fields were harvested with combines with yield mapping capabilities. Harvest platforms were 24 to 25 feet wide, therefore the plot width ensured at least one harvest pass through the plot would contain only grain from that plot.

Cooperator's Responsibilities

The growers were responsible for selecting varieties and seeding rates, and adjusting and operating their planters. The cooperating growers were also responsible for harvesting the plots and collecting yield monitor data. The industry cooperators were responsible for transporting their seeding unit to each location and adjusting and operating their seeder to the desired conditions. The university partners were responsible for experimental design, calibrating the seeders, collecting and analyzing data, and overall coordination of the study.

Equipment Calibration

The seeders equipped with seed-singulation metering systems (control planters and Great Plains 1510P) were calibrated according to settings from the manual and calibrations were verified by capturing seed for a specified number of drive-wheel revolutions. Because seed size differed by variety, the volumetric metering systems (Sunflower 9412 and John Deere 1590) were calibrated to meter as close to the desired seeding rate as possible. The calibration was accomplished by capturing the output from each seed cup while rotating the drive tire for 80 revolutions. To establish a baseline, this procedure was repeated at least three times after the desired seeding rate was achieved.

Emergence Evaluation

Two locations were staked in each plot immediately after planting at each field to conduct stand counts for a total of 8 locations per treatment per field. The configuration (number and length of rows) differed with each treatment and was intended to result in approximately the same number of seeds dropped. Four rows measuring 8 feet long were staked at each location with the drilled, 7.5-in. spacing plots. Fours rows measuring 4 feet long were staked in the paired row and 15-in. row spacing plots, and 2 rows measuring 4 feet long were staked in the control plots. The theoretical seed drop was determined from the calibration results and the row number.

After the crop was planted, each site was monitored until initial emergence. After initial emergence, stand counts were conducted daily at all locations within the field. Each row that was counted was considered a separate observation. An emergence percentage (EP) for each observation was calculated from the theoretical seed drop for each row.

The emergence rate index (ERI) was calculated for each plot according to the following equation, as an indication of how fast the crop emerged. For this experiment, the percentage of plants emerged was calculated from the final stand and not the theoretical seed dropped. Therefore the ERI only assesses the rate of emergence for the crop.

$$ERI = \sum_{n=1}^{x} \frac{EMG_n - EMG_{n-1}}{DAP_n}$$

where:

EMG is the percentage of plants emerged
DAP is days after planting
n is the day of the observation

Results

The actual seeding rates for the seeders differed at each location but were within 2 to 7% of the target seeding rate. The coefficient of variation among the metering cups for all drills with volumetric metering systems was well below the industry accepted standard of 15%.

The emergence percentage and emergence rate indices are shown for each seeder by field in Table 2. Emergence conditions were generally good across all locations, with average emergence percentage ranging from 73 to 94%. Seed was planted into good soil moisture at all locations, and rainfall after planting promoted good emergence. Although rainfall was not recorded, all fields received some rain within five days of planting.

The John Deere drill either had the greatest emergence percentage or the emergence percentage was not significantly different from that of the seeder with the greatest value at all locations. Emergence percentage for the Great Plains twin-row plot was not significantly different from that of the seeder with the greatest value at 3 of 5 fields. The emergence percentage for the farmer-operated planters was not significantly different than the seeder with the greatest value at 3 of 5 fields. Emergence percentage for the Sunflower drill was significantly less than that of the other seeders for Field 1. This difference was attributed to a mechanical difficulty encountered during planting that was not discovered until seeding was completed. The emergence percentage for the Sunflower drill was also significantly less than that of the other seeders at Field 3. This difference was primarily attributed to seeding depth. Each manufacturer's representative adjusted seeding depth to the desired target depth. Field observations indicated that the Sunflower drill was placing seed deeper than the other seeders were. The deeper seed placement likely caused the slower emergence as measured by the lower ERI for the Sunflower drill at Field 3.

The John Deere drill either had the greatest ERI or the ERI was not significantly different from the greatest at all fields. The Great Plains twin-row ERI was not significantly different than the seeder with the greatest ERI at 4 fields and the planter ERI was not significantly different than that of the seeder with the greatest ERI at 3 fields. A greater ERI indicates faster soybean emergence.

For each location, the seeding rate of the Great Plains twin-row and 7.5-in. configurations was the same; thus, the primary difference between the treatments was the within-row seed spacing. The twin-row configuration typically had greater emergence percentages and ERI at many locations, although not statistically significant. This may be attributed to the closer spaced seeds generating a collectively greater emergence force.

Soybean yield data are shown in Table 3 for the five fields. The average yield at fields ranged from 16 to 33 bu a^{-1}. The only location with a significant yield difference was Field 2, where the row-crop planter had significantly greater yield than all other treatments. Observations during the growing season showed that the control (30 in.) and twin-row treatments were slightly taller than the 7.5-in. rows were at Fields 2 and 3. These two treatments also had the greatest yield at these fields.

There was no consistent relationship between the two emergence measurements (EP and ERI) and crop yield. The significantly lower emergence percentage for the Sunflower drill at Fields 1 and 3 did not translate into lower yields. Although it was never significant, the Great Plains twin-row treatment always yielded more than the Great Plains 7.5-in. rows did.

Planters varied in configuration and age, but all were in good operating condition and adjusted per the farmer's (operator's) recommendation. The results from these operating conditions indicate that, when adjusted properly, no-till soybean drills can provide seeding results similar to those of row-crop planters. These results suggest that seeding rates should not be increased when soybeans are planted with no-till drills. Seeding-rate recommendations may need to be revisited to determine whether narrow rows need greater seeding rates. In the lower yielding environment of the 2003 growing season, however, improved stand establishment did not translate into higher yield.

Acknowledgments

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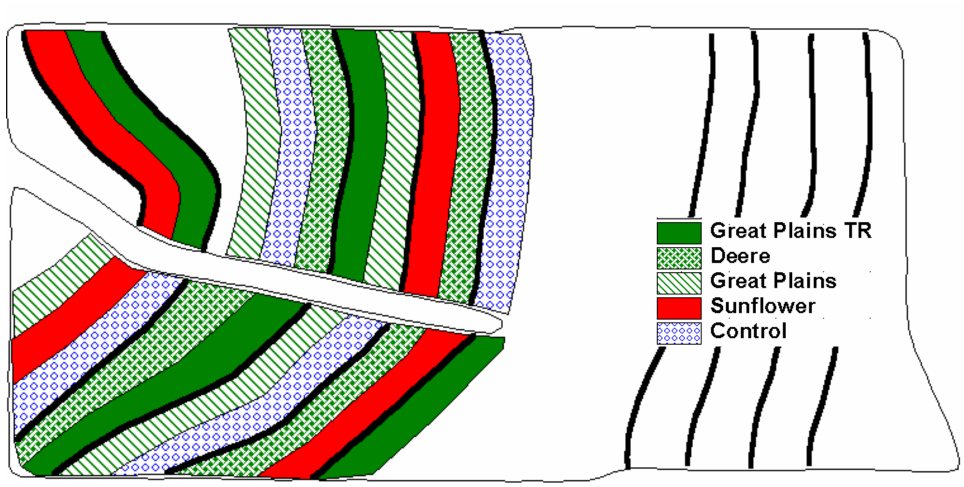

Figure 1. Typical plot layout for fields with terraces that were contour planted.

Plot polygons were redrawn in ArcView on the basis of the data logged from planter tractors. Buffers were created at 15 feet inside the plot polygons, and yield data were selected from the center of the plot. The yield monitor data from within this buffered polygon were averaged to obtain an average yield for each plot.

Table 1. Cropping decisions specific to each field.

Field	Previous Crop	Target Seeding Rate, (seeds/a)	Planting Date	Control Seeding Unit	Soybean Variety
1	Corn	160,000	May 14	Case-IH 955 12-row	Pioneer 93B72
2	Grain Sorghum	160,000	May 15	Case-IH 950 6-row	Midland 382NRR
3	Grain Sorghum	180,000	May 22	Kinze 2200 12-row	Asgrow AG3701
4	Grain Sorghum	120,000	May 28	Kinze 3600 16-row	Midland 382NRR
5	Grain Sorghum	130,000	May 28	John Deere 1770 16-row	Midland 391STS

Table 2. Emergence percentage (EP) and emergence rate index (ERI) by treatment and field.

	Field 1		Field 2		Field 3		Field 4		Field 5	
Seeder	EP	ERI	EP	ERI	EP	ERI	EP	ERI	EP	ERI
Deere	80.5 [a,b]	12.4 [a,b]	92.9	11.7 [a]	97.3 [a]	14.0 [a]	93.3 [a]	14.9	74.1 [a,b]	13.1 [a,b]
Great Plains										
7.5 in.	81.1 [a,b]	11.7 [b]	94.6	10.9 [b]	90.1 [a]	13.0 [b,c]	84.6 [b,c]	14.5	70.6 [c]	12.8 [b]
twin row	75.4 [b]	10.4 [c]	99.4	11.0 [a,b]	92.1 [a]	13.7 [a,b]	85.5 [b]	14.2	79.4 [a,b]	13.4 [a,b]
Sunflower	57.8 [c]	9.9 [c]	95.1	10.4 [b]	77.4 [b]	10.8 [d]	79.8 [c]	14.0	67.3 [c]	11.7 [c]
SBS	78.5 [a,b]	13.5 [a]								
Planter	82.8 [a]	13.2 [a]	87.4	10.2 [b]	93.4 [a]	12.9 [c]	86.0 [b]	16.1	71.8 [a,c]	13.8 [a]

* Values followed by the same letter within a column are not statistically different. A column with no letters indicates that no significant differences were found between treatments.

Table 3. Soybean yield by treatment and field.

Seeder	Field 1	Field 2	Field 3	Field 4	Field 5
Deere	21.2	15.5 [a]	14.4	20.5	33.0
Great Plains					
7.5 in.	21.5	14.7 [a]	14.5	21.8	31.8
twin row	27.5	16.1 [a]	17.3	22.0	32.6
Sunflower	23.5	15.4 [a]	16.3	21.6	32.8
SBS	22.2				
Planter	21.6	20.7 [b]	17.1	21.4	32.5

* Values followed by the same letter within a column are not statistically different. A column with no letters indicates that no significant differences were found between treatments.

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