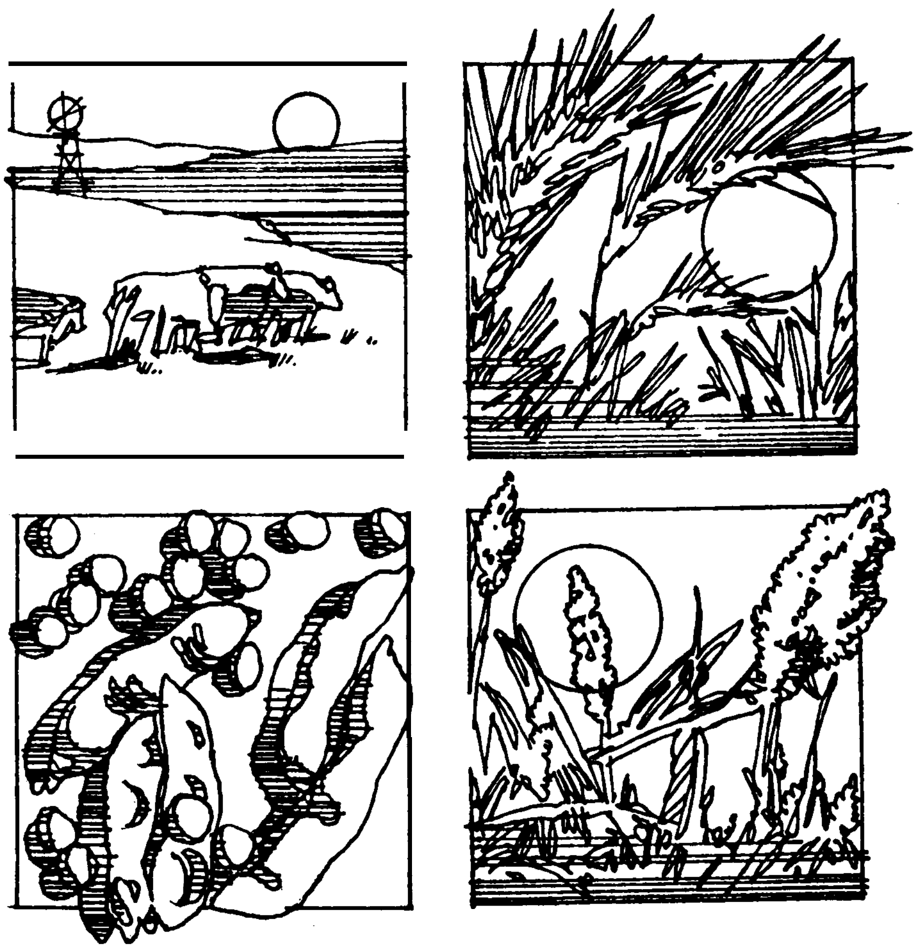
1990
AGRICULTURAL RESEARCH



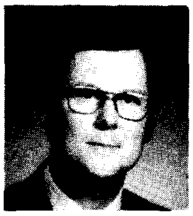
Report of Progress 599

Agricultural Experiment Station

Kansas State University, Manhattan

Walter R. Woods, Director

SOUTHEAST KANSAS BRANCH STATION



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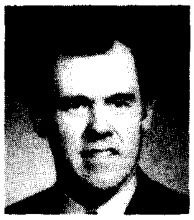

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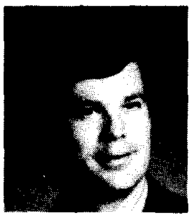

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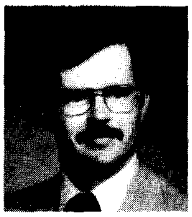

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Contribution No. 90-448-S from the Kansas Agricultural Experiment Station.

PERFORMANCE OF STEERS OFFERED SUPPLEMENTS CONTAINING DIFFERENT LEVELS OF CORN GLUTEN MEAL WHILE CONSUMING AMMONIATED WHEAT STRAW[1]

Kenneth P. Coffey, Joseph L. Moyer, and Lyle W. Lomas

Summary

Sixty crossbred steers having Limousin sires were offered ammoniated wheat straw ad libitum and 20% crude protein supplements at a level of 4 lb/head/day while grazing dormant tall fescue pastures in the winter. The supplements were formulated to provide either 0, 25, 50, or 70% of the supplemental crude protein from corn gluten meal (CGM). Ending weight and gain were affected (P<.10) by supplemental treatment. Both linear (P<.05) and quadratic effects (P<.10) described the gain response of steers offered increasing levels of CGM. Regression analysis produced an equation indicating that maximum gain would have been achieved with 20.7% of the supplemental protein supplied by CGM.

Introduction

Numerous studies have evaluated the use of protein sources such as corn gluten meal, feather meal, blood meal, fish meal, distillers grains, etc. These are classified as rumen by-pass protein sources because a large portion of their protein escapes degradation in the rumen. Performance of cattle is generally improved when these proteins are offered in combination with either non-protein nitrogen or rumen degradable protein. These situations promote adequate rumen activity and also provide dietary protein to the animal's small intestine. However, more information is needed to determine the specific situations in which rumen by-pass proteins would benefit performance and at what levels they should be supplied. This experiment was conducted to evaluate performance of steers grazing winter fescue pastures with ad libitum access to ammoniated wheat straw and offered 20% crude protein (CP) supplements with increasing proportions of the protein supplied by corn gluten meal.

Experimental Procedure

Sixty Limousin crossbred steers were randomly allotted by weight into four replicates of eight head and four replicates of seven head. The replicates were then randomly allotted to receive one of the four supplements shown in Table 1. The replicates were allotted to one of eight tall fescue - ladino clover pastures beginning on January 5, 1989. The pastures had previously been grazed until November and had limited forage availability. Ammoniated wheat straw was provided ad-libitum to each pasture replicate. All steers were offered 2 lb./head daily of a 20% crude protein supplement until February 7. Then the steers in each replicate were offered their respective supplement at a level of 4 lb./head daily until the termination of the study on March 22.

The supplements were formulated to contain 20% CP and were balanced for crude protein, energy, calcium, phosphorus, and vitamins A,D, and E. Either 0, 25, 50, or 70% of the supplemental protein was present as corn gluten meal.

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[1]Corn gluten meal was donated by Farmland Industries, Kansas City, KS.

Linear regression was used to regress CGM level on daily gain. The resulting regression equation was used to determine the level of corn gluten meal that would give a maximum rate of gain.

Results

Steers offered ration CGM-25 (25% of the supplemental protein from CGM) tended to be heavier than those offered the other rations. Both a linear ($P<.05$) and quadratic ($P<.10$) trend were observed for total and daily gain. The equation:

$$ADG = .2121 + .00706(CGM) - .000175(CGM)^2$$

Where

ADG = average daily gain
CGM = % of supplemental protein provided by corn gluten meal.

best described the response of cattle to increasing levels of CGM. A level of 20.7% of the supplemental protein provided by CGM was calculated to provide maximum gain.

In this study, providing greater than 25% of the supplemental protein from CGM resulted in decreased performance. However, providing 25 % of the supplemental protein from CGM tended to improve performance compared with the control diet. Therefore, providing a portion of the supplemental protein from rumen by-pass sources may enhance performance. However, caution should be used, because excess rumen by-pass protein may be detrimental to animal performance.

Table 1. Composition of Supplements Offered to Stocker Steers Consuming Winter Fescue Pasture and Ammoniated Wheat Straw.

Ingredient	Ration CGM-0	CGM-25	CGM-50	CGM-70
	lb/ton			
Ground grain sorghum	1273	1359	1451	1475
Cotton seed meal	678	421	157	-
Corn gluten meal	-	167	333	464
Ground limestone	32	28	26	22
Dicalcium phosphate	10	18	26	32
Vit A,D,E premix	7	7	7	7

Table 2. Performance and Consumption of Ammoniated Wheat Straw by Stocker Steers Offered Supplements Containing Increasing Levels of Corn Gluten Meal.

Item	Ration CGM-0	CGM-25	CGM-50	CGM-70
	Pounds			
Initial wt.	698	698	698	697
Final wt.	714	721	705	687
Total gain[ab]	16	23	7	-10
Daily gain[ab]	.21	.30	.10	-.14
Daily Straw Consumption	4.6	5.0	6.9	4.6

[a]Linear effect (P<.05).
[b]Quadratic effect (P<.10).

PERFORMANCE OF COW-CALF PAIRS OFFERED FEATHER MEAL[2]

Kenneth P. Coffey

Summary

Thirty-one fall-calving cow/calf pairs, and 12 replacement heifers were offered 5 lb/day of 20% crude protein supplements containing either soybean meal (SBM) or feather meal (FM) for 65 days. The FM supplement contained 4.8% feather meal and was formulated to provide 20% of the supplemental protein from FM. No significant differences were detected in cow, calf, or heifer performance between supplement groups. Therefore, although this study involved a small number of cows, it appears that feather meal may be used as a protein supplement in limited amounts without reducing animal performance. Considering the low cost per unit of protein of feather meal, this feed source offers the potential to reduce supplement costs.

Introduction

Feather meal is a high-protein by-product of the poultry processing industry made by processing feathers with high pressure and steam. Feather meal has approximately 85% crude protein and readily escapes degradation in the rumen. Protein sources that escape rumen degradation have been shown to improve cattle performance, if properly fed. Therefore, this study was conducted to evaluate feather meal in a supplement for cow/calf pairs and replacement heifers.

Experimental Procedure

Thirty-one crossbred fall-calving cows with calves and 12 crossbred replacement heifers were allotted randomly into two groups. Each group was placed on a separate 15-acre tall fescue pasture and received ad libitum access to fescue-bromegrass mixed hay. Cows and heifers were offered 5 lb/head/day of a supplement containing either soybean meal (SBM) or feather meal (FM) for 65 days beginning on January 20 (Table 1). The supplements were formulated to provide equal quantities of supplemental protein and energy. The FM supplement was formulated to provide 20% of the supplemental protein from feather meal. Response to supplemental protein from another rumen by-pass protein source (corn gluten meal) was optimal when it provided at 20% of the supplemental protein. Urea was used to provide 10% of the supplemental protein to ensure that rumen function was not reduced by inadequate rumen degradable protein.

Results

Because of the low cost per unit of protein, the FM supplement cost $11.52/ton less than the SBM supplement. No significant differences were detected between the SBM and FM supplements. However, variability within a supplemental group was high for all parameters because of variation in breeding and age within a group. However, there was a tendency for FM cows to gain more weight than SBM cows, whereas their calves gained 7.8% less weight than SBM calves. There was also a tendency for calves from FM supplemented cows to consume more creep feed.

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[2]Feather meal was donated by Simmons Industries, Southwest City, MO.

Therefore, considering supplement cost differences and minimal performance differences between supplements, feather meal may have a place in cattle rations. As with any other rumen by-pass protein source (blood meal, corn gluten meal, etc.), proper feeding is important. Feather meal is very unpalatable. Steers have been known to refuse a supplement with as little as 5% feather meal. Therefore, it is advisable to gradually increase the concentration of feather meal to the desired level in the supplement. Also, one should always be careful not to feed too high a level of feather meal. If this is done, too much protein escapes the rumen, reducing rumen efficiency at digesting fiber and thereby reducing performance.

Table 1. Composition of Feather Meal (FM) and Soybean Meal (SBM) Supplements Offered to Cows.

Ingredient	SBM	FM
	-------- %	--------
Ground grain sorghum	71.6	81.8
Soybean meal (44%)	27.6	12.0
Feather meal	-	4.8
Urea	-	.6
Vitamin A,D,E	.8	.8
Supplement cost, $/ton	$117.32	$105.80

Table 2. Performance by Cows, Calves, and Replacement Heifers Offered 5 lb/day of Supplements Containing Feather Meal (FM) or Soybean Meal (SBM).

Item	SBM	FM	SE[a]
Cows[b]			
Init. wt., lb.	1162	1184	46.8
Final wt., lb.	1208	1236	43.0
Total gain, lb.	46	52	17.9
Daily gain, lb.	.71	.80	.275
Daily supplement cost, c/day	29.3	26.5	
Calves[b]			
Init. wt., lb.	271	273	13.6
Final wt., lb.	432	423	20.5
Total gain, lb.	161	149	10.0
Daily gain, lb.	2.47	2.30	.154
Daily creep feed cons., lb.	5.5	6.4	
Replacement heifers[b]			
Init. wt., lb.	898	919	30.4
Final wt., lb.	967	980	29.5
Total gain, lb.	68	61	6.7
Daily gain, lb.	1.05	.93	.103

[a]Pooled standard error of the mean value for each variable.
[b]No significant differences were detected (P<.10).

PERFORMANCE BY STOCKER STEERS GRAZING WINTER FESCUE AND OFFERED SUPPLEMENTS CONTAINING FEATHER MEAL WITH DIFFERENT LEVELS OF UREA[1]

Kenneth P. Coffey and Joseph L. Moyer

Summary

Forty crossbred steers were offered 20% crude protein supplements containing 4.8% feather meal with either 0, .7, or 1.4% urea while grazing dormant winter fescue pastures with ad libitum hay. Performance was similar across urea levels but tended to decline with 1.4% urea. Therefore, in rations containing feather meal, urea may be included at low levels without reducing animal performance.

Introduction

Feather meal is a by-product of the poultry processing industry and contains approximately 85% crude protein, of which a high percentage by-passes rumen degradation. Protein sources that escape rumen degradation have been shown to improve animal performance but must be properly fed to prevent reduction in rumen efficiency by a deficiency of rumen degradable protein. Urea is a readily available crude protein source but also must be used at limited levels to maximize protein efficiency. From the standpoint of protein efficiency of the animal, one should be able to use a combination of urea and by-pass protein. However, the relative proportions should be established. This experiment was conducted to determine the optimal level of urea that could be fed with a supplement containing feather meal.

Experimental Procedure

Forty Simmental crossbred steers were weighed full on 2 consecutive days, then randomly allotted by weight into eight replicates of five head each. The replicates were then randomly allotted to one of eight tall fescue pastures on February 1 and offered ad libitum access to a second-cutting hay consisting of smooth bromegrass and tall fescue. Each pasture group was offered one of three supplements containing 4.8% feather meal. Two replicates received supplements containing no urea (U-0), whereas three replicates each received supplements containing either .7 (U-.7) or 1.4% (U-1.4) urea (Table 1). Commercial mineral blocks were provided free-choice. The steers were weighed full on March 15 and 16 to terminate the study. Performance and hay consumption were measured.

Results

No differences were detected in the performance of steers consuming supplements containing different levels of urea (Table 2). However, there was a tendency for performance to decline with U-1.4. Therefore, it appears that limited amounts of urea may be used with supplements containing feather meal to reduce ration costs without depressing performance.

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[1]Appreciation is expressed to the following: Simmons Industries, Southwest City, MO. for donation of feather meal; Steve Clark for providing cattle for the experiment.

Table 1. Composition of Supplements Containing Feather Meal and Different Levels of Urea.

Item	U-0	U-.7	U-1.4
	----------	%	----------
Grain sorghum	78.27	83.33	88.33
Soybean meal	16.68	10.92	5.22
Feather meal	4.70	4.70	4.70
Urea	-	.70	1.40
Vit A,D,E premix	.35	.35	.35
Supplement cost, $/ton	109.61	103.68	97.77

Table 2. Performance by Steers Offered Supplements Containing Feather Meal With Different Levels of Urea.

Item	U-0	U-.7	U-1.4
No. head	10	15	15
Init. wt., lb.	628	625	625
Final wt., lb.[a]	706	698	692
Total gain, lb.[a]	71	73	67
Daily gain, lb.[a]	1.65	1.71	1.55

[a]One calf on the U-0 supplement died. Therefore, the means shown are for nine head.

EFFECT OF IMPLANT, COPPER BOLUS, AND SUMMER ROTATION TO BERMUDAGRASS ON PASTURE AND SUBSEQUENT FEEDLOT PERFORMANCE OF STEERS GRAZING HIGH-ENDOPHYTE TALL FESCUE INTERSEEDED WITH LADINO CLOVER[1]

Kenneth P. Coffey, Joseph L. Moyer, and Lyle W. Lomas

Summary

Fifty-nine crossbred steers were used in the second year of a study to evaluate the effect of different management practices on pasture and subsequent feedlot performance by stocker steers grazing high-endophyte tall fescue interseeded with ladino clover. Management practices evaluated were the effect of implanting with Synovex-S, orally administering a bolus containing copper oxide needles, and summer rotation to bermudagrass. Steers rotated to bermudagrass tended to have lower (P>.10) ending pasture and feedlot weights and pasture gain. Rotated steers had lower (P<.05) hot carcass weights and dressing percentages than continuously grazed cattle. Implanted cattle produced more (P<.01) gain per animal and per acre during the pasture phase but tended (P<.10) to gain less during the feedlot phase than non-implanted steers. Cattle receiving boluses with copper oxide needles were similar in all respects to cattle not receiving boluses. Responses in the second year of this experiment were similar in many respects to those in the first year. Implanted steers showed improved pasture gains but reduced feedlot gains such that overall performance was not different. Rotation of cattle to bermudagrass again tended to reduce animal performance, but some of the reduction was compensated for in the feedlot phase. Therefore implanting cattle grazing tall fescue - ladino clover pastures should provide substantial improvements in gain during the pasture phase. The effects on subsequent feedlot performance may be negative, however.

Introduction

Performance of cattle grazing tall fescue containing the endophytic fungus, Acremonium coenophialum, has typically been suboptimal. Many treatments and management practices have been and are currently being tested to minimize the effects of A. coenophialum on cattle. In the present experiment, Synovex implant, copper oxide needles, and grazing fescue-ladino clover pastures in the spring and fall and bermuda in the summer were evaluated as treatments to help minimize performance reductions caused by the endophyte.

Experimental Procedure

Fifty-nine Limousin crossbred steers were used in an experiment to compare continuous grazing (CG) of tall fescue-ladino clover pastures vs. rotation of the cattle from fescue - ladino pastures in the spring and fall to bermudagrass in the summer (RG); implant with Synovex-S (I) vs. no implant (NI); and bolus with copper oxide needles (CO) vs. no copper (NCO). Approximately 70% of the fescue plants were infected with A. coenophialum. Steers were dewormed with levamisole phosphate and given Terminator@ ear tags to control face flies. Continuously grazed cattle were divided into five replicates of five head each, and each

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[1]Appreciation is expressed to the following: Syntex Animal Health, Inc., West Des Moines, IA for implants and partial financial support; Cooper's Animal Health, Kansas City, MO for providing copper boluses; Prince Agri Products, Quincy, IL for providing trace mineral package; Pitman-Moore, Inc., Mundelein, IL for providing dicalcium phosphate; Steve Clark for use of experimental cattle.

replicate was then placed on a specific 5-acre pasture for a 186-day grazing period beginning on May 5. The remaining cattle were divided into one replicate of 12 head and two replicates of 11 head, with each replicate assigned to a 5-acre pasture. Within each management, half of the steers received I and within each management by implant combination, half of the steers received 20 g of copper oxide needles in a polyethylene capsule. On June 16, RG cattle were moved such that each replicate was assigned to one 5-acre bermudagrass pasture until September 17. At that time, the steers originally receiving an implant were reimplanted. Rotated cattle were returned to the fescue - ladino pastures on September 17 and grazed those pastures until November 7. All steers had ad libitum access to water and mineral supplement throughout the experiment.

On November 7, all cattle were dewormed with fenbendazole, implanted with Synovex-S, vaccinated against clostridial infection, and then transported to the SEKES feedlot facility at Mound Valley. Steers were fed a silage-based ration, with levels of grain sorghum increased until a final ration of 80% ground grain sorghum, 15% corn silage, and 5% protein supplement on a dry matter basis was achieved. The steers were fed the finishing ration for 121 days, then slaughtered, and carcass data were collected.

Results

Rotation of the cattle to bermudagrass tended to reduce (P<.10) ending pasture weight and per animal gain by 45 lb (Table 1). Gain/acre also tended (P>.10) to be lower with RG. Implanted cattle gained 18.3% more (P<.01) weight per animal, had 19.1% more gain/acre, and were 27 lb. heavier (P<.10) at the end of the pasture phase than NI. Administering boluses with copper oxide needles had no effect on pasture performance.

During the feedlot phase (Table 2), RG and CG cattle gained similarly (P>.10), resulting in CG steers weighing 40 lb more (P<.10) at the end of the feedlot phase. Non-implanted steers gained 26 lb. more than I during the finishing phase, so that final weights of I and NI were similar (Table 2).

Continuously grazed cattle produced heavier (P<.10) carcasses with higher dressing % than RG, but other carcass characteristics were similar (Table 3). Neither implant nor copper bolus affected carcass characteristics.

Cattle rotated to bermudagrass during the summer numerically consumed more feed per day and more efficiently converted feed to gain but the differences were not statistically significant (Table 4).

These data indicate that removing the cattle from fescue - ladino pastures during the summer months and grazing them on bermudagrass did not help animal performance but actually hindered individual animal gains. Improvements in performance from Synovex were greater than normally expected. However, similar improvements in performance of cattle grazing high endophyte tall fescue have been shown with other implants. In both years of the present experiment, feedlot performance was affected by pasture performance. Treatments that improved pasture performance reduced feedlot performance, and treatments that reduced pasture performance tended to improve feedlot performance.

Table 1. The Effect of Implant, Copper Oxide Needles, and Summer Rotation to Bermudagrass on Steer Grazing Performance.

Item	Management		Implant		Copper Oxide	
	CG	RG	I	NI	CO	NCO
No. Steers	25	34	30	29	29	30
Initial wt., lb.	755	755	753	756	756	754
End pasture wt., lb.	961	916	952	925	945	932
Gain, lb.	207	162	200[a]	169[b]	190	179
Gain/acre, lb.	207	183	212[a]	178[b]	201	189
Daily gain, lb.	1.11	.87	1.07[a]	.91[b]	1.02	.96

[a,b]Means within the same main effect and row with unlike superscripts differ (P<.01).

Table 2. The Effect of Implant, Copper Oxide Needles, and Summer Rotation to Bermudagrass on Steer Feedlot Performance.

Item	Management		Implant		Copper Oxide	
	CG	RG	I	NI	CO	NCO
Initial wt., lb.	961	916	952	925	945	933
Final wt., lb.	1360[a]	1320[b]	1336	1343	1345	1335
Total gain, lb.	399	404	392[b]	418[a]	408	403
Daily gain, lb.	3.32	3.34	3.27[b]	3.48[a]	3.40	3.35

[a,b]Means within the same main effect and row with unlike superscripts differ (P<.10).

Table 3. The Effect of Implant, Copper Oxide Needles, and Summer Rotation to Bermudagrass on Steer Carcass Characteristics.

Item	Management		Implant		Copper Oxide	
	CG	RG	I	NI	CO	NCO
Hot car. wt., lb.	826[a]	784[b]	806	805	807	804
Dressing %	60.7[a]	59.4[b]	60.3	59.9	60.0	60.2
Backfat, in.	.43	.38	.42	.39	.38	.43
Ribeye area, in^2	13.7	13.5	13.5	13.7	13.7	13.6
Quality grade[c]	9.4	9.2	9.2	9.4	9.4	9.2
Yield grade	2.9	2.7	2.9	2.8	2.9	2.7

[a,b]Means within the same main effect and row with unlike superscripts differ (P<.05).
[c]9 = high select; 10 = low choice; etc.

Table 4. The Effect of Summer Rotation to Bermudagrass on Feed Intake and Efficiency during the Subsequent Feedlot Phase.

Item	Continuous	Rotated
Daily feed intake, lb.	26.5	27.3
Daily feed DM/gain, lb	8.10	7.65

PERFORMANCE BY HEIFERS GRAZING HIGH-ENDOPHYTE TALL FESCUE AND OFFERED DIFFERENT LEVELS OF TRACE MINERALS[1]

Kenneth P. Coffey, Joseph L. Moyer, and Lyle W. Lomas

Summary

Thirty-six black or black-baldy heifers that continuously grazed tall fescue pastures infected with the endophytic fungus, Acremonium coenophialum, were offered trace mineral packages formulated to provide either 25 (L), 100 (M), or 400 % (H) of NRC requirements for zinc, manganese, iodine, iron, copper, and cobalt. Half of the heifers allotted to each trace mineral level were orally dosed with 20 g of copper oxide needles (C) in polyethylene capsules, whereas the remaining half received no copper (NC) other than the amount present in the trace mineral packages. The purpose of the experiment was to evaluate the effect of trace mineral levels on heifer performance and blood parameters and to further evaluate the interaction of additional copper with different levels of other trace minerals. Neither trace mineral levels nor copper oxide boluses affected animal performance. However, C heifers maintained stable serum copper and ceruloplasmin levels while NC heifers displayed declining serum copper and ceruloplasmin levels with the levels from some heifers falling in the copper deficiency range. Therefore, cattle grazing endophyte-infected fescue may demonstrate declining copper levels that may result in copper deficiency. However, unless stresses other than the fescue-related heat stress are imposed upon the cattle, performance may not be affected by the copper deficiency.

Introduction

Cattle grazing tall fescue infected with the endophytic fungus, Acremonium coenophialum, demonstrate symptoms of toxicity including reduced performance, elevated temperature, excessive salivation, and reduced daytime grazing. Many times, these cattle do not shed their hair coats or their hair coats are discolored. The latter is also a symptom of copper deficiency. Also, previous work at Oregon showed that fescue cattle had lower copper levels than those grazing other forages. Copper is very important in a number of essential enzyme functions in the body, one of which is the initiation of the immume system. This experiment was conducted to determine how copper or different levels of trace minerals affect blood copper levels and performance of heifers grazing high-endophyte tall fescue.

Experimental Procedure

Thirty-six Angus and Angus x Hereford heifers were randomly allotted by weight into six pasture replicates and placed on one of six 7.5 acre tall fescue pastures. The fescue was highly infected with the endophytic fungus. Heifers were weighed after a 16 hour removal from feed and water on May 18 and October 11 to determine beginning and ending weights, respectively. Two replicates each received ad libitum access to one of the three trace mineral packages shown in

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[1]Appreciation is expressed to the following: Prince Agri Products, Quincy, IL. for providing trace mineral packages; Pitman-Moore, Inc., Mundelein, IL for providing dicalcium phosphate; Cooper's Animal Health, Kansas City, MO for providing copper boluses; Alice Parscale, Monett, MO for providing cattle for the experiment.

Table 1, which were formulated to provide .25 (L), 100 (M), or 400% (H) of the NRC requirements for the elements zinc, manganese, iron, copper, iodine, and cobalt. Half of the heifers in each replicate were orally dosed with 20 g of copper oxide needles (CU) in polyethylene capsules whereas the remaining half received no boluses of copper (NB). Blood samples were collected by jugular puncture on May 18, August 11, and October 11 to determine serum copper, zinc, ceruloplasmin, and blood hematocrit.

Results

Neither trace mineral levels nor copper oxide boluses affected animal performance (Table 2). However, blood parameters were affected by both trace mineral levels and copper boluses. Serum copper and ceruloplasmin levels over time are shown in Table 3. Ceruloplasmin is a copper-containing enzyme, which is indicitive of the copper status of the animal. In heifers that received the copper oxide needles, serum copper and ceruloplasmin levels remained relatively stable throughout the grazing season. However, in heifers that received copper only through the trace mineral mixture, ceruloplasmin and copper levels declined by 56 and 27 %, respectively. Some of the heifers that received no copper oxide bolus had copper levels below .5 ppm, which is considered deficient.

Responses of serum copper level to the copper oxide bolus differed in combinations with the different trace mineral levels, resulting in a significant bolus x trace mineral level interaction. Copper levels were highest in heifers receiving CU in combination with M. Heifers receiving CU in combination with either L or H had similar serum copper levels. All groups receiving CU had higher serum copper levels than NB. Within NB heifers, those offered H had the lowest serum copper levels, possibly indicating an antagonistic effect on copper of high levels of one of the other trace minerals in H.

The data presented in this report are both interesting and perplexing in that fescue cattle may become copper deficient. However, preventing the copper deficiency did not improve animal performance. Therefore, cattle may tolerate copper deficiency, if other outside stresses are minimized.

Table 1. Trace Mineral Salt Treatments Offered to Heifers Grazing High Endophyte Tall Fescue.

Element	Low	Medium	High
	--------	%	--------
Zinc	.25	1.0	4.0
Manganese	.125	.50	2.0
Iron	.125	.5	2.0
Copper	.01	.04	.16
Iodine	.0025	.01	.04
Cobalt	.0025	.01	.04

Table 2. Performance by stocker heifers offered different levels of trace minerals in salt mixtures and bolused with copper oxide needles.

	Trace mineral level			Copper bolus	
Item	Low	Medium	High	Bolus	No bolus
Initial wt., lb.	432	431	432	432	432
Final wt., lb.	509	518	508	517	506
Gain, lb.	77	87	76	85	75
Daily gain, lb.	.53	.60	.52	.58	.51
Mineral cons., g/day	10	24	20		

No statistical differences were detected.

Table 3. Effect of copper oxide needles on serum ceruloplasmin and copper at different dates.

		Date		
Item	Bolus	5/18	8/11	10/11
Ceruloplasmin, mg/dl	Bolus	16.3[b]	15.9[b]	17.1[b]
	No bolus	15.9[b]	14.6[b]	7.0[c]
Copper, ppm	Bolus	1.1[ef]	1.5[d]	1.6[d]
	No bolus	1.1[ef]	1.1[e]	.8[f]

[a]Significant bolus x time interaction for serum ceruloplasmin and copper.
[b,c]Ceruloplasmin levels differ (P<.01).
[d,e,f]Copper levels differ (P<.05).

Table 4. Effect of trace mineral level and copper oxide needles on serum copper levels (ppm).[a]

Item	Trace Mineral Level		
	Low	Medium	High
Bolus	1.3[c]	1.5[b]	1.3[c]
No bolus	1.1[d]	1.0[d]	.9[e]

[a]Significant bolus x trace mineral level for serum copper levels.
[bcde]Copper levels differ.

NIACIN AS A SUPPLEMENTATION FOR CATTLE GRAZING TALL-FESCUE PASTURES[1]

F. K. Brazle[2], K. Coffey, L. Corah[3] and J. Moyer

Summary

Stockers were not benefited by niacin supplement while grazing tall fescue pasture in the spring or fall. There was a trend toward lower body temperatures for niacin-supplemented cattle, but this was not significant. Niacin fed at 2 to 4 g per head daily did not reduce the fescue endophyte fungus problem.

Introduction

When fed at high levels, niacin helps dissipate body heat by stimulating peripheral vasodilation. Research with stressed calves shipped off of fescue pastures has shown increased gains when niacin was added to the receiving diet. This suggests that niacin may help reduce the heat stress and resulting gain reduction caused by the endophyte fungus in tall fescue. The objective was to determine if supplemental niacin fed to cattle grazing tall fescue pastures would improve average daily gain moderate body temperature.

Experimental Procedure

In Trial I, 125 mixed-breed steers were allotted randomly on March 31 to either niacin or control groups. There were two pastures per treatment. Each group was fed 2.6 lb of grain, with or without 4 grams of niacin per head daily. Steers were stocked at one steer/acre and grazed 65% endophyte-infected tall fescue pastures. Dry weather caused the trial to be terminated on May 16 after 45 days. At the start and end of the trial, steers were individually weighed and their body temperatures were recorded.

In Trial II, 200 mixed-breed steers were individually weighed and allotted randomly on October 10 to either a niacin bolus or control group. Half of each group of steers was assigned to either a low (30%) or high (80%) endophyte fungus-infected tall fescue pasture. Each steer in the niacin group was given a niacin bolus on d 1 and d 32 of the 64-d trial. Boluses were designed to release 2 g of niacin/day. In addition, all steers received 3 lb of grain sorghum per head daily. The steers were weighed off trial on December 13.

In Trial III, 40 mixed-breed heifers were weighed and allotted randomly on October 4 to either a niacin-supplemented or control group. Half of each group was assigned randomly to either a Mo-96 (fungus-free) tall fescue pasture or a K-31 (70% fungus-infected) tall-fescue pasture. Niacin was added to a mineral

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[1]Sincere appreciation is expressed to Lonza, Inc., for funding trial; to 3-G Farms, Uniontown; Sheldon Delange, Girard, Kansas, for providing cattle, facilities; Glenn Newcomer, Extension Agricultural Agent, Bourbon County; and Dean Stites, Extension Agricultural Agent, Crawford County.

[2]Extension Livestock Specialist, Southeast Kansas.

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mixture, and the heifers consumed approximately 4 g of niacin/day during the 63-d trial. The heifers were weighed individually, and body temperatures were recorded at the start and end of the trial.

Results

There was no difference (P>.05) in daily gain between niacin-supplemented and control groups in any of the three trials (Tables 1, 2, and 3). In Trials I and III, body temperature of the niacin-supplemented cattle tended to be lower but was not statistically significant.

In order for appetite and performance to improve on fungus infected pastures, a substantial reduction in the normally elevated body temperature likely would have to occur. This was not the case in these spring and fall trials. However, a summer trial might have different results. For stocker cattle grazing tall fescue primarily in the spring and fall, a niacin supplement does not appear to be beneficial, at least at the 2 to 4 g/d level used in these trials.

Table 1. Effect of Niacin in a Grain Supplement on Steer Performance while Grazing Tall Fescue Pastures (Trial I).

Item	Control	Niacin
No. Steers	60	65
Starting Wt. (lbs)	748	744
ADG (lbs) 45 d	1.37	1.35
Body Temp °F	103.4	103.2

Table 2. Effect of Niacin Bolus on Steers Gains while Grazing High and Low Endophyte Tall Fescue Pastures (Trial II).

Item	Low Endophyte Fungus		High Endophyte Fungus	
	Control	Niacin	Control	Niacin
No. Steers	50	50	50	50
Starting Wt	574	574	573	573
Daily gain, lb	1.24[a,b]	1.35[a]	1.26[a,b]	1.13[b]

[a,b]Means in a row with unlike superscripts differ (P<.05).

Table 3. Effect of Niacin in Mineral Mixture on Heifers Gains, Body Temperatures, and Serum Prolactin while Grazing High and Low Endophyte Tall Fescue Pastures.

Item	Endophyte Free		High Endophyte	
	Control	Niacin	Control	Niacin
No. Steers	10	10	10	10
Starting Wt. (lbs)	608	610	609	606
ADG (lbs) 63 d	1.26	1.04	.81	.84
Body Temp. °F	103.6	103.3	103.4	102.9
Initial prolactin, ng/ml	12.2	10.3	12.5	5.3
Final prolactin, ng/ml[a]	42.6	45.8	23.0	3.5

[a]High vs. low endophyte effects were different (P<.05).

PERFORMANCE BY STOCKER CATTLE OFFERED FEEDSTUFFS CONTAINING ACREMONIUM COENOPHIALUM AND SUPPLEMENTED WITH AMAFERM (ASPERGILLUS ORYZAE FERMENTATION EXTRACT)[1]

K.P. Coffey, F.K. Brazle[2] and J.L. Moyer

Summary

Sixty-four stocker steers were offered endophyte-free fescue hay ad libitum with either bromegrass or high-endophyte fescue seed screenings and supplements with or without Amaferm (Aspergillus oryzae fermentation extract). Steers offered bromegrass screenings gained faster (P<.01), consumed more feed (P<.01), and more efficiently converted feed dry matter to gain (P<.01). Amaferm did not affect the previously mentioned parameters or reduce rectal temperatures. Steers consuming high-endophyte fescue screenings demonstrated many of the symptoms of tall fescue toxicity, but Amaferm did not offset the toxic effects.

Introduction

Tall fescue is one of the most important cool-season forages in the United States, providing over 35 million acres of forage for livestock. Cattle grazing fescue typically exhibit a number of symptoms, including reduced feed intake, weight gains and milk production; higher rectal temperature and respiration rate; and reduced serum prolactin levels. These symptoms have been attributed to the presence of the endophytic fungus, Acremonium coenophialum. Aspergillus oryzae fermentation extract (Amaferm) has been shown to reduce rectal temperatures and improve dry matter digestibility in cattle. The objective of this experiment was to evaluate the effects of Amaferm on cattle consuming forage diets supplemented with high endophyte and endophyte-free grass seed screenings.

Experimental Procedure

Sixty-four black or black-baldy steers (avg. wt. 569 lb) were allotted randomly by weight into one of 16 groups of four head each and placed in drylot pens located at Mound Valley, KS. Steers received an individually numbered ear tag and corresponding tattoo, and Terminator fly tag, were dewormed with fenbendazole, and were vaccinated against pinkeye. All replicates were offered endophyte-free tall fescue hay ad libitum for 90 days beginning on June 30. The replicates were randomly assigned to receive either fescue (F) or bromegrass (B) seed screenings offered at a rate of 4.5 lb/head daily. Within each screening type, the cattle were offered 2 lb of a soybean hull supplement containing essential macro and trace minerals and either no Amaferm (C) or 2g of Amaferm (A) in 2 lb of supplement.

Initial and final weights represent the mean of weights measured in the morning on 2 consecutive days. Rectal temperatures were measured at 14-d intervals throughout the study. Temperatures were measured beginning at 7 am with the exception of Sept. 7. On that day, temperatures were measured beginning

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[1]Sincere appreciation is expressed to the following: Biozyme Enterprises, Inc., St. Joseph, MO. for providing product and financial assistance; Rich Porter, Miller, KS for providing cattle to conduct the study.

[2]Extension Livestock Specialist, Southeast Kansas.

at 1 pm. Blood samples were collected for serum prolactin analysis on June 30, July 27, Aug. 24, and Sept. 24.

Results

Steers offered B were 32 lb heavier (P<.01) at the end of the 90 d feeding period, gained .39 lb/d faster (P<.01), consumed 1.5 lb more (P<.01) feed dry matter per day and produced each pound of gain on 12 lb less (P<.01) dry matter than steers offered F (Table 1). Amaferm did not positively or negatively affect the above parameters.

Ergovaline levels of forages offered are presented in Table 2. By extrapolation of the ergovaline concentration in the fescue screenings to the entire diet, we conclude that steers offered F consumed an average of 193 ppb ergovaline in the daily diet, whereas those offered B consumed non-detectible levels of ergovaline.

Rectal temperatures were higher (P<.01) from steers offered F on July 27 and tended to be higher (P<.10) from those steers on Sept. 7 and Sept. 21 than from steers offered B (Table 3). Steers offered A tended (P<.10) to have higher temperatures than steers offered C on July 13 and Aug. 11. Otherwise, temperatures were similar among treatments.

Serum prolactin levels tended (P<.10) to be higher from B than from F on July 24 (Table 5). Although serum prolactin levels on Aug. 24 were higher from B than from F, a screenings by supplement interaction was detected (P<.05). On that date, no supplement effects were apparent from F but cattle offered C had higher prolactin levels than A when the cattle were consuming brome screenings. Serum prolactin levels on Sept. 21 and 28 were higher from B than from F. Amaferm supplementation had no effect on serum prolactin levels, other than the previously mentioned difference on Aug. 24.

Therefore, feeding of endophyte-infected fescue screenings may reduce weight gain, forage intake, and feed conversion. Amaferm did not appear to offset the adverse effects of the tall fescue toxins.

Table 1. Performance of Steers Offered Fescue or Bromegrass Screenings with or without Amaferm.

Item	Screenings type		Supplement	
	Brome	Fescue	Control	Amaferm
Initial wt., lb	568	571	568	571
Final wt., lb[a]	645	613	629	629
Total gain, lb[a]	77.1	42.7	61.1	58.7
Daily gain, lb[a]	.86	.47	.68	.65
DM intake, lb/d[a]	14.3	12.8	13.7	13.4
Feed:gain[a]	16.9	28.9	23.5	22.3

[a]Brome vs. fescue screenings (P<.01).

Table 2. Ergovaline Concentration (ppb) of Feedstuffs Offered to Steers.

Item	Ergovaline conc.
Fescue hay	none detected
Fescue screenings	610 ppb
Bromegrass screenings	none detected

Table 3. Rectal Temperatures from Steers Offered Fescue or Bromegrass Screenings with or without Amaferm.

Date	Screenings type		Supplement	
	Brome	Fescue	Control	Amaferm
June 30	103.4	103.3	103.3	103.4
July 13[c]	102.6	102.7	102.5	102.8
July 27[a]	103.1	103.9	103.4	103.6
Aug. 11[c]	101.5	101.6	101.3	101.7
Aug. 24	103.2	103.0	102.9	103.3
Sept. 7[b]	105.1	105.7	105.3	105.5
Sept. 21[b]	100.9	101.4	101.2	101.1
Sept. 28	102.0	102.5	102.2	102.3

[a]Brome vs. fescue screenings (P<.01).
[b]Brome vs. fescue screenings (P<.10).
[c]Control vs. Amaferm (P<.10).

Table 4. Serum Prolactin Levels (ng/ml) from Steers Offered Fescue or Bromegrass Screenings with or without Amaferm.

	Bromegrass		Fescue	
Date	Control	Amaferm	Control	Amaferm
June 30	173.2	129.5	177.7	237.7
July 27[b]	21.2	21.3	8.7	13.9
Aug. 24	19.6[c]	9.6[d]	1.9[e]	1.8[e]
Sept. 21[a]	8.3	10.6	1.0	1.3
Sept. 28[a]	26.1	27.0	1.7	2.7

[a]Brome vs. fescue screenings ($P<.05$).
[b]Brome vs. fescue screenings ($P<.10$).
[cde]Means within a row with unlike superscripts differ ($P<.05$).

INFLUENCE OF GRAZING DIFFERENT FESCUE VARIETIES ON SUBSEQUENT FEEDLOT PERFORMANCE OF STEERS[1]

Kenneth P. Coffey, Joseph L. Moyer, and Lyle W. Lomas

Summary

The third year of a feedlot study was conducted to evaluate the effect of previously grazing different fescue varieties on subsequent feedlot performance of steers. Thirty, Angus x Hereford, crossbred steers were fed a common feedlot ration consisting of 80% ground grain sorghum, 15% corn silage, and 5% protein supplement on a dry matter basis for 126 days following a 223-day grazing period. The steers previously grazed either high-endophyte Kentucky 31 (HE), low-endophyte Missouri 96 (MO96), or HE interseeded with ladino clover (HE+LC). Steers that previously grazed MO96 were heavier (P<.05) at the initiation of the feedlot phase but gained less (P<.05) during the feedlot phase than those that previously grazed HE+LC. Final weights were similar (P>.10) among previous forage types. Therefore, cattle that grew the least during the pasture phase appeared to compensate for this lower performance once placed in the feedlot, resulting in improved feedlot gain.

Introduction

Tall fescue stands with plants that are infected with the endophytic fungus, Acremonium coenophialum, have been shown to adversely affect the performance of animals consuming this forage. The symptomology of tall fescue toxicity does not immediately disappear when the cattle are removed from the fescue. However, the carryover effects of previously grazing tall fescue on subsequent feedlot performance are inconclusive. The data in this report represent the third year of a 3-year study that emphasizes the effects of grazing different fescue varieties on subsequent feedlot performance of cattle.

Experimental Procedure

Thirty, Angus x Hereford, crossbred steers were allotted randomly by weight into six replicates of five head each. The replicates were allotted randomly such that two replicates each were assigned to graze either high-endophyte Kentucky 31 (HE), low-endophyte Missouri 96 (MO96), or HE interseeded with ladino clover (HE+LC) for 223 days beginning on April 5. The cattle were not implanted and received no supplemental feed during the pasture phase. The cattle were weighed off of pasture on the mornings of November 22 and 23 to determine pasture ending weights and feedlot initial weights. The cattle were moved to the SEKES feedlot facility at Mound Valley, with previous pasture replicates maintained. All steers were implanted with Synovex-S, dewormed with levamisole, and vaccinated against clostridial infection. The cattle were fed a corn silage based ration initially. Grain level replaced corn silage until a final ration of 80% ground grain sorghum, 15% corn silage, and 5% protein supplement was being offered. The supplement contained monensin to provide 25 g/ton in the complete ration. The cattle were fed for 126 days, then slaughtered, and carcass data were collected.

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[1]Appreciation is expressed to Alice Parscale, Monett, MO for providing cattle for the experiment.

Results

Steers that previously grazed HE+LC entered the feedlot phase lighter ($P<.05$) than those that previously grazed MO96 (Table 1). Final weights were similar, however, indicating that these cattle compensated for reduced pasture phase gains. Steers that previously grazed MO96 gained 44 lb less ($P<.05$) than those that previously grazed HE+LC. Steers that previously grazed HE gained similarly to those that previously grazed either MO96 or HE+LC. Daily dry matter intake and feed conversion were similar among previous forage treatments.

Carcass quality grades from steers that previously grazed HE+LC and MO96 were higher ($P<.05$) than that from steers that previously grazed HE (Table 2). Otherwise, carcass characteristics were similar among previous forage treatment.

Data from the third year of the study are somewhat different from the two previous years. Cattle grazing HE+LC performed poorly during the 1988 grazing season. This was a dry season that resulted in loss of most of the ladino clover in the pastures. In addition, the HE+LC pastures received less N fertilizer, resulting in lower forage availability. These factors probably account for the reduced animal performance. Considering the data from all 3 years leads to the conclusion that feedlot performance of cattle grazing endophyte-infected fescue will probably not be hindered. Furthermore, cattle that had the lowest pasture performance gained the fastest when placed in the feedlot.

Table 1. Effect of Previous Pasture Type on Feedlot Performance of Steers.

Item	HE	HE+LC	MO96
Initial wt., lb.	806[ab]	759[b]	848[a]
Final wt., lb.	1223	1200	1245
Gain, lb.	418[ab]	442[a]	398[b]
Daily gain, lb.	3.31[ab]	3.50[a]	3.16[b]
Daily DM intake, lb.	21.2	22.6	23.3
Daily feed DM/gain	6.35	6.46	7.41

[a,b]Forage type means within the same row with unlike superscripts differ ($P<.05$).

Table 2. Effect of Previous Pasture Type on Carcass Characteristics.

Item	HE	HE+LC	MO96
Hot carcass wt., lb.	734.5	712.5	745.0
Quality grade	9.4[b]	10.2[a]	10.1[a]
Backfat, in.	.50	.59	.49
Ribeye area, in^2	13.3	12.1	12.3
Yield grade	2.9	3.4	3.3

[ab]Means within the same row with unlike superscripts differ ($P<.05$).

THE EFFECT OF TREATMENT WITH EITHER OXFENDAZOLE OR LEVAMISOLE PHOSPHATE ON WEIGHT GAIN OF STOCKER CALVES[1]

Kenneth P. Coffey and Joseph L. Moyer

Summary

Ninety mixed-breed steers were used in an experiment to evaluate the effects of implant and anthelmintic treatments on cattle performance and fecal parasite egg counts. The cattle were randomly allotted by weight into nine groups: three groups received levamisole phosphate (L), three groups received oxfendazole (O), and three groups received no anthelmintic treatment (C). Within each group, half of the steers received an estradiol-progesterone implant (Synovex-S). Steers received anthelmintic treatments on day 1 and 28 of the experiment. Implanted cattle were 26 lb. heavier at the end of the 112-day study. Fecal egg counts were higher from C than from either L or O on day 14 and higher than L on day 28. An anthelmintic by implant interaction was detected (P<.05) for animal gain. Cattle treated with O showed no additional response to implant. Implanted C cattle tended to gain more (P>.10) than non-implanted C cattle, whereas implanted L cattle gained 35% more than non-implanted L cattle. Therefore, although implanting steers with Synovex-S appears to be a viable management practice, internal parasite control was not necessary in this study.

Introduction

Internal parasite control in cattle is a major concern in many parts of the country. Many products are currently available that claim to control internal parasites. A number of anthelmintics classified as second-generation anthelmintics are currently available or in developmental stages. These anthelmintics have greater efficacy against more parasites and more stages of those parasites. The purpose of this experiment was to evaluate a second-generation anthelmintic (oxfendazole) that is currently in the developmental stages and to determine the interaction of anthelmintics with Synovex-S implant.

Experimental Procedure

Ninety mixed breed steers were allotted randomly by weight to either implant (Synovex-S;I) or non-implanted (NI) treatments. Steers were then grouped by weight within implant treatment and assigned randomly to one of nine smooth bromegrass pastures. The pastures were then randomly allotted such that the cattle grazing those pastures would receive either no anthelmintic treatment (C), subcutaneous injection on days 1 and 28 with levamisole phosphate (L), or intraruminal injection on days 1 and 28 with oxfendazole. The steers were allowed to graze their assigned pasture for 112 days beginning in May. Fecal samples were collected from all of the cattle on May 2 (day 1), May 16 (day 14), May 30 (day 28), June 13 (day 42), and August 22 (day 112) for fecal egg counts.

Results

Cattle receiving the Synovex-S implant were 26.2 lb. heavier (P<.05) at the end of the 112-day study than those not receiving an implant (Table 1).

[1]Appreciation is expressed for providing partial financial support, oxfendazole, and implants to conduct the experiment.

Anthelmintic treatment had no effect on final steer weight. An implant x anthelmintic treatment was detected for steer gain. Gains were similar (P>.10) between implanted and non-implanted steers that received either no anthelmintic treatment or oxfendazole, although implanted C steers tended to gain more than non-implanted C steers. Levamisole-treated steers that were implanted gained 35% more weight than non-implanted L steers.

Fecal nematode egg counts were similar among treatments on days 1, 42, and 112 (Table 2). Steers receiving no anthelmintic treatment had higher (P<.05) fecal egg counts on day 14 than steers that were treated with L or O. On day 28, steers treated with L had lower (P<.05) fecal egg counts than C or steers treated with O. However, in all instances, fecal egg counts were low.

In summary, implanting with Synovex-S improved animal performance across anthelmintic treatments by over 23%. However, this response was not consistent within anthelmintic treatments, as demonstrated by an anthelmintic by implant interaction. Cattle treated with levamisole exhibited the greatest response to the implant, whereas cattle treated with oxfendazole exhibited no response to the implant. Whether these differences could be repeated or not is uncertain. Anthelmintic treatment with either levamisole or oxfendazole did not affect animal performance, indicating that internal parasite infestation was not of sufficient magnitude to adversely affect performance. This was verified by fecal egg counts remaining low throughout the study, even in the control cattle.

Table 1. Weight and Performance of Stocker Steers Treated with Synovex-S and Different Anthelmintics.

Item	Implant		Anthelmintic		
	No Imp.	Syn.	Control	Lev	Oxf
Initial wt., lb.	627	627	626	628	628
Final wt., lb.	805	831	827	806	820

	Control		Levamisole		Oxfendazole	
	No Imp.	Syn.	No Imp.	Syn.	No Imp.	Syn.
Total gain, lb.	190[a]	213[a]	151[b]	205[a]	191[a]	193[a]
Daily gain, lb.	1.70[a]	1.90[a]	1.35[b]	1.82[a]	1.71[a]	1.73[a]

[a,b]Means within a row with unlike superscripts differ (P<.05).

Table 2. Fecal Egg Counts from Steers Treated with Different Anthelmintics.

Date	Control	Levamisole	Oxfendazole
	---------------	eggs/3 gm	------------------
May 2	8.4	11.5	5.0
May 16	2.9[a]	0.0[b]	0.0[b]
May 30	5.3[c]	0.0[d]	2.3[c]
June 13	13.3	0.0	0.7
August 22	34.2	50.7	30.9

[a,b]Means within a row with unlike superscripts differ (P<.05).
[c,d]Means within a row with unlike superscripts differ (P<.10).

RICE MILL FEED AS A FEED FOR GROWING CATTLE

F. K. Brazle[1] and K.P. Coffey

Summary

Heifers were fed either rice mill feed and dehydrated alfalfa pellets (RA) or grain sorghum and dehydrated alfalfa pellets (GA). The RA heifers consumed more feed but gained slower (P<.05), resulting in poorer feed efficiency. Rice mill feed is a poor feedstuff for growing calves when included in rations at high levels.

Introduction

Many by-products have been fed to growing cattle. Some have been found to be excellent feed sources, whereas others have little value for animal growth. Rice mill feed is a by-product that consists of about 40% rice bran and 60% rice hulls. The objective of this study was to evaluate rice mill feed as a feedstuff for growing heifers.

Experimental Procedure

Twenty-four heifers (607 lbs) were allotted randomly to diets of either 67% rice mill feed + 33% dehydrated alfalfa pellets (RA) or 67% ground grain sorghum + 33% dehydrated alfalfa pellets (GA). Four heifers were assigned per pen (200 ft^2/head) with three pens/treatment. They were fed to appetite for 60 d on the diets shown in Table 1.

The starting and ending weights were obtained after the heifers had been held off feed for 12 hr.

Dry matter digestibility, as well as rate and extent of digestion, was determined by in vitro techniques. The samples were analyzed for crude protein, natural detergent fiber, acid detergent fiber, and acid detergent lignin. Data were subjected to analysis of variance, and results are reported as least squares means.

Results

The RA heifers gained slower (P<.05), consumed 27% more feed and had much poorer (P<.05) feed conversions than the GA heifers (Table 2). The rice mill feed contained more fiber and lignin and a lower 48-hr dry matter digestibility than either grain sorghum or alfalfa pellets (Table 3). The digestible fraction of rice mill feed was degraded fairly rapidly (less than 6 hr, Figure 1), which partially explains the excellent feed intake of heifers fed the RA diet. However, the total digestibility of rice mill feed was too low for economical stocker gains when fed at the level used in this trial.

During the first 2 wk of the trial, the GA heifers showed signs of lactic acidosis, and one heifer was treated for this condition. The rapid rate of

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[1]Extension Livestock Specialist, Southeast Kansas.

digestion of the grain sorghum (Table 3 and Figure 1) would explain the acidosis and could also explain the lower intake of the GA diet.

Both groups were fed 2 lb per head daily of long-stem prairie hay on days 48, 52, and 56 of the trial because of bloat. This would suggest that the roughage factor in both diets was not sufficient to sustain good rumen function. Even though the acid detergent fiber level of rice mill feed was similar to that of many roughages in cattle rations, the small particle size of this feed may limit its value as a roughage.

Table 1. Composition of Heifer Growing Rations.

Ingredients	Rice Mill Feed + Alfalfa	Grain Sorghum + Alfalfa
	------lb per ton------	
Rice Mill Feed	1330	----
Grain Sorghum	----	1330
Dehydrated Alfalfa Pellets	660	660
Salt	10	10

Table 2. Effect of Diet on Heifer Performance and Simulated Trucking Shrink.

Item	Rice Mill Feed + Alfalfa	Grain Sorghum + Alfalfa
No. Heifers	12	12
Starting Wt., lbs	602	612
Daily Gain, lbs	.90[a]	1.63[b]
Daily Intake, lbs	16.53[a]	13.03[b]
Feed/Gain	18.7[a]	7.97[b]

[a,b]Means in a row with unlike superscripts differ ($P<.05$).

Table 3. Chemical Composition and In Vitro Digestibility of Feedstuff.

Items	Dehydrated Alfalfa	Grain Sorghum	Rice Mill Feed
Neutral detergent fiber, %	42.57	15.72	55.24
Acid detergent fiber, %	31.20	5.52	38.78
Acid detergent lignin, %	6.52	.87	8.77
48-hr DM digestibility, %	74.80	94.50	49.40
Digestion Rate, %/hr	6.03	5.79	.91

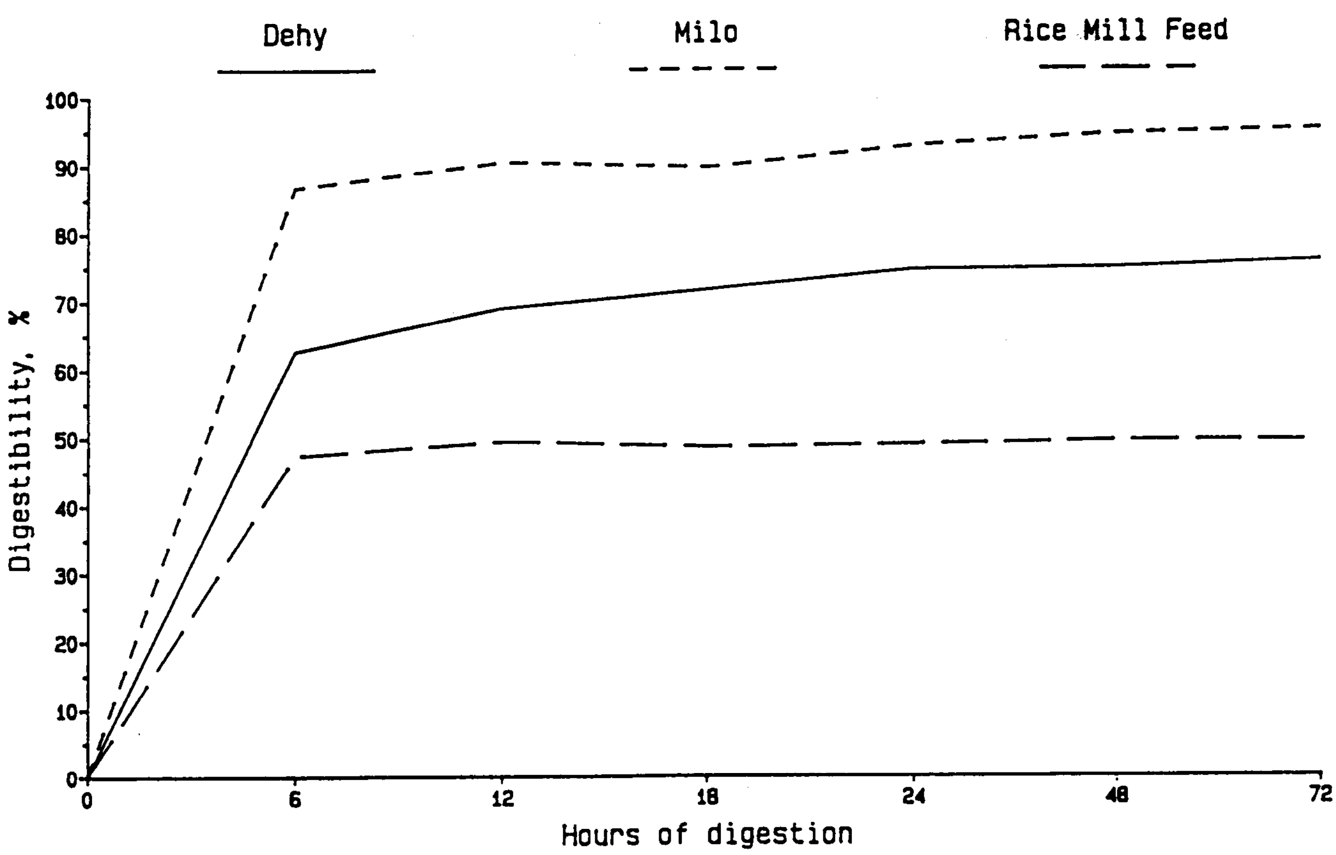

Figure 1. In Vitro Rate of Digestion of Feedstuffs.

ALFALFA VARIETY PERFORMANCE IN SOUTHEASTERN KANSAS

Joseph L. Moyer

Summary

Alfalfa yields averaged higher in 1989 than in previous years. Total yield of the cultivar 'WL-320' was higher than that of six other cultivars in 1989, followed closely by 630 and 'Dart'. In 4-year average production, 630, WL-320, KS196, 'Endure', and 'Southern Special' were significantly greater than the four lowest-yielding cultivars.

Introduction

The importance of alfalfa as a feed crop and/or cash crop has increased in recent years. The worth of a particular variety is determined by many factors, including its pest resistance, adaptability, longevity under specific conditions, and productivity. The fourth growing season of this test has just concluded.

Experimental Procedure

The 15-line test was seeded (12 lb/acre) in April, 1986 at the Mound Valley Unit. Plots were sprayed with Lorsban (1 qt/acre) on April 20, 1989 to control a moderate but increasing weevil population. Six harvests were obtained in 1989, after plots were fertilized with 0-40-150 lb/acre of N-P_2O_5-K_2O on December 5, 1988, and with 14-36-100 on June 9, 1989.

Results

Forage yields for each of the five cuttings and total 1989 production are shown in Table 1. Yields were excellent in 1989, ranging from 7.35 to 8.82 tons/acre (12% moisture), despite a period of drought prior to the first cutting. Stands remained generally good in 1989, with an occasional thinning plot. The four highest-yielding cultivars produced significantly more forage than four low-yielding cultivars in 1989 (Table 1). The first group consisted of WL-320, 630, 'Dart' and 636, whereas the latter included 655, K82-21, 'Riley' and 'Kanza'. WL-320 and Dart had relatively high yields in cut 2, whereas 630 and 636 produced relatively well in cut 1. K82-21 and 655 produced relatively poorly in cuts 1 and 3, whereas Riley's weakest performances were in cuts 3 and 6.

Average 4-year forage production (Table 2) of the top-yielding cultivar, 630, was significantly greater than production of seven other cultivars in the test. Five high-yielding cultivars produced significantly more forage than the four that yielded least. WL-320 has performed well except in 1988: 'Endure' was generally a consistent performer, along with KS196; K82-21 and 655 yielded adequately in the first 2 years of the test, but fell behind other cultivars thereafter.

Table 1. 1989 Forage Yield of Alfalfa Varieties, Mound Valley Unit, SEK Station.

Source	Variety	Harvest Dates 5/11	6/8	7/11	8/7	9/8	11/20	Total
		tons/acre @ 12% moisture						
USDA-KSU	KS196 EXP	2.31ab[1]	1.64abc	1.25abcde	1.43a	0.99a	0.71cd	8.33abc
Waterman-Loomis	WL-320	2.30ab	1.81a	1.36ab	1.36a	1.04a	0.96ab	8.82a
PAG Seeds	Endure	2.52a	1.62abc	1.29abcd	1.28a	0.96a	0.72cd	8.39abc
Garst	636	2.34a	1.58abc	1.36ab	1.45a	1.06a	0.64cde	8.43ab
Garst	630	2.32a	1.74ab	1.40a	1.35a	1.06a	0.75cd	8.61ab
Waterman-Loomis	South. Spec.	1.96bcd	1.55bc	1.36ab	1.38a	1.06a	1.07a	8.37abc
Cargill	EXP 339	2.24abc	1.82a	1.35ab	1.30a	0.96a	0.70cde	8.38abc
USDA-KSU	Riley	2.18abcd	1.48c	1.12de	1.28a	0.94a	0.52e	7.53de
Agripro	Arrow	2.26abc	1.60abc	1.32abcd	1.28a	1.07a	0.69cde	8.22abc
Agripro	Dart	2.25abc	1.76ab	1.34abc	1.42a	1.00a	0.80bc	8.58ab
Asgrow/O's Gold	Eagle	2.21abc	1.74ab	1.22abcde	1.32a	0.97a	0.72cd	8.18bc
Great Plains Res.	Cimarron	2.23abc	1.55bc	1.17bcde	1.34a	0.95a	0.81bc	8.04bcd
USDA-KSU	K82-21 EXP	1.86d	1.44c	1.14cde	1.29a	0.93a	0.76cd	7.42e
Garst	655	1.94cd	1.53bc	1.05e	1.31a	0.96a	0.57de	7.35e
USDA-KSU	Kanza	2.17abcd	1.50c	1.23abcde	1.26a	0.98a	0.66cde	7.79cde
	Average	2.21	1.62	1.26	1.34	0.99	0.74	8.16
	LSD(.05)	0.30	0.21	0.18	NS	NS	0.16	0.53

[1]Means within a column followed by the same letter do not differ (P=.05) according to Duncan's test

Table 2. 4-Year Average Forage Yields of Alfalfa Varieties, Mound Valley Unit, SEK Station.

Source	Variety	Year 1986	1987	1988	1989	4-Yr. Avg.
		- - - - - tons/acre @ 12% moisture - - - - -				
Garst	630	3.64abc	7.88bc	8.92a	8.61ab	7.26a
Waterman-Loomis	WL-320	3.78abc	8.10ab	7.883bcd	8.82a	7.13ab
USDA-KSU	KS196 EXP	3.86abc[1]	8.44a	7.82bcd	8.33abc	7.11ab
PAG Seeds	Endure	4.07a	8.01ab	7.94bc	8.39abc	7.10ab
Waterman-Loomis	South Spec.	3.96ab	7.84bc	7.99bc	8.37abc	7.04ab
Garst	636	3.50c	7.88bc	7.78bcd	8.43ab	6.90abc
Agripro	Arrow	3.58bc	7.74bc	8.03b	8.22abc	6.89abc
Cargill	EXP 339	3.56bc	7.83bc	7.69bcd	8.38abc	6.87abc
Agripro	Dart	3.72abc	7.65bc	7.92bcd	8.58ab	6.85bc
Great Plains Res.	Cimarron	3.90abc	7.58bc	7.79bcd	8.04bcd	6.83bc
Asgrow/O's Gold	Eagle	3.76abc	7.67bc	7.58bcd	8.18bc	6.80bc
Garst	655	3.96ab	7.46c	7.73bcd	7.35e	6.62c
USDA-KSU	Kanza	3.54bc	7.40c	7.72bcd	7.79cde	6.61c
USDA-KSU	K82-21 EXP	4.04a	7.63bc	7.22d	7.42e	6.58c
USDA-KSU	Riley	3.72abc	7.70bc	7.29cd	7.53de	6.56c
	Average	3.77	7.79	7.81	8.16	6.88
	LSD(.05)	0.38	0.45	0.59	0.53	0.34

[1]Means within a column followed by the same letter do not differ (P=.05) according to Duncan's test.

LESPEDEZA INTERSEEDING, LIME APPLICATION, AND P-K FERTILIZER ON NATIVE GRASS MEADOW

Joseph L. Moyer

Summary

Forage production in 1989 was affected by prior P-K fertilization, and fertilizer effects were also noted in 1987 and 1988. The low amount of lespedeza produced in seeded plots of either cultivar did not affect forage yield or quality in any of the 3 years, even with lime and fertilization.

Introduction

Hay production from native meadow has been increased by small amounts of nitrogen (N). However, returns from fertilization do not always cover the cost, and fertilization can encourage undesirable species. Because native hay is usually low in nutrients, such as protein and minerals, legumes in the stand could add N for grass growth and improve overall forage quality. This study was established to determine whether lime and/or P-K fertilization would promote legume establishment, production, and native forage yield and quality.

Experimental Procedure

Lime was applied to designated plots on March 19, 1980 at 2400 lb ECC/acre. Fertilizer sufficient to provide 40 lb/acre each of P_2O_5 and K_2O was applied in April, 1980. Legumes were broadcast-seeded in 1981, but dry spring weather prevented stand establishment. In 1987, 1988, and 1989, the plot area was burned on April 9, 7, and 13, respectively. Seeding was performed with a no-till plot seeder using a rate of 20 lb/acre on April 21 in 1987 and 1989, and on April 20 in 1988. Common Korean lespedeza seed was obtained locally, and Ark S-100 ('Marion') seed was obtained from Dr. Beuselinck at the University of Missouri. One in^2 was clipped from the center, of each plot for determination of botanical composition, then the remainder of the plots was harvested with a flail mower (3'x 20' strip) on June 28, 1989. Subsamples of the chopped forage were collected for moisture and crude protein determinations.

Results

Fertilization with P and K in 1980 increased yield of native grass forage in 1989 (Table 1), particularly in plots seeded with Ark S-100. Liming had no effect on forage yield in 1989. The percentage of lespedeza in forage was affected only by seeding treatment. Even though seeding of both cultivars resulted in statistically significant amounts of lespedeza in the forage, the actual dry matter was only 60-70 lb/a on June 28. Other forbs (weeds) accounted for more than twice the dry matter of lespedeza in the forage.

The low amount of lespedeza produced during the 3 years was not sufficient to affect forage quality or to fix a significant amount of atmospheric N. Because late-summer and early-fall regrowth of grass and legume was not harvested, no carryover effect was measured in the second or third years. Thus, neither lespedeza improved native meadow forage production, even with the addition of lime and/or P-K fertilizer.

Table 1. Forage Yield (12% moisture) and Broadleaf Content (% dry matter) of Forage from Native Meadow with or without P-K Fertilization, as Affected by Lime and Lespedeza Interseeding.

Treatment	Yield	Lespedeza	Other Forbs
	tons/A	- - - - %	- - - -
Legume Interseeding			
None	1.85	0.2	5.6
Korean	1.88	1.8	4.5
Marion	1.95	1.9	3.6
LSD(0.05)	NS	0.6	NS
Lime			
None	1.89	1.2	4.3
2400# E.C.C.	1.90	1.4	4.8
LSD(0.05)	NS	NS	NS
Fertilizer			
None	1.83	1.2	4.8
0-40-40	1.96	1.4	4.3
F Value	*	NS	NS

SOUTHEAST KANSAS BRANCH STATION
KANSAS STATE UNIVERSITY

FORAGE YIELDS OF TALL FESCUE VARIETIES IN SOUTHEASTERN KANSAS

Joseph L. Moyer

Summary

In the third harvest year of the test, 'Martin', 'Forager', and 'Phyter' yielded more first-cut forage than 'Stef', but for the entire year, only Martin produced more forage than Stef. Over the 3 years of the test, Phyter, Martin, and four other cultivars yielded more than Stef and 'Johnstone'.

Introduction

Tall fescue is the most widely grown forage grass in southeastern Kansas. New and old cultivars were compared for agronomic adaptation and forage quality, because effects of a variety chosen for a new seeding will be felt for as long as the stand exists.

Experimental Procedure

Plots were seeded on September 4, 1986 at 20 lb/acre at the Mound Valley Unit, ostensibly with seed free of *Acremonium coeniphialum* endophyte. Plots were 30 x 7.5 ft each, in four randomized complete blocks. Application of 150-45-40 lb/acre of $N\text{-}P_2O_5\text{-}K_2O$ was made on December 5, 1988, followed by fertilization with 50 N September 12, 1989. Plots were cut on May 11, September 8, and November 28, 1989. A subsample from each plot was collected for moisture determination.

Results

April drought affected early growth in 1989, reducing first-cut yields. 'Martin', 'Forager' and 'Phyter' yielded significantly more than 'Stef'; Martin and Forager also yielded more than 'Kenhy', but only Martin outyielded 'Johnstone' (Table 1). Abundant summer rains and cool August conditions produced a second cutting in September with a higher average yield than cut 1. In the second cutting, Kenhy and 'Ky 31' were the highest-yielding, producing significantly more than 'Fawn'. Fall growth (cut 3) was also unusually high in 1989. There were seven cultivars in the high-yield group, four in a low-yield group, and 'Mo-96' between. For the year, there was little significant difference, except that Martin produced more than Stef. Three-year average production was significantly higher from the six top-producing cultivars than from Stef and Johnstone. Phyter ranked first in 3-year average production (0.5 tons/acre/year more than the test average). Earlier tests indicated that Phyter and Martin were above-average in forage quality (Report of Progress 543, 1988).

Table 1. Third-year (1989) and 3-Year Avg. Forage Yield (@12% moisture) of Tall Fescue Varieties, Mound Valley Unit, SEK Branch Experiment Station.

Variety	1989 Forage Yield				3-Year
	Cut 1 (5/11)	Cut 2 (9/8)	Cut 3 (11/28)	Total	Average Yield
	- - - - - - - - - - - - tons/acre	- - - - - - - - - - - - - -			
Phyter	2.49abc	2.87ab	1.40a	6.76ab	7.13a
Martin	2.72a	2.82ab	1.41a	6.96a	7.01a
Forager	2.52ab	2.5labc	1.13bc	6.17ab	6.91a
Festorina	2.34abcd	2.84ab	1.47a	6.64ab	6.90a
MO-96	2.38abcd	2.66ab	1.30ab	6.34ab	6.88a
Kenhy	1.78cd[1]	3.10a	0.85d	5.73ab	6.86a
Cajun	2.08abcd	2.66ab	1.47a	6.22ab	6.73ab
Ky-31	2.18abcd	3.08a	0.98cd	6.24ab	6.67ab
Triumph	2.02abcd	2.61abc	1.37a	6.00ab	6.62ab
Fawn	2.38abcd	2.32bc	1.36a	6.05ab	6.62ab
Mozark	2.38abcd	2.55abc	1.46a	6.39ab	6.59ab
Johnstone	1.96bcd	2.68ab	l.00cd	5.64ab	6.12bc
Stef	1.65d	2.79ab	0.98cd	5.42b	5.73c
Average	2.23	2.67	1.23	6.13	6.63
LSD(.05)	0.62	0.62	0.19	NS	0.58

[1]Means within a column followed by the same letter are not significantly (P<.05) different.

BIG BLUESTEM CULTIVAR EVALUATION

Joseph L. Moyer

Summary

Forage productivity and quality, seed production, and other adaptive traits were measured on four big bluestem cultivars for 3 years. Forage production was similar among the entries, averaging about 1.7 tons/acre/year. Forage IVDMD was generally highest for 'Rountree' and lowest for 'Kaw'. Seed production was generally highest for TO4237 and Kaw and lowest for 'Pawnee'. No other differences were found. Nitrogen (50 lb/acre) was added to the plots in 1989 for the first time, and TO4237 yielded more than Pawnee.

Introduction

Warm-season, perennial grasses are needed to fill a production void left by cool-season grasses in certain forage systems. Reseeding improved varieties of a native species, such as big bluestem, also could help fill the summer production "gap." This test compared old and new cultivars for several agronomic and adaptive traits.

Experimental Procedure

Big bluestem was seeded with a cone planter in 12--inch rows on June 20, 1985 at 12 lb PLS/acre in four randomized blocks. Plots were sprayed with 1 lb/acre of 2,4-D on June 13, 1986, and burned each spring thereafter in early April. Stand counts, plant heights, and other measurements were taken after the first growth season, the center rows were cut twice in 1986 and 1988 and on June 29, 1987 for forage production, and culms from the outside rows were counted and threshed for estimation of seed production. On May 17, 1989, 50 lb N/acre as urea was applied to the plots, and forage yield was taken on July 3.

Results

Forage production was similar among the entries for the first 3 years, averaging about 1.7 tons/acre/year (Table 1). After N was added in the fourth year, TO4237 produced more forage by July 3 than 'Pawnee'. Forage quality in terms of crude protein and IVDMD contents varied little. However, IVDMD was generally highest for 'Rountree' and lowest for 'Kaw', with the same trend for crude protein content.

Seed production was generally highest for TO4237 and Kaw and lowest for Pawnee (Table 1). The number of seedheads per unit area was also usually highest for T04237, particularly in 1987 when differences in seed yield most favored that cultivar.

Plant stands appeared to improve during the course of the study, but there were no significant differences among cultivars from 1985-88. Pawnee had relatively high plant vigor ratings throughout the study. Kaw had vigorous plants early in the study, but declined relative to other cultivars in the last 2 years. Conversely, Rountree had relatively low vigor ratings for the first 2 years, but had ratings higher than Raw and TO4237 by 1988. Canopy characteristics were similar among the cultivars, except that foliage height was greater for Raw than Pawnee and Rountree in 1987.

Table 1. Forage and Seed Production Traits of Big Bluestem Cultivars at the Mound Valley Unit, SEK Branch Experiment Station.

Trait	Cultivar			
	TO4237	Kaw	Rountree	Pawnee
Forage Production (tons/acre @ 12% moisture)				
1986, Cut 1	0.85a[1]	0.91a	0.88a	0.83a
Cut 2	0.64a	0.79a	0.85a	0.74a
Total	1.49a	1.70a	1.73a	1.57a
1987	1.63a	1.61a	1.32a	1.40a
1988, Cut 1	1.22a	1.32a	1.08a	1.14a
Cut 2	0.66a	0.76a	0.79a	0.75a
Total	1.88a	2.08a	1.87a	1.90a
3-Year Total	5.00a	5.40a	4.92a	4.86a
1989[2]	2.40a	2.22ab	2.19ab	2.02b
Forage Crude Protein (%)				
1986, Cut 2	6.5a	6.la	6.6a	6.2a
1987, Cut 1	5.la	5.2a	5.4a	5.5a
1988, Cut 1	4.2a	4.3a	4.5a	4.3a
Cut 2	5.2a	5.2a	5.4a	5.2a
1989[2]	5.5a	5.8a	5.4a	5.3a
Forage Digestibility (%IVDMD)				
1986, Cut 2	53.6a	51.6a	51.3a	53.7a
1987, Cut 1	56.0a	55.7a	56.0a	56.6a
1988, Cut 1	49.0a	49.4a	50.8a	50.8a
Cut 2	49.0ab	47.3b	49.2a	48.6ab
Seed Production (lb/acre)				
1986	188a	121ab	63b	54b
1987	384a	211b	122c	112c
1988	147a	153a	143a	106b
Seedhead Production (culms/ft^2)				
1986	4.6a	3.5a	3.0a	2.6a
1987	8.6a	5.7b	5.8b	5.2b
1988	6.la	4.7a	6.2a	5.la

[1]Means within a row followed by the same letter are not significantly different (P=.05), according to Duncan's test.
[2]Harvested after 50 lb N/acre added in May, 1989.

Table 2. Adaptability Traits of Big Bluestem Cultivars at the Mound Valley Unit, SEK Branch Experiment Station.

Trait	Cultivar T04237	Kaw	Rountree	Pawnee
Plant Stand (%)				
1985	10a[1]	12a	17a	16a
1986	50a	50a	65a	49a
1987	61a	62a	64a	51a
1988	72a	72a	68a	68a
Plant Vigor Rating (l-9, where l-best)				
1985	5.5ab	6.5a	4.0b	5.8a
1986	4.0ab	5.0a	2.5b	4.5ab
1987	4.0b	2.5b	4.5ab	7.5a
1988	4.5b	4.5b	6.5a	6.5a
Foliage Height (cm)				
1986	120a	115a	122a	115a
1987	140ab	146a	130bc	120c
Foliage Width (cm)				
1986	19a	16a	18a	20a
1987	18a	16a	16a	18a

[1]Means within a row followed by the same letter are not significantly different (P=.05), according to Duncan's test.

EFFECTS OF FLUID FERTILIZER PLACEMENT AND TIMING ON TALL FESCUE AND BROMEGRASS YIELD

Daniel W. Sweeney and Joseph L. Moyer

Summary

Knife applications of N resulted in 0.55 to 0.95 ton/a higher fescue and bromegrass forage yields than broadcast or dribble applications. Highest yields were obtained when two-thirds of the N was applied in the fall and one-third was applied in the spring, whereas 100% of the N in the fall gave poorest yields.

Introduction

Several million acres of seeded cool-season grasses exist in eastern Kansas, mostly tall fescue and smooth bromegrass pastures. Much of the cool-season grass in southeastern Kansas has been in long-term production and continually fertilized by top-dressing. This study was initiated in 1986 to determine how yield of tall fescue and smooth bromegrass is affected by 1) timing of N application, 2) method of fluid N application as either broadcast, dribble, or knife at 4", and 3) N rates of 75 and 150 lb/a.

Experimental Procedure

Nitrogen fertilization timing schemes were 1) 100% of the N applied in the fall, 2) 100% of the N applied in the spring, or split N applications consisting of 3) 67% of the N in fall and 33% of the N in spring and 4) 33% of the N applied in fall and 67% of the N in spring. Target application dates were late Oct. or early Nov. for the fall UAN (urea-ammonium nitrate solution - 28% N) fertilization, and spring N applications were in mid-March. Dribble and knife spacings were 15 inches. Uniform broadcast applications of 39 lb P_2O_5/a and 77 lb K_2O/a were made each fall immediately preceding N application. A 3 ft x 20 ft area was harvested in mid-May.

Results

Tall fescue or bromegrass yields were affected by timing of N application in 1989 (Table 1). The highest yields for both fescue and bromegrass were obtained with two-thirds of the N applied in the fall and one-third in the spring, and lowest yields resulted when all N was applied in the fall, although differences were less than 0.5 ton/a. Knife applications resulted in 0.55 to 0.95 ton/a higher yield than broadcast or dribble for both fescue and bromegrass. Increasing the N rate from 75 to 150 lb/a increased fescue and bromegrass yields by approximately 0.5 ton/a. However, yield was increased by more than 1 ton/a when 75 lb N/a was applied as compared to the check. A three-way interaction of timing, method, and N rate for fescue yield suggested, especially at the 150 lb N/a rate, that yield was increased by knife as compared to surface applications in systems including split fall-spring applications, whereas knifing 150 lb N/a in the spring or fall did not result in large increases in yields above those with surface applications.

Table 1. Effect of Fluid N Rate, Placement and Time of Application on Tall Fescue and Smooth Bromegrass Yields in 1989.

Item	Yield @ 12% moisture	
	Fescue	Bromegrass
	----- ton/a	-------
Timing		
100% of N in fall	2.05	2.58
67% of N in fall - 33% of N in spring	2.52	3.07
33% of N in fall - 67% of N in spring	2.26	2.92
100% of N in spring	2.33	3.00
LSD (0.05)	0.24	0.32
Method		
Broadcast	2.15	2.52
Dribble	2.03	2.70
Knife	2.70	3.47
LSD (0.05)	0.21	0.28
N Rate (lb/a)		
75	2.04	2.68
150	2.56	3.11
LSD (0.05)	0.17	0.23
Interaction(s)	TxMxN	NS
Check[1]	1.00	1.15

[1]Not included in the 4x3x2 factorial analyses.

EFFECT OF LEGUMES ON SUBSEQUENT GRAIN SORGHUM YIELD IN CONSERVATION TILLAGE SYSTEMS

Daniel W. Sweeney and Joseph L. Moyer

Summary

Previous legume crops increased grain sorghum yields at two sites in the first year after the legume (1987), but not in the second year (1988). However, in the third year at one site, yield was approximately 15 bu/a higher where red clover was grown in 1986-87 than where grain sorghum had been continuously cropped. Tillage affected grain sorghum yields in 1987 and at one site in 1989, but not in 1988. In the first year after the legumes, N application rate did not affect yields; however, yields tended to increase with N rate in 1988 and 1989.

Introduction

This study was initiated to evaluate the use of spring-seeded (red clover) and fall-seeded (hairy vetch) legumes in reduced and no-tillage systems on subsequent grain sorghum production. Nitrogen rates up to 120 lb/a were applied in each system to determine the effect of legume on N requirements for grain sorghum.

Experimental Procedure

The experiment was a split-split plot arrangement of a randomized complete block design with three replications. The whole plots were previous crop: red clover, hairy vetch, or grain sorghum. The first split was tillage system: reduced tillage or no tillage. The second split was N rates: 0, 30, 60, 90, and 120 lb/a. The experiment was conducted on two adjacent sites at the Parsons Field of the Southeast Kansas Branch Experiment Station. Site 1 had 24 lb available P per acre and 160 lb available K per acre, whereas Site 2 had 8 lb available P per acre and 120 lb available K per acre in the surface soil zone. Site 1 was plowed from native grass in spring 1979, whereas Site 2 was plowed from native grass in fall 1983. To establish the previous crop for subsequent grain sorghum production, red clover was planted on March 21, 1986, grain sorghum was planted on June 17, 1986, and hairy vetch was planted on September 10, 1986. No-till plots in the red clover and hairy vetch areas were sprayed with 1 qt/a of glyphosate and 3 pt/a of 2,4-D ester in May, 1987. No-till plots in the previous grain sorghum area were sprayed with 1 qt/a of glyphosate in May. Reduced tillage plots in all previous crop areas were offset disced with one pass in May. Nitrogen as UAN solution (28% N) was dribble applied in June prior to planting at the rates listed above. Pioneer 8585 grain sorghum seed was planted in all areas at 62,000 seed/a. Grain sorghum was replanted in the plots in 1988 and 1989 similar to 1987.

Results

At Site 1 in 1987, yields of grain sorghum following either red clover or hairy vetch were higher than those of grain sorghum following grain sorghum (Table 1). At Site 2, the lower soil P and K fertility site, grain sorghum yields following hairy vetch were 11 bu/a higher than those following red clover; however, this difference was not significant. Both previous legume crop systems resulted in higher yield in 1987 than continuous grain sorghum. However, in 1988, grain sorghum yield was not significantly affected by previous legume crop. At Site 1, though not statistically significant, yields were more than 13 bu/a less with continuous grain sorghum than where legumes were grown in 1986-87. In 1989 at Site 1, grain sorghum grown in the area cropped to red clover in 1986-87 yielded approximately 15 bu/a more than grain sorghum that had been grown continuously since 1986. Yields at Site 2 in 1989 were not significantly affected by previous crop.

At both sites in 1987, reduced tillage resulted in more than 15 bu/a higher yields than no tillage; however, tillage did not affect grain sorghum yield in 1988 (Table 1). Tillage did not affect yield at Site 1 in 1989; however, reduced tillage resulted in approximately 9 bu/a higher yields than no tillage at Site 2. For the first grain sorghum crop to follow the legume systems (1987), N rate did not significantly affect yields at either site. In contrast, for the second grain sorghum crop to follow the legumes (1988), increasing N rates tended to increase yields, with no interaction between previous crop and N application rate. In 1989 at Site 1, grain sorghum yield tended to be increased with increasing N rates. However, a tillage by N rate interaction resulted from maximum yield being obtained with 90 lb N/a in reduced tillage, whereas in no tillage, maximum yield was obtained with 120 lb N/a. At Site 2 in 1989, yield increased with increasing N to 90 lb N/a with no further increase at 120 lb N/a.

Table 1. Effect of Previous Crop, Tillage, and N Rate on Grain Sorghum Yield at Two Sites at the Parsons Field in 1987, 1988, and 1989.

Treatment Means	Grain Sorghum Yield					
	Site 1			Site 2		
	1987	1988	1989	1987	1988	1989
	---------------- bu/a			----------------		
Previous Crop						
Red clover	56.7	87.2	59.1	39.1	68.5	41.7
Hairy vetch	55.5	88.6	50.2	50.4	74.9	41.4
Grain Sorghum	27.9	73.9	43.4	21.9	69.8	41.7
LSD (0.05)	10.4	NS	10.2	12.7	NS	NS
Tillage						
Reduced	59.3	83.3	52.4	45.5	72.6	46.0
No-tillage	34.1	83.1	49.4	28.8	69.5	37.3
LSD (0.05)	12.7	NS	NS	11.3	NS	7.4
N rate (lb/a)						
0	45.0	77.3	36.6	35.0	68.7	32.9
30	43.9	80.5	46.6	34.8	67.1	38.0
60	47.3	81.1	52.4	39.3	71.5	42.2
90	48.2	86.8	57.3	37.9	73.3	47.5
120	49.1	90.3	61.7	38.7	74.6	47.5
LSD (0.05)	NS	6.2	5.9	NS	4.3	5.1
Interaction(s)	NS	NS	TxN	NS	NS	NS

EFFECTS OF P AND K RATES AND FLUID FERTILIZER APPLICATION METHOD ON DRYLAND ALFALFA YIELD[1]

Daniel W. Sweeney, Joseph L. Moyer, and John L. Havlin

Summary

Total alfalfa yield was increased by fluid P additions up to 120 lb P_2O_5/a; however the major reponse appeared to be due to the first 40 lb P_2O_5/a. Alfalfa yield was increased by 80 lb K_2O/a but not by higher K rates. Fluid fertilizer placement did not affect alfalfa yields in 1989.

Introduction

Alfalfa production in Kansas totals approximately 1 million acres. Efficient fertilizer use can result in large economic returns for alfalfa producers. Limited work has been done in Kansas concerning fertilizer options for alfalfa. Therefore, a study was initiated to determine how alfalfa yields are affected by P and K rates and method of fluid fertilizer application.

Experimental Procedure

An on-station site was planted in fall 1987. Background soil P and K levels in the surface 6" were 11 and 120 lb/a, respectively. The treatments were randomized in a complete block with four replications. Two separate analyses (experiments) were made. The first analysis compared liquid fertilizer P rates of 0, 40, 80, and 120 lb P_2O_5/a and K rates of 0, 80, and 160 lb K_2O/a when dribble applied. The second analysis compared broadcast, dribble, and knife (4-inch depth) application methods at P rates of 40 and 80 lb P_2O_5/a and K rates of 0 and 80 lb K_2O/a. Fertilizer applications were made preplant in fall 1987. Fertilizer solutions were also applied in fall 1988. Cuttings were taken from a 3 x 20' area of each plot.

Results

Experiment 1

At the first cutting in 1989, significant yield increases were obtained with P and K rates up to 80 lb P_2O_5/a and 80 lb K_2O/a (Table 1). First cutting yields increased approximately 50% with 80 lb P_2O_5/a as compared to no-P treatments. Though differences in mean yields were smaller, second and third cutting yields tended to increase with the addition of 40 lb P_2O_5/a, but higher P rates did not significantly increase yields. Phosphorus additions increased total yield by 0.66 to 1.06 ton/a above the check. The addition of 80 lb K_2O/a resulted in significant increases in yield for all cuttings and the total; however, a further increase to 160 lb K_2O/a did not result in additional increases in yield.

Experiment 2

Yield of individual cuttings or total yield was not significantly affected by fluid fertilizer placement in 1989 (Table 2). Dribble and knife applications

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[1]Research is partially supported by grant funding from the Fluid Fertilizer Foundation.

tended to result in higher yield than with broadcast, but the differences were small. The absence of interactions suggests that the effect of P or K additions on alfalfa yield was not influenced by placement method.

Table 1. Alfalfa Yield in 1989 as Affected by P and K Rates of Dribble Applied Fluid Fertilizer.

	Yield @12% Moisture				
	Cutting				
Treatment	1	2	3	4	Total
	ton/a				
	P_2O_5 (lb/a)				
0	1.06	1.23	1.05	0.70	4.04
40	1.36	1.37	1.17	0.79	4.70
80	1.50	1.45	1.18	0.77	4.91
120	1.50	1.48	1.27	0.85	5.10
LSD (0.05)	0.15	0.14	0.12	0.10	0.40
	K_2O (lb/a)				
0	1.20	1.28	1.07	0.71	4.26
80	1.40	1.44	1.24	0.82	4.85
160	1.47	1.44	1.24	0.82	4.95
LSD (0.05)	0.13	0.12	0.10	0.08	0.34
Interaction	NS	NS	NS	NS	NS

Table 2. Alfalfa Yield in 1989 as Affected by Placement Method and P and K Rates of Fluid Fertilizer.

Treatment	Yield @12% Moisture				
	Cutting				
	1	2	3	4	Total
	ton/a				
Method					
Broadcast	1.32	1.35	1.09	0.76	4.52
Dribble	1.40	1.40	1.13	0.77	4.70
Knife	1.44	1.43	1.16	0.73	4.78
LSD (0.05)	NS	NS	NS	NS	NS
P_2O_5 (lb/a)					
40	1.35	1.39	1.14	0.74	4.61
80	1.42	1.41	1.12	0.77	4.73
LSD (0.05)	NS	NS	NS	NS	NS
K_2O (lb/a)					
0	1.30	1.33	1.08	0.71	4.42
80	1.48	1.47	1.17	0.80	4.92
LSD (0.05)	0.10	0.08	0.07	0.08	0.25
Interaction(s)	NS	NS	NS	NS	NS

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

Daniel W. Sweeney

Summary

In general, conventional and reduced tillage have resulted in higher grain sorghum yields than no-tillage. Applying N resulted in large increases in grain sorghum yield, with anhyrous ammonia tending to result in highest yields. In contrast, soybean yields have been little or not affected by tillage or residual N application method.

Introduction

Many kinds of rotational systems are employed in southeastern Kansas. This experiment was designed to determine the effect of selected tillage and nitrogen fertilization options on the yields of grain sorghum and soybeans in rotation.

Experimental Procedure

A split-plot design with four replications was initiated in 1983, with tillage systems as whole plots and N treatments as subplots. The three tillage systems were conventional, reduced, and no tillage. The conventional system consisted of chiseling, discing, and field cultivation. The reduced-tillage system consisted of discing and field cultivation. Glyphosate was applied each year at 1.5 qt/a to the no-till areas. The four nitrogen treatments for the 1983, 1985, 1987, and 1989 grain sorghum were a) zero N applied, b) anhydrous ammonia knifed to a depth of 6 inches, c) broadcast urea-ammonium nitrate (UAN - 28% N) solution, and d) broadcast solid urea. N rates were 125 lb/a.

Results

Averaged across the 4 years of grain sorghum, conventional tillage has tended to result in higher yields than no tillage, even though the difference was not significant in 1983 (Table 1). Small fluctuations occurred, but conventional and reduced tillage generally resulted in similar yields. As evidenced by the values obtained in the checks, N supplied by soybeans grown in alternate years was not sufficient to maintain yields. In general, any of the N fertilization systems resulted in large increases in yield as compared to the check. Except for 1983, anhydrous ammonia tended to result in highest yields. However, except for 1987, use of either urea or UAN for surface N fertilization did not result in a large decrease in grain sorghum yield. Yield was affected by an interaction between tillage and N fertilization system in 1985. This was due to the large yield increase obtained with anhydrous ammonia in no-tillage plots as compared to smaller increases with anhydrous ammonia in conventional or reduced-tillage plots.

Although soybean yield generally tends to be less with no tillage, the differences have not been significant (data not shown). Residual N affected soybean yield only in 1984. However, because yields were less than 7 bu/a, the yield differences between N treatments were less than 1.5 bu/a (data not shown).

Table 1. Effect of Tillage and N Fertilization on Yield of Grain Sorghum Grown in Rotation with Soybeans.

Treatments	Yield 1983	1985	1987	1989	4-crop Avg.
	------------- bu/a -------------				
Tillage					
Conventional	46.8	95.4	69.8	52.3	66.1
Reduced	45.9	95.0	75.5	43.3	64.9
No-tillage	42.8	58.8	52.0	30.1	45.9
LSD (0.05)	NS	7.3	11.6	15.8	
N Fertilization					
Check	45.0	65.6	30.4	18.9	40.0
Anhydrous ammonia - knifed	45.2	92.3	92.0	55.0	71.1
UAN solution - broadcast	43.9	85.6	60.4	47.1	59.3
Urea solid - broadcast	46.4	88.9	80.3	46.7	65.6
LSD (0.05)	NS	5.5	9.2	7.6	
T x N Interaction	NS	*	NS	NS	

SOIL COMPACTION EFFECTS ON SOYBEAN AND GRAIN SORGHUM AND SELECTED SOIL PROPERTIES[1]

Daniel W. Sweeney and Mary Beth Kirkham

Summary

Compaction schemes did not affect soybean or grain sorghum yields in 1987 or 1988. However, in 1989, yield of Williams 82 soybeans and Pioneer 8585 grain sorghum was reduced by all compaction and by wheel track compaction.

Introduction

Claypan soils are typical in southeastern Kansas. Usually, these soils have approximately 1 ft of silt loam overlying 3 ft or more of silty clay. Therefore, mechanical operations that affect the top 12" of soil may significantly impact plant growth and crop production. Soil compaction is one possible consequence of tillage and harvesting operations. Thus, the objective of this experiment was to determine the effect of selected compaction systems on soybean and grain sorghum growth and yield and on soil properties.

Experimental Procedure

The experiment was established at the Columbus Field of the Southeast Kansas Branch Experiment Station in 1987. Five compaction systems comprised the whole plots of a split-plot experimental design. The compaction regimes include 1) entire area compacted, 2) wheel track compaction, 3) wheel track compaction that has received a subsequent chisel operation, 4) wet disc operation, and 5) no intentional compaction. Subplots were two soybean varieties, Williams 82 and Bay, and one grain sorghum variety, Pioneer 8585. Plots were compacted in the spring each year by use of a four-wheel drive tractor with a total weight of 18640 lb in 1987 and 20,140 lb in 1988 and 1989. Double passes in the same track were made by the tractor. In addition, since the tire width was 20", side-by-side, double-passed tracks were used to make a 40" compacted area. These tracks were made perpendicular to the subsequent row planting. The chisel operation for designated wheel track treatments was done perpendicular to the wheel tracks in April at a depth of 8" and on a spacing of 12". The no intentional compaction treatment also received a chisel operation in 1989. Wet disc operations were done in May. All plots, including those receiving no intentional compaction, were disced and field cultivated in June prior to planting. Soybeans and grain sorghum were planted in mid-June at approximately 140,000 and 66,000 seeds/a, respectively. Soybeans were fertilized with 153 lb/a of 6-24-24 applied as a side band with the planter. Grain sorghum was fertilized with a blend of 67 lb N/a as urea (46-0-0) and 145 lb/a of 6-24-24 applied as a side band with the planter.

Plots were harvested for yield. Yield components were determined from a sample taken from a 30 x 52" area within the plot. In addition, plant height at maturity, leaf area index, and dry weight were measured. Oxygen diffusion rates at 4" and gravimetric moisture content were measured in the soil.

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[1] Research is partially supported by grant funding from the Kansas Soybean Commission.

Results

Visual symptoms were apparent by 1988, but the compaction systems did not result in statistical differences in yield of soybeans or grain sorghum in 1987 or 1988 (Table 1). Plant population, plant height, and soil penetration resistance were affected by compaction in 1988 (data not shown). In 1989, yield of both Williams 82 soybeans and Pioneer 8585 were reduced by the all-compaction treatment. In addition, wheel track compaction resulted in lower Williams 82 yield than in the wheel track system that received a chisel treatment as an attempt to disrupt any compaction zone. These results suggest that short-term compaction resulting from situations similar to those encountered in this study may not result in a significant decrease in yield. However, continued compaction with no effort to eliminate any potential compacted soil zones could result in decreased crop production.

Table 1. Effect of Selected Compaction Schemes on Yield of Williams 82 and Bay Soybeans and Pioneer 8585 Grain Sorghum in 1987, 1988, and 1989.

	Yield							
	Williams 82			Bay			8585	
Compaction Scheme	1987	1988	1989	1987	1988	1989	1988	1989
	bu/a							
No intentional compaction	22.8	11.4	37.8	22.8	19.2	35.7	66.1	75.1
All compacted	21.0	10.2	27.7	22.2	17.1	28.6	59.0	51.5
Wheel track	21.3	11.1	34.0	21.7	22.6	33.0	69.8	61.3
Wheel track - chisel	22.4	14.3	37.3	22.1	20.4	36.6	69.5	77.6
Wet Disc	23.7	14.6	40.5	23.7	23.0	33.7	66.7	77.3
LSD (0.05)	NS	NS	3.0	NS	NS	NS	NS	18.0

EFFECT OF TILLAGE SYSTEMS ON SOYBEAN YIELD[1]

Daniel W. Sweeney and Mary Beth Kirkham

Summary

Soybean yields were not affected by tillage either grown in rotation with grain sorghum or as a continuous monocrop in 1988. In 1989 in either rotation, yield tended to be highest with spring chisel. Yields in 1989 tended to be lower with conservation-type tillage systems.

Introduction

Southeastern Kansas accounts for approximately one-third of soybean production in the state. Thus, much of Kansas soybean production occurs on claypan soils typical of the area. Usually, these claypan soils have approximately 1 ft of silt loam overlying 3 ft or more of silty clay. Therefore, mechanical operations such as tillage that affect the top 12" of soil may significantly impact plant growth and crop production. The objective of this study was to determine the effect of six selected tillage systems on soybean yield in continuous monoculture and in rotation with grain sorghum.

Experimental Procedure

The experiment was established at the Mound Valley Field in 1988. Three areas were subdivided from a 9-acre field: one was for continuous soybeans, and the second and third areas were in rotation with grain sorghum, so that soybean information was collected one year from the second area and in the next year from the third area. The six planned tillage systems included late winter chiseling, spring chiseling, spring plowing, ridge tillage, reduced tillage, and no tillage. Three cultivars (Williams 82 - Group III; Sparks - Group IV; Bay - Group V) were planted in each tillage system.

Results

Tillage system did not significantly affect soybean yield in 1988 (Table 1); however, yields tended to be lower with no tillage than with the other systems, for soybeans grown continuously or in rotation with grain sorghum. However, when soybeans were grown in rotation, 1988 yields were influenced by an interaction between tillage system and cultivar. In 1989, yields of soybeans in both rotations were affected by tillage system, with the spring chisel treatment resulting in the highest yields. In general, treatments that involved limited or no tillage tended to result in lower soybean yields in 1989.

Averaged across tillage systems, yields in 1988 were higher for Bay than Sparks, with Williams 82 having intermediate values at both sites (Table 1). In 1989, Williams 82 produced the highest yields. Yields of Bay (Group V) were low, probably because of frost.

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[1] Research is partially supported by grant funding from the Kansas Soybean Commission.

Table 1. Effect of Selected Tillage Systems on Yield of Soybeans in 1988 and 1989 Grown Continuously or in Rotation with Grain Sorghum.

Treatment Means	Soybean Yield: Continuous Soybeans 1988	1989	In Rotation with Grain Sorghum 1988	1989
	------------ bu/a		------------	
Tillage				
Late Winter Chisel	20.4	18.9	22.5	15.8
Spring Chisel	20.8	24.3	23.5	21.6
Spring Plow	21.1	23.7	21.0	15.8
Ridge-tillage	21.6	12.5	21.6	18.7
Reduced	20.0	15.1	21.2	14.4
No-tillage	18.5	12.3	20.0	15.1
LSD (0.05)	NS	4.4	NS	4.1
Cultivar				
Williams 82	20.7	20.1	22.1	20.2
Sparks	19.2	17.5	20.1	17.7
Bay	21.3	15.7	22.8	12.8
LSD (0.05)	1.5	2.4	0.9	2.0
Interaction	NS	NS	TxC	NS

EFFECT OF PREVIOUS RESIDUE MANAGEMENT AND N RATE ON YIELDS IN A CONTINUOUS SMALL GRAIN - DOUBLECROP SOYBEAN ROTATION

Daniel W. Sweeney

Summary

In general, doublecrop soybean yields have been low from 1983 to 1989 with no defined trend in response from wheat straw residue management. However, wheat (or oat) yields have often been lower where the previous doublecrop soybeans were planted no-till as compared to burn and disc or discing only. Increased N rates for wheat have had little effect on wheat or soybean yields.

Introduction

Doublecropping soybeans after wheat or other small grains, such as oats, is practiced by many producers in southeastern Kansas. Several options exist for dealing with straw residue from the previous small grain crop. The method of managing the residue may affect not only the doublecrop soybeans but also the following small grain crop. Wheat (or oat) residue that is not removed by burning or is not incorporated before planting soybeans may result in immobilization of N applied for the following small grain crop (usually wheat). Therefore, an additional objective of this study was to observe whether an increase in N rate, especially where doublecrop soybeans were grown with no-tillage, could increase small grain yields.

Experimental Procedure

Three wheat residue management systems for doublecrop soybeans with three replications were established in spring 1983: no-tillage, disc only, and burn then disc. After the 1983 soybean harvest, the entire area was disced, field cultivated, and planted to wheat. Before field cultivation, 6-24-24 was broadcast in all areas. In spring, urea was broadcast as a topdressing to all plots, so that the total N rate was 83 lb N/a. Wheat yield was determined in areas where the three residue management systems were imposed previously. In spring 1985, residue management plots were split, and two topdress N rates were applied for wheat. These two rates were added to give total yearly N applications of 83 and 129 lb N/a. These residue management and total N rate treatments were continued through 1989, except in 1986 and 1987, when oats were planted in the spring because of wet conditions in the fall.

Results

In general, yields of doublecrop soybeans were low during the 7 years of this study (Table 1). Yields rarely exceeded 15 bu/a. The disc only treatment tended to result in higher yields in years where residue management resulted in significant differences. No-tillage tended to result in lower or no yields, partly because of weed pressure. In 1987 and 1989, the residual N that was applied to the previous wheat crop resulted in higher soybean yield in the burn then disc treatment and in the disc only treatment. However, yield was not increased by residual N in the no-tillage plots (interaction data not shown).

In general, the previous residue management used for doublecrop soybeans affected the subsequent wheat or oat crops (Table 2). Small grain yields have been up to 20 bu/a less where soybeans were doublecropped no-till in the previous year. Often, yield differences were small between the burn then disc treatment and the disc only treatment. Averaged across residue management systems, increasing the N rate never resulted in an increase in small grain yield. However, oat yields in 1987 were affected by an interaction between residue management system and N rate. Increasing N rate lowered oat yields in areas where doublecrop soybeans had been planted no-till, whereas increasing N rate increased oat yields where the residue management had been either burn then disc or disc only.

Table 1. Soybean Yield as Influenced by Small Grain Residue Management and Residual N Application Rates.

Treatment Means	Soybean Yield						
	1983	1984	1985	1986	1987	1988	1989
	----------------			bu/a			----------------
Small grain residue mgmt.							
Burn then disc	7	-	15	10	13	1	11
Disc only	4	-	21	12	17	3	10
No-tillage	6	-	0	9	13	6	0
LSD 0.05	NS	-	2	NS	3	2	6
N Rate (lb/a)							
83	-	-	12	10	13	3	5
129	-	-	13	12	15	4	10
LSD 0.05	-	-	NS	NS	1	NS	2
Interaction	-	-	NS	NS	*	NS	**

Table 2. Wheat Yield in 1984, 1985, 1988, and 1989 and Oat Yield in 1986 and 1987 as Influenced by Previous Small Grain Residue Management and N Application Rates.

Treatment Means	Small Grain Yield					
	1984	1985	1986	1987	1988	1989
	bu/a					
Previous residue mgmt.						
Burn, then disc	63	59	79	51	58	40
Disc only	59	55	85	49	53	45
No-tillage	43	48	64	42	50	33
LSD 0.05	13	8	6	NS	5	NS
N Rate (lb/a)						
83	-	53	77	47	56	38
129	-	55	75	47	51	40
LSD 0.05	-	NS	NS	NS	5	NS
Interaction	-	NS	NS	*	NS	NS

EFFECT OF TIMING OF LIMITED IRRIGATION ON SOYBEANS PLANTED AT TWO DATES

Daniel W. Sweeney and George V. Granade

Summary

In 1987, limited irrigation did not significantly increase the yield of soybeans planted in early or late June. An interaction ($p<0.10$) suggested that during 1987, irrigation may have been more important for late-planted soybeans than for those planted in early June. In 1988, soybean yield was increased by as much as 25% by the addition of limited irrigation. In 1989, though yield tended to be increased by approximately 4 bu/a, the difference was not significant.

Introduction

Irrigation of soybeans is not extensive in southeastern Kansas. This is due partly to the lack of large irrigation sources. Limited irrigation, supplied by the substantial number of ponds in the area, could be used to help increase soybean yields. The objectives of this experiment were to determine the optimum reproductive growth stage for irrigation with a limited water supply and to determine if planting date affects soybean responses to irrigation.

Experimental Procedure

An experiment was established in 1987 to determine the effect of four irrigation schemes on yield of three soybean cultivars planted at two dates. The four irrigation schemes were no irrigation, 1" applied at the R1 growth stage (first bloom), 1" applied at the R4 growth stage (pod 0.75" long at one of four uppermost nodes), and 1" applied at R6 growth stage (full-sized green beans at one of the four uppermost nodes). The two planting dates were early and late June. The three soybean cultivars were Crawford, Douglas, and Sparks. All cultivars were seeded at approximately 146,000 seed/a. All areas were fertilized with 112 lb/a of 6-24-24 prior to planting.

Results

In 1987, soybean yield was not significantly affected by irrigation scheme, planting date, or cultivar selection (Table 1) and averaged 38.7 bu/a. An interaction ($p<0.10$) between irrigation scheme and planting date in 1987 suggested that yields of the three cultivars planted at the early date were not affected by irrigation schemes. However, when the three cultivars were planted in late June, they appeared to respond to the irrigation systems. Yields were increased by 3 to 6 bu/a when the soybeans received 1" of irrigation at the R1 and R6 reproductive growth stages, as compared to either no irrigation or irrigation at the R4 stage (data not shown). Even though rainfall occurred sporadically in 1987, the yields suggest that moisture stress periods were minimal. In contrast, yields were lower in 1988 and were likely influenced by dry conditions. Thus, soybean yields were 2.5 to 4.1 bu/a higher with irrigation than without in 1988. In 1989, an interaction similar to that in 1987 between irrigation scheme and planting date was observed. Yield tended to be unaffected by irrigation at the early planting date; however, yields from the late planting date were increased by approximately 7 to 11 bu/a (data not shown). An interaction between planting date and cultivar in 1987 showed that Sparks was little affected by planting date, whereas both Crawford and Douglas yielded approximately 2 to 3 bu/a less when planted in late June rather than in early

June. In 1988, the planting date by cultivar interaction was due to the larger reduction in yield for Douglas planted at the later date than for the other two varieties. In 1989, the interaction was due to lower yields at the early date with Sparks than Crawford or Douglas, whereas all cultivars yielded approximately the same when planted at the later date. In addition, in 1988, early June planting and Sparks soybeans resulted in higher yield than late planting and Crawford and Douglas cultivars. In 1989, the differences between planting dates were not significant, although Sparks tended to yield approximately 5 bu/a less than Crawford and Douglas.

Table 1. Effect of Timing of Limited Irrigation on Yield of Soybean Planted at Two Dates in 1987 and 1988.

Treatment Means	Yield 1987	Yield 1988	Yield 1989
	-----------	bu/a	-----------
Irrigation by growth stage			
None	36.8	16.4	25.0
R1	39.6	18.9	29.4
R4	38.3	20.0	28.5
R5	39.9	20.5	29.8
LSD (0.05)	NS	2.3	NS
Planting Date			
Early June	39.4	20.1	29.8
Late June	37.9	17.9	26.6
LSD (0.05)	NS	1.6	NS
Cultivar			
Crawford	38.9	18.1	30.2
Douglas	38.4	18.6	29.1
Sparks	38.7	20.2	25.2
LSD (0.05)	NS	0.9	1.6
Interaction(s)	PxC IxP (0.10)	PxC	PxC IxP (0.10)

EFFECTS OF SULFUR RATE, METHOD, AND SOURCE ON TALL FESCUE[1]

Daniel W. Sweeney and Joseph L. Moyer

Summary

Fluid S additions had a minimal effect on tall fescue yield; however, some quality parameters appeared to be improved. Perhaps because of low April rainfall, fertilizer placement did not affect final forage yield.

Introduction

Since sulfur is a necessary element for both plants and animals, sulfur fertilization not only may benefit forage growth but may improve animal performance. Tall fescue is one of the major forages in southeastern Kansas, as well as in other parts of the country. Thus, this research was initiated to evaluate the effect of fluid S rate, method of application, and source on yield and quality of tall fescue.

Procedure

Site 1 was established in spring 1988 at an off-station location (Terry Green farm), and Site 2 was established in spring 1989 at a second off-station location (Calonder farm). Factors included 0 lb S/a compared with 15 and 30 lb S/a as ammonium sulfate (AS) and ammonium thiosulfate (ATS) as fluid sources. Methods of application were broadcast, dribble, and knife. Spacing for dribble and knife applications was 15 inches. Nitrogen was balanced to 150 lb N/a with UAN. Uniform broadcast applications of 77 lb P_2O_5/a and 84 lb K_2O/a were made to all plots each year. In mid-May, final forage production was harvested near full bloom at both sites.

Results

Though the differences were small, the application of 30 lb S/a as ATS increased final forage yield ($p<0.10$) at site 1 in 1989 as compared to 0 or 15 lb S/a (Table 1). The application of 30 lb S/a as ATS also increased N content and decreased neutral-detergent fiber (NDF) values in the final yield as compared to no S. Both sources resulted in increases in S concentration in fescue tissue; however, ATS resulted in significant increases at both 15 and 30 lb S/a application rates, whereas AS only resulted in increased S concentration at the 30 lb S/a rate. At site 2, there were no responses in yield, N content, or S content to S additions of either source (Table 2). NDF was slightly increased with ATS application at 15 lb S/a, but was reduced by 30 lb S/a to a value similar to that obtained with no S application.

At Site 1 in 1989, knifing tended to result in higher yield, N content, and S content in forage than broadcasting, with dribble applications resulting in intermediate values (Table 1). Placement method had no effect on NDF values at Site 1. At Site 2, knifing also tended to result in higher yield, N content, S

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[1] Research is partially supported by grant funding from the Fluid Fertilizer Foundation, Texas Sulphur Products Co., The Sulphur Institute, and Allied-Signal Inc.

content, and lower NDF values than broadcast applications (Table 2). However, in general, effects of knifing were not significantly different than those obtained with dribble applications.

Table 1. Effect of S Rate and Method of Application on Final Forage Yield, N, S, and Neutral-Detergent Fiber (NDF) Content of Tall Fescue Fertilized with Ammonium Sulfate (AS) and Ammonium Thiosulfate (ATS) at Site 1 in 1989.

Treatment	Yield		N		S		NDF	
	AS	ATS	AS	ATS	AS	ATS	AS	ATS
	-- ton/a --		---- % ----		--- ppm ---		---- % ----	
Rate (lb/a)								
0	3.03	3.03	1.59	1.59	1310	1310	57.6	57.6
15	3.07	2.95	1.66	1.66	1380	1590	57.6	57.1
30	3.13	3.25	1.61	1.69	1570	1760	57.7	56.6
LSD (0.05)	NS	NS	NS	0.08	190	170	NS	NS
LSD (0.10)	NS	0.21	NS	0.06	160	140	NS	0.7
Method								
Broadcast	3.04	2.89	1.53	1.54	1350	1440	57.6	56.6
Dribble	3.03	3.07	1.58	1.63	1400	1600	57.4	57.3
Knife	3.15	3.27	1.74	1.77	1510	1630	57.9	57.4
LSD (0.05)	NS	0.25	0.09	0.08	NS	NS	NS	NS
LSD (0.10)	NS	0.21	0.08	0.06	NS	140	NS	NS
RxM Interaction	NS	NS	NS	*	NS	**	NS	NS

Table 2. Effect of S Rate and Method of Application on Final Forage Yield, N, S, and Neutral-detergent Fiber (NDF) Content of Tall Fescue Fertilized with Ammonium Sulfate (AS) and Ammonium Thiosulfate (ATS) at Site 2 in 1989.

Treatment	Yield AS	Yield ATS	N AS	N ATS	S AS	S ATS	NDF AS	NDF ATS
	-- ton/a --		---- % ----		--- ppm ---		---- % ----	
Rate (lb/a)								
0	2.46	2.46	1.67	1.67	1350	1350	61.3	61.3
15	2.21	2.71	1.72	1.57	1390	1330	60.7	62.8
30	2.26	2.48	1.63	1.63	1390	1380	61.1	61.2
LSD (0.05)	NS	NS	NS	NS	NS	NS	NS	1.1
LSD (0.10)	NS	NS	NS	NS	NS	NS	NS	0.9
Method								
Broadcast	2.20	2.32	1.53	1.46	1310	1180	62.4	63.2
Dribble	2.30	2.64	1.71	1.63	1430	1380	60.7	61.4
Knife	2.43	2.69	1.78	1.77	1400	1490	60.1	60.7
LSD (0.05)	NS	NS	0.16	0.14	NS	180	1.5	1.1
LSD (0.10)	NS	0.27	0.13	0.12	NS	150	1.2	0.9
RxM Interaction	NS	NS	NS	NS	NS	NS	NS	NS

PERFORMANCE TESTING OF SMALL GRAIN VARIETIES

George V. Granade and Ted Walter[1]

Summary

Winter wheat and barley were planted in mid-October, 1988, and spring oats and spring wheat were planted in mid-March, 1989. Winter wheat was harvested in June with an average yield of 74 bu per acre. Winter barley had an average yield of 46 bu per acre. The spring small grains were harvested in early July. Spring oat varieties, Ogle and Bates, had the highest yields. Yields of spring wheat were much lower than those of winter wheat. The spring wheats do not appear very promising because of the warm humid conditions in early spring in southeastern Kansas, which increase the potential for diseases.

Introduction

The small grain variety tests are conducted to help southeastern Kansas growers select varieties best adapted for the area. Complete results for these tests are available in Kansas Agric. Expt. Stn. Report of Progress 577 and Report of Progress 588. The small grains tested in 1989 included winter wheat, winter barley, spring oats, and spring wheat.

Experimental Procedure

Forty-two winter wheat and five winter barley cultivars were planted on October 12, and October 4, 1988, respectively, and six spring oats and nine spring wheat cultivars were planted on March 14, 1989. Seeding rates were 1,080,000 seeds per acre for wheat, 70 lb. per acre for barley, and 90 lb. per acre for spring oats. All grains were fertilized with 75 lb. N per acre before planting.

Winter Wheat Results

Average yield for all varieties tested was 74 bu/a, with Pioneer 2163, Pioneer 2551, Terra 201 exp., Karl, AGSECO 7846, AgriPro Lincoln, Terra 152 exp., and Caldwell being the top yielders. The fall was very favorable for planting and establishing stands. The winter was cold, but the wheat was well established, so there was little, if any, winterkill. The spring was drier than normal, but rainfall was adequate to produce excellent yields. Yields of some varieties are shown in Table 1.

[1] Department of Agronomy, KSU.

Winter Barley Results

Barley yields ranged from 26 to 66 bu/a (Table 2). Lodging was a major problem for most varieties. Post produced the highest yield for 1989 and for the 2- and 3-year averages.

Spring Oats Results

Yields and yield components of spring oats are shown in Table 3. Average yield of the test was 58 bu per acre, and test weights averaged 31 lb per bushel. Yields ranged from 48 to 72 bu per acre, with Ogle being the highest yielding variety. Yields were lower than normal because of a cool spring and low rainfall for April.

Spring Wheat Results

Yields and yield components for spring wheat are shown in Table 4. The spring wheat test averaged 24 bu per acre, and the highest yielding cultivar was Marshall (34 bu per acre). Test weight ranged from 44 to 57 lb per bushel. The dry spring reduced yields for these wheats.

Table 1. Winter Wheat Yields of Selected Varieties, Parsons, 1989.

Brand	Variety	1989 Yield	Test Weight	Plant Height
		Bu/a	Lb/bu	In
Pioneer	2551 (S)	89	56.4	33
Pioneer	2163	89	56.9	32
Terra	201 Exp. (S)	88	56.3	34
---	Karl	86	59.1	34
AGSECO	7846	85	60.5	34
AgriPro	Lincoln (S)	84	58.0	37
Terra	152 Exp.	84	58.0	34
---	Caldwell (S)	82	57.0	37
Pioneer	2180	79	55.9	28
---	TAM 107	79	58.1	34
AgriPro	Twain (S)	78	59.5	36
---	Cardinal (S)	78	54.7	41
Pioneer	2172	78	56.2	30
---	Siouxland	78	57.9	40
	Test mean	74	58.0	35
	$LSD_{0.05}$	7	2.1	2

Planted: October 12, 1988
Harvested: June 16, 1989
Fertilizer: 75 lb N/a on October 3, 1988

Table 2. Yield and Yield Components for Winter Barley, 1989.

Variety	Yield 1989	Yield 1988-89	Yield 1987-89	Plant Height	Test Weight
	-----------Bu/a-----------			In	Lb/bu
Dundy	43	64	62	24	39.2
Hitchcock	43	62	60	27	41.0
Kanby	26	61	60	28	38.4
Post	66	83	83	30	39.9
Schuyler	50	69	69	28	41.6
$LSD_{0.05}$	16			3	NS
Test mean	46			27	40.0

Planted: October 4, 1988
Harvested: June 19, 1989
Fertilizer: 75 lb N/a on October 3, 1988

Table 3. Yield and Yield Components of Spring Oats, 1989.

Variety	1989 Yield	Test Weight	Mid-Bloom	Plant Height	Lodging
	Bu/a	Lb/bu	Mon Day	In	%
Bates	68	31.1	5 21	28	11
Don	53	32.1	5 18	25	28
Hazel	55	29.4	5 22	26	1
Ogle	72	30.2	5 21	28	5
Starter	48	32.6	5 18	27	8
Larry	54	28.9	5 18	27	7
$LSD_{0.05}$	12	1.8	1	2	7
Test mean	58	30.7	5 20	26	10

Planted: March 14, 1989
Harvested: July 6, 1989
Fertilizer: 75 lb N/a on October 3, 1988

Table 4. Yield and Yield Components of Spring Wheat, 1989.

Variety	Yield 1989	Yield 1988-89	Yield 1987-89	Plant Height	Protein Content
	-----------Bu/a-----------			In	%
Anza	25	19	--	24	14
Guard	28	20	26	24	16
Marshall	34	24	28	25	16
Norseman	28	19	24	25	17
Olso	26	19	21	26	17
Phoenix	8	7	--	22	17
Yecora Rojo	22	19	--	21	15
Yolo	16	11	--	24	14
Fjeld	27	--	--	25	
Test mean	24	17	22	24	
$LSD_{0.05}$	5	3	2	2	

Planted: March 14, 1989
Harvested: July 5, 1989
Fertilizer: 75 lb N/a on October 3, 1988

CORN HYBRID PERFORMANCE TEST

George V. Granade and Ted Walter[1]

Summary

A corn performance test was planted in Crawford County on bottomland to determine the top corn hybrids in southeastern Kansas. Several hybrids have potential for this area on bottomland soils. Yields averaged 136 bu/a, with a range of 112 to 154 bu/a.

Introduction

Corn hybrids are grown in southeastern Kansas on bottomland soils. Determining which hybrids will perform best in this area is of prime importance to farmers.

Experimental Procedure

In 1989, 46 corn hybrids were planted in an off-station test on bottomland in Crawford County. All corn was planted on April 14 in 30-inch rows. The corn was thinned to a population of 16,080 plants per acre on May 8. Corn was harvested on September 21.

Results

Above-average rainfall and below-normal temperatures during the growing season were favorable factors for corn production. The test averaged 136 bu/a, with a range of 112 to 154 bu/a. Table 1 shows the yields and yield components of some of the highest yielding corn hybrids. Complete results are compiled in Kansas Agric. Expt. Stn. Report of Progress 583.

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[1] Department of Agronomy, KSU.

Table 1. Bottomland Corn Hybrid Yields, Crawford County, 1989.

Brand	Hybrid	Yield	Test Weight	Days to Silking
		Bu/a	Lb/bu	
ORO	190	154	58	73
Cargill	7877	153	56	72
Golden Acres	T-E 6988	151	58	74
Funk's	G-4673B	150	58	75
Pioneer	3379	149	58	74
Jacques	8210	148	58	73
Cargill	7990	147	56	74
Pioneer	3189	147	58	76
Triumph	1650 FG	145	59	75
DeKalb-Pfizer	DK 711	144	58	75
Nebraska	715	142	55	77
Garst	TP 4445	141	58	74
Golden Acres	T-E X8905	141	57	75
BO-JAC	601	140	59	74

Planted: April 14, 1989
Harvested: September 21, 1989
Fertilizer: 120 lb N/a; 70 lb P_2O_5/a; 70 lb K_2O/a. Applied before planting.
Herbicide: Lasso plus Atrazine as a pre-emergent herbicide.

SOYBEAN VARIETY PERFORMANCE TEST

George V. Granade and William T. Schapaugh[1]

Summary

Soybean varieties from maturity groups III, IV, and V were planted in mid-June at the Columbus Field of the Southeast Kansas Branch Station. Weather conditions were very favorable for good soybean growth, but an early frost in October may have hurt group V soybean's yields. Maturity group V soybean varieties continue to have the most consistent high yields for southeastern Kansas. However, group III and IV soybeans had higher yields than group V in 1989.

Introduction

Soybeans are an important crop for southeastern Kansas, which has approximately one-third of the state's acreage. Testing and developing varieties that are adapted to the area is of prime importance to local farmers.

Experimental Procedure

Soybean cultivars from maturity groups III, IV, and V were tested in 1989 at the Columbus Field. Soybeans were planted on June 9 in 30-inch rows with a John Deere Max-emerge planter equipped with cones.

Results

Below-normal temperatures and above-normal rainfall provided good conditions for soybean growth. However, an early frost in October hurt yields of group V soybeans. Yields for maturity group V soybeans averaged 39.7 bu per acre, whereas yields for the group III and IV soybean were 46.4 bu per acre. Some of the more commonly grown varieties are listed in Table 1. Complete results are compiled in Kansas Agric. Expt. Stn. Report of Progress 591.

[1] Department of Agronomy, KSU.

Table 1. Soybean Cultivar Yields, Columbus Field, 1987.

Brand	Variety	Maturity Group	1989 Yield	1988-89 Yield	1987-89 Yield
			Bu/a	Bu/a	Bu/a
-----	Harper	III	49.3	37.6	30.9
Merschman	Washington VI	III	48.7	37.3	31.2
Ohlde	3983	III	47.7	----	----
----	Resnik	III	45.5	35.7	----
----	Sherman	III	46.8	36.3	30.1
Terra	Advance	III	43.9	31.2	----
Terra	Cycle	III	44.9	36.1	----
Terra	Marathon	III	44.6	30.8	----
Terra	Triumph	III	49.1	33.9	28.8
-----	Williams 82	III	40.0	33.4	29.2
-----	Zane	III	50.0	37.0	31.0
	Test mean		46.4		
	$LSD_{(0.05)}$		NS		
Asgrow	A 4393	IV	48.8	36.5	----
Atlas	485	IV	47.9	----	----
----	Crawford	IV	40.8	31.8	29.1
Merschman	Atlanta II	IV	48.4	38.0	34.2
Merschman	Dallas	IV	48.7	37.2	34.0
NeCo	1350	IV	49.1	37.5	34.8
Northrup King	S42-50	IV	48.9	----	----
Ohlde	O-4450	IV	51.7	----	----
Oro	410 Exp.	IV	48.9	----	----
----	Spencer	IV	47.2	34.9	30.3
Terra	Competitor	IV	49.2	36.9	32.6
	Test mean		46.4		
	$LSD_{(0.05)}$		NS		
----	Bay	V	38.4	33.2	31.2
Deltapine	415	V	41.9	----	----
----	Essex	V	43.4	35.7	33.6
----	Hutcheson	V	41.7	36.3	33.7
Northrup King	S53-34	V	37.1	33.4	----
Ohlde	5660	V	39.4	33.9	----
----	Pershing	V	39.8	33.3	31.2
Pioneer	5482	V	42.5	33.8	----
Pioneer	9531	V	42.3	35.6	----
----	Stafford	V	40.5	34.5	30.5
Stine	5970	V	35.7	----	----
	Test mean		39.7		
	$LSD_{(0.05)}$		4.8		

Planted: June 9, 1989.
Herbicide: 0.33 lb Lexone DF/a + 1.5 pt Dual/a.

PERFORMANCE OF EARLY MATURITY SOYBEANS IN SOUTHEASTERN KANSAS

George V. Granade

Summary

Twenty-two soybean cultivars from maturity groups 00, 0, and I were planted in late April in southeastern Kansas. Despite drier than normal conditions in April, yields averaged 36.3 bu per acre. Two-year averages ranged from 15 to 37 bu per acre. Group I soybean cultivars had higher yields than either the group O or OO soybean cultivars.

Introduction

Interest has increased in growing early soybeans, with wheat following them in the fall. Maturity group 00, 0, and I soybeans are normally grown in the northern part of the United States; however, the possibility exists of growing these soybeans in southeastern Kansas. The growing season will be shorter, and plant height will be reduced. The objective of this study was to examine yield potential of group OO, O, and I soybeans.

Experimental Procedure

Twenty-two soybean cultivars from maturity groups 00, 0, and I were obtained and planted on April 19, 1989 on the Calvin Flaharty farm near McCune. Soybeans were drilled in 7-inch rows at the rate of 336,000 seeds per acre. Plant height, height to first pod, maturity, yield per acre, and number of seeds per pound were recorded. A composite seed sample from the four replications was analyzed for protein and oil content.

Results

Yields ranged from 18 to 48 bu per acre, with Terra Runner being the top yielder (Table 1). All cultivars matured during late July to early August and were harvested in mid-August. Protein content ranged from 34 to 39 percent, and oil content ranged from 18 to 20 percent. Cultivars from maturity group I generally yielded higher than cultivars from maturity group O or OO. Seed quality was greatly improved in 1989 compared to previous years, probably because of the cooler summer and higher amount of rainfall in July and August.

Table 1. Yield and yield components of Group O, OO, and I Soybeans, 1989.

Brand	Cultivar	1989 Yield	Average 2-Yr	Average 3-Yr	Height Plant	Height Pod	Seed Quality Score[2]	Maturity Mon	Maturity Day	Protein[1]	Oil[1]
		------bu/a-----			---in---					----%----	
Terra	Runner	48.3	--	--	31	5	2	8	9	34.8	19.5
Hoegemeyer	160 Exp.	47.7	--	--	31	5	2	8	8	33.9	20.2
Northrup King	S15-50	47.1	36.7	37.1	29	5	3	8	10	35.5	19.3
Pioneer	9202	44.8	36.7	34.2	24	4	2	8	9	36.3	19.3
Terra	Runner III	43.3	--	--	29	4	2	8	7	35.7	19.4
Pioneer	9161	43.1	35.4	--	25	4	2	8	7	35.3	19.6
Pioneer	9181	43.0	35.8	32.9	23	5	3	8	7	35.8	19.3
----	Weber 84	42.5	35.2	36.1	33	6	2	8	7	36.0	19.5
Hoegemeyer	150	39.6	33.5	--	32	4	2	8	8	34.8	20.5
Northrup King	S23-12	38.8	33.3	--	27	5	3	8	9	34.7	20.2
Pioneer	1677	37.8	30.6	--	24	4	2	8	4	35.1	19.4
Terra	180 Exp.	37.4	--	--	26	4	2	8	8	35.2	19.9
Terra	085 Exp.	36.7	--	--	25	4	3	8	3	37.3	18.6
----	Hardin	36.2	--	--	27	4	3	8	7	36.2	19.0
----	Hodgson 78	33.2	30.4	27.9	27	4	3	7	31	36.2	19.0
----	Sibley	31.9	27.3	28.0	28	4	3	8	5	37.0	18.9
----	Dawson	30.1	23.2	22.2	26	4	4	7	26	36.7	18.8
----	Dassel	28.1	21.5	29.7	23	3	3	7	30	36.9	18.4
----	Evans	27.0	20.8	20.6	24	3	4	7	24	37.5	18.5
----	Chico	18.2	25.2	18.3	21	3	4	7	20	38.1	18.2
----	McCall	19.0	14.6	15.8	22	3	3	7	20	37.1	17.9
----	Maple Ridge		17.7	12.3	12.7	18	3	4	7	21	
38.5	17.6										
LSD$_{0.05}$		8.5			4	1	1		2		
Test mean		36.3			26	4	3	8	3		

[1] Protein and oil content based on 13 percent moisture.
[2] Score on scale of 1 to 5, 1 being very good and 5 being very poor.

Planted: April 19, 1989
Herbicide: 1.6 pt. Treflan Pro 5 + 0.6 lb Scepter per acre as ppi.
Harvested: August 18, 1989

IRRIGATION OF EARLY MATURITY SOYBEANS IN SOUTHEASTERN KANSAS

George V. Granade

Summary

Nine soybeans from group I were planted in late April and grown with irrigation in southeastern Kansas. Yields ranged from 42 to 55 bu per acre, with Weber 84 being the top yielder. Seed quality, protein content, and oil content were good.

Introduction

Early maturity soybeans are growing in popularity; however, seed quality is not as good as that of full-season soybeans. One possible reason is lack of moisture late in the growing season. Thus, a study was established to examine the effect of irrigation on group I soybeans.

Experimental Procedure

Nine soybean cultivars from maturity group I were planted on April 25, 1989 on the David Dhooghe farm east of Parsons. Soybeans were drilled in 7-inch rows at the rate of 336,000 seeds per acre. Irrigation was applied as needed. Plant height, height to first pod, maturity, yield per acre, seed quality, and number of seeds per pound were recorded. A composite seed sample from the four replications was analyzed for protein and oil content.

Results

Soybean yields and yield components are shown in Table 1. Soybeans were irrigated four times in late June and July for a total of 5 inches. Seed quality of all cultivars was rated good. However, because of atypical rainfall during the summer, we cannot determine if irrigation will improve seed quality. Soybean yields were very good, averaging 50 bu per acre. Protein content ranged from 36 to 38 percent, and oil content was 19 percent.

Table 1. Yield and Yield Components of Irrigated Group I Soybeans, 1989.

Brand	Cultivar	Yield	Height Plant	Height Pod	Maturity Mon	Maturity Day	Seed Quality	Seed Size	Protein[1]	Oil[1]
		bu/a	---in---		Mon	Day	Score[2]	seed/lb	----%----	
----	Weber 84	55.1	32	5	8	19	2	3850	36.7	18.9
Pioneer	9181	52.8	23	4	8	16	3	2890	35.9	18.9
Northrup King	S15-50	52.6	31	4	8	19	2	3560	35.9	19.3
Hoegemeyer	150	50.7	25	4	8	16	2	3300	36.0	19.2
----	Sibley	50.2	27	5	8	15	2	2700	37.2	18.8
----	Hardin	47.5	24	4	8	16	2	3680	37.6	18.4
Terra	Runner III	44.7	24	4	8	15	2	2990	36.5	18.9
----	Hodgson 78	42.3	26	4	8	13	3	3260	37.5	18.8
$LSD_{0.05}$		ns	2	ns		2	ns	300		
Test mean		49.5	27	4	8	17	2	3280		

[1] Protein and oil content based on 13 percent moisture.
[2] Score on scale of 1 to 5, 1 being very good, and 5 being very poor.

Planted: April 25, 1989
Herbicide: 3 pt Squadron per acre as ppi.
Harvested: August 28, 1989
Irrigation amount and date: 1.25 in. on June 25, July 5, July 12, and July 19 for a total of 5 in.

EFFECT OF PLANTING DATE ON EARLY MATURITY SOYBEANS[1]

George V. Granade

Summary

Soybeans from maturity groups OO, O, and I each were planted in early April, mid-April, and early May. Yield, seed quality and size, plant height, height to first pod, plant population, and maturity were measured. Soybeans from maturity group I planted in mid-April and early May had the highest yields in 1989. The two- and three-year averages indicated early May as the optimal planting date for group I soybean cultivars.

Introduction

Interest in early maturing soybeans has increased in southeastern Kansas. However, the best time to plant these soybeans has not been determined. The objective of this study was to examine the effect of planting dates on yield and yield components of soybean cultivars from maturity groups OO, O, and I.

Experimental Procedure

Three soybean cultivars each were obtained from maturity groups OO, O, and I and all were planted on April 6, April 21, and May 11 at the Parsons Field. Planting rate was 336,000 seeds per acre, using a 12 row, 7-inch grain drill equipped with a cone planter. Yield, maturity, plant height, pod height, plant population, seed size, and seed quality were measured.

Results

Yield and yield components are shown in Tables 1 and 2. There were significant differences for yield, seed size, plant height, and maturity because of the interaction of soybean cultivar and planting date. Highest yield for Weber 84 was from the April 21 planting, whereas the other cultivars peaked with the May 11 planting. Plant height of the soybean cultivars decreased with planting date. Weber 84 and Hodgson 78 were the tallest cultivars. Height to first pod was higher for the group I soybeans than either the O or OO soybean cultivars. Seed quality was good for all cultivars, except Chico and Maple Ridge. Seed quality was improved in 1989 because of the below-normal temperatures and atypical rainfall. Seventy percent of the seeds planted emerged, regardless of cultivar or planting date.

[1]This research is supported by a grant from the Kansas Soybean Commission.

Table 1. Yield and Yield Components of Group OO, O, and Soybean Cultivars for Three Planting Dates, 1989.

Soybean Cultivar	Maturity Group	Planting Date	Yield 1989	Yield 2-yr	Yield 3-yr	Seed Quality	Seed Size	Maturity
		Month Day	------Bu/A------			Score[1]	Seeds/lb	Mo-day
Chico	OO	April 6	21.0	13.7	15.5	4	5590	7-13
		April 21	21.1	16.0	17.2	3	4610	7-21
		May 11	23.4	20.4	23.6	2	3530	8- 3
Maple Ridge	OO	April 6	20.2	12.1	12.4	4	3580	7-11
		April 21	23.0	17.1	16.7	3	3650	7-23
		May 11	29.6	24.0	22.6	3	3310	8- 4
McCall	OO	April 6	24.3	13.9	16.5	3	3400	7-16
		April 21	26.2	19.7	23.8	3	3530	7-29
		May 11	35.0	28.8	30.3	3	3120	8-16
Dassel	O	April 6	26.1	15.9	15.5	3	3640	7-24
		April 21	33.9	26.5	24.7	2	3220	8- 9
		May 11	37.8	31.6	30.0	2	3130	8-14
Dawson	O	April 6	29.4	17.3	20.7	3	3640	7-20
		April 21	35.5	25.7	29.0	3	3250	8- 8
		May 11	38.7	30.9	28.5	3	3110	8-10
Evans	O	April 6	26.6	15.6	17.3	3	4180	7-17
		April 21	29.6	21.7	22.6	3	3590	8- 3
		May 11	36.0	27.2	28.2	2	3350	8- 8
Hodgson 78	I	April 6	26.5	17.4	20.2	4	3420	8-16
		April 21	42.3	34.0	35.3	3	3010	8-14
		May 11	45.4	35.2	34.2	3	3410	8-14
Sibley	I	April 6	31.8	19.0	20.1	3	3310	8-11
		April 21	36.4	27.5	29.4	3	3110	8- 6
		May 11	48.2	33.9	32.4	2	3190	8-15
Weber 84	I	April 6	33.6	21.1	23.2	3	3600	8- 6
		April 21	43.8	33.0	34.6	2	3290	8-14
		May 11	41.0	33.3	30.8	2	4390	8-15
	LSD[2] $_{(0.05)}$		6.9	4.7	4.2	0.6	397	8
	Test mean		32.1	23.4	24.3	3	3580	

[1]Score -- based on scale of 1 to 5; 1 - very good to 5 - very poor.
[2]LSD was calculated from interaction of main effects not from single factor analysis.

Table 2. Plant Population, Plant Height, and Pod Height of Soybeans from Maturity Groups OO, O, and I Planted at Three Different Dates, 1988.

Soybean Cultivar	Maturity Group	Planting Date	Plant Population	Plant Height	Pod Height
		Mo Day	Plants/a	In	In
Chico	OO	April 6	244,000	17	2
		April 21	230,000	18	3
		May 11	235,000	15	3
Maple Ridge	OO	April 6	296,000	17	3
		April 21	272,000	19	3
		May 11	303,000	17	4
McCall	OO	April 6	299,000	21	4
		April 21	301,000	21	3
		May 11	259,000	18	3
Dassel	O	April 6	343,000	21	4
		April 21	322,000	19	3
		May 11	329,000	16	3
Dawson	O	April 6	242,000	21	3
		April 21	202,000	21	3
		May 11	197,000	18	3
Evans	O	April 6	235,000	24	3
		April 21	214,000	23	3
		May 11	268,000	18	3
Hodgson 78	I	April 6	268,000	29	4
		April 21	190,000	26	4
		May 11	232,000	23	4
Sibley	I	April 6	259,000	28	4
		April 21	276,000	25	4
		May 11	342,000	22	4
Weber 84	I	April 6	353,000	30	4
		April 21	298,000	29	4
		May 11	364,000	25	5
		$LSD_{(0.05)}$	NS	NS	NS
<u>Average Effects</u>					
Chico	OO		236,000	17	3
Maple Ridge	OO		290,000	18	3
McCall	OO		286,000	20	4
Dassel	O		331,000	19	3
Dawson	O		214,000	20	3
Evans	O		239,000	21	3
Hodgson 78	I		230,000	26	4
Sibley	I		292,000	25	4
Weber 84	I		338,000	28	4
		$LSD_{(0.05)}$	50,000	2	0.6
		April 6	282,000	23	3
		April 21	256,000	22	4
		May 11	281,000	19	4
		$LSD_{(0.05)}$	NS	2	NS

EARLY MATURING SOYBEANS COMPARED WITH FULL-SEASON SOYBEANS[1]

George V. Granade

Summary

Soybeans cultivars from maturity groups OO, O, I, III, IV, and V were planted in both late April and early June in two row spacings and at two seeding rates at the Parsons Field of the Southeast Kansas Experiment Station. Weber 84 and Zane planted on April 24 and Zane, Hodgson 78, and Weber 84 planted on June 20 were the highest yielding cultivars. McCall had the highest protein and oil content. However, Weber 84 and Zane had the highest estimated process value per acre.

Introduction

Interest in planting early soybeans (maturity groups OO, O, and I) has increased, but questions have been asked about how they compare to full-season soybeans (maturity groups III, IV, and V). A study was initiated to examine how early soybeans yields and yield components compare to those of full-season soybeans when planted in April or June at two seeding rates and two row spacings.

Experimental Procedure

Soybean cultivars from maturity groups OO, O, I, III, IV, and V were planted at the Parsons Field of the Southeast Kansas Experiment Station. Soybeans were sowed in 7- and 30-inch rows at the rate of 139,000 and 336,000 seeds per acre on April 24 and June 19. Date of first bloom, maturity, plant height, pod height, yield, seed size, seed quality, protein and oil content, estimated process value per bushel (EPVB), and estimated process value per acre (EPVA) were determined. The EPVB value is calculated from the January, 1990 Chicago Board of Trade futures prices for soybean oil ($0.193/lb) and 44.0 precent protein soybean meal ($183.10/ton) on Sept. 1, 1989. The EPVA was calculated by multiplying the EPVB value times the yield of each cultivar.

Results

Yield and yield components are shown in Table 1 and seed quality, protein and oil content, EPVB and EPVA are shown in Table 2. Yields ranged from 9 to 36 bu per acre. Weber 84, Hodgson 78, and Zane were top yielders when planted either in April or June. One possible explanation for high yields from these three cultivars was the above normal rainfall during June, July and August. Bay, regardless of planting date, had low yields which was probably due to the early frost. Hodgson 78 when planted in April has the highest 2- and 3-year averages. Maturity of the group OO, O, and I soybeans was later than in previous years.

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[1]This research is supported by a grant from the Kansas Soybean Commission.

Plant height, and height to first pod for the group OO, O, and I soybeans were taller than what has been typically seen in the past.

Seed quality was good to poor for all cultivars regardless of planting date. Weber 84 planted in April and Stafford planted in June seed quality was good. Protein content ranged from 37 to 40 percent and oil content ranged from 16 to 19 percent. McCall had the highest protent content for either planting date whereas the highest oil content for the April date was McCall and for the June date was Hodgson 78. McCall had the highest EPVB value, but Weber 84 and Zane had the highest EPVA values.

Table 1. Yield and Yield Components of Selected Group OO, O, I, III, IV, and V Soybeans Planted in April and June, Parsons, 1989.

Soybean	Maturity	Row	Seeding	Date		Yield					Height	
Cultivar	Group	Spacing	Rate	Planted		1989	2-yr	3-yr	Maturity		Plant	Pod
		In.	Seeds/a	Mo	Day	-----Bu/a-----			Mo	Day	---In---	
McCall	OO	7	139,000	4	24	19.6	--	--	8	8	14	2
			336,000	4	24	21.6	16.7	21.7	8	10	18	3
		30	139,000	4	24	13.5	--	--	8	9	19	2
			336,000	4	24	11.1	--	--	8	15	19	3
Dawson	O	7	139,000	4	24	20.8	--	--	8	13	16	2
			336,000	4	24	25.4	19.4	24.1	8	14	19	2
		30	139,000	4	24	23.9	--	--	8	13	19	2
			336,000	4	24	14.0	--	--	8	16	21	3
Hodgson 78	I	7	139,000	4	24	27.6	--	--	8	20	21	3
			336,000	4	24	31.5	28.3	32.6	8	22	24	4
		30	139,000	4	24	25.7	--	--	8	22	24	3
			336,000	4	24	19.5	--	--	9	1	26	4
Weber 84	I	7	139,000	4	24	36.5	--	--	8	22	25	4
			336,000	4	24	34.0	26.3	--	8	24	26	4
		30	139,000	4	24	31.9	--	--	8	22	27	3
			336,000	4	24	30.0	--	--	8	22	28	5
Zane	III	7	139,000	4	24	35.1	--	--	9	7	23	5
			336,000	4	24	32.3	25.9	27.8	9	19	28	7
		30	139,000	4	24	32.0	--	--	9	16	26	4
			336,000	4	24	13.9	--	--	10	6	28	5
Crawford	IV	7	139,000	4	24	21.1	--	--	10	15	37	6
			336,000	4	24	18.2	14.8	16.3	10	13	39	7
		30	139,000	4	24	22.3	--	--	10	12	45	7
			336,000	4	24	14.9	--	--	10	17	43	7
Stafford	IV	7	139,000	4	24	30.6	--	--	10	15	28	5
			336,000	4	24	23.2	21.1	--	10	21	35	7
		30	139,000	4	24	32.5	--	--	10	9	31	7
			336,000	4	24	31.3	--	--	10	11	34	7
Bay	V	7	139,000	4	24	11.8	--	--	10	25	34	6
			336,000	4	24	15.2	15.5	20.4	10	24	39	6
		30	139,000	4	24	14.6	--	--	10	25	35	6
			336,000	4	24	9.4	--	--	10	24	38	5

Table 1. Continued

Soybean Cultivar	Maturity Group	Row Spacing	Seeding Rate	Date Planted		Yield			Maturity		Height	
						1989	2-yr	3-yr			Plant	Pod
		In.	Seeds/a	Mo	Day	-----Bu/a-----			Mo	Day	---In---	
McCall	OO	7	139,000	6	19	31.2	--	--	9	5	30	4
			336,000	6	19	26.7	--	--	9	9	30	4
		30	139,000	6	19	21.4	20.0	18.8	9	17	27	3
			336,000	6	19	25.2	--	--	9	19	26	5
Dawson	O	7	139,000	6	19	32.0	--	--	9	12	24	4
			336,000	6	19	33.5	--	--	9	11	29	4
		30	139,000	6	19	25.2	21.0	18.9	9	12	25	3
			336,000	6	19	28.3	--	--	9	12	24	4
Hodgson 78	I	7	139,000	6	19	34.1	--	--	9	22	28	4
			336,000	6	19	36.3	--	--	9	21	29	4
		30	139,000	6	19	28.8	23.9	21.3	9	23	26	4
			336,000	6	19	30.8	--	--	9	20	26	4
Weber 84	I	7	139,000	6	19	35.3	--	--	9	26	31	5
			336,000	6	19	28.6	--	--	9	28	34	6
		30	139,000	6	19	29.1	22.8	--	9	28	29	4
			336,000	6	19	25.6	--	--	9	27	29	5
Zane	III	7	139,000	6	19	34.6	--	--	10	8	30	4
			336,000	6	19	33.1	--	--	10	10	32	6
		30	139,000	6	19	25.2	22.6	23.6	10	11	28	5
			336,000	6	19	19.2	--	--	10	12	29	6
Crawford	IV	7	139,000	6	19	27.4	--	--	10	23	39	8
			336,000	6	19	20.8	--	--	10	20	39	6
		30	139,000	6	19	23.3	18.9	21.3	10	17	40	7
			336,000	6	19	22.7	--	--	10	24	37	7
Stafford	IV	7	139,000	6	19	29.6	--	--	10	20	35	8
			336,000	6	19	17.9	--	--	10	25	37	7
		30	139,000	6	19	24.9	22.2	--	10	19	31	6
			336,000	6	19	17.8	--	--	10	22	33	6
Bay	V	7	139,000	6	19	18.1	--	--	10	25	43	7
			336,000	6	19	9.7	--	--	10	26	39	7
		30	139,000	6	19	19.8	21.4	25.8	10	26	39	7
			336,000	6	19	11.5	--	--	10	26	40	6
					$LSD^{1}_{0.05}$	9.9	--	--		9	4	2

[1]LSD is calculated from single factor analysis, not the interaction of main effects.

Herbicide: 0.25 lb Lexone DF + 2 pt Dual 8E/a - Preplant incorporated on April 21, 1989.

Table 2. Seed Quality, Protein Content, Oil Content, and Estimated Process Value of Selected Group OO, O, I, III, IV, and V Soybeans, 1989.

Soybean Cultivar	Maturity Group	Row Spacing	Seeding Rate	Date Planted		Seed Quality	Seed Content[1]		EPVB[2]	EPVA[3]
							Protein	Oil		
		In.	Seeds/a	Mo	Day	Score[4]	------%-----		/b	/a
McCall	OO	7	139,000	4	24	3	37.2	19.1	$6.83	$134.00
			336,000	4	24	3	38.0	18.3	$6.84	$147.80
		30	139,000	4	24	4	38.4	18.9	$6.95	$ 94.00
			336,000	4	24	5	40.5	18.1	$7.12	$ 79.20
Dawson	O	7	139,000	4	24	3	37.6	19.0	$6.87	$143.00
			336,000	4	24	3	37.6	19.2	$6.89	$174.80
		30	139,000	4	24	4	38.0	18.5	$6.86	$163.70
			336,000	4	24	4	38.4	18.3	$6.88	$ 96.20
Hodgson 78	I	7	139,000	4	24	3	37.7	18.5	$6.83	$188.30
			336,000	4	24	4	38.1	18.5	$6.87	$216.30
		30	139,000	4	24	4	38.4	18.7	$6.92	$177.60
			336,000	4	24	4	39.0	18.4	$6.96	$135.70
Weber 84	I	7	139,000	4	24	3	37.1	18.8	$6.78	$247.40
			336,000	4	24	2	37.4	18.3	$6.76	$229.60
		30	139,000	4	24	3	37.3	18.8	$6.81	$217.10
			336,000	4	24	3	38.7	18.2	$6.90	$207.40
Zane	III	7	139,000	4	24	3	37.6	18.6	$6.83	$239.20
			336,000	4	24	4	37.6	18.2	$6.77	$219.10
		30	139,000	4	24	4	38.2	18.5	$6.88	$220.50
			336,000	4	24	5	38.9	17.6	$6.87	$ 95.80
Crawford	IV	7	139,000	4	24	4	38.8	16.6	$6.74	$142.60
			336,000	4	24	4	38.6	16.6	$6.72	$123.60
		30	139,000	4	24	4	38.6	17.1	$6.76	$150.80
			336,000	4	24	4	38.7	16.5	$6.71	$100.20
Stafford	IV	7	139,000	4	24	3	38.2	16.9	$6.71	$205.10
			336,000	4	24	4	38.6	16.9	$6.75	$156.70
		30	139,000	4	24	3	37.8	17.8	$6.75	$219.70
			336,000	4	24	4	38.1	17.7	$6.76	$211.80
Bay	V	7	139,000	4	24	4	37.4	17.4	$6.65	$ 79.30
			336,000	4	24	3	38.3	17.2	$6.74	$103.50
		30	139,000	4	24	4	37.9	17.1	$6.68	$ 97.70
			336,000	4	24	4	37.9	17.3	$6.71	$ 63.20
McCall	OO	7	139,000	6	19	4	38.2	18.8	$6.92	$215.70
			336,000	6	19	4	39.8	18.0	$7.02	$186.90
		30	139,000	6	19	4	40.0	18.1	$7.06	$151.30
			336,000	6	19	4	38.8	17.8	$6.87	$173.70
Dawson	O	7	139,000	6	19	4	38.5	18.3	$6.89	$220.40
			336,000	6	19	4	37.6	18.9	$6.86	$230.10
		30	139,000	6	19	4	37.5	18.7	$6.81	$171.60
			336,000	6	19	3	37.1	18.8	$6.78	$192.20
Hodgson 78	I	7	139,000	6	19	4	38.9	18.9	$7.00	$239.20
			336,000	6	19	4	37.7	19.5	$6.93	$251.80
		30	139,000	6	19	4	38.3	19.0	$6.95	$200.40
			336,000	6	19	4	37.7	18.9	$6.85	$211.20

Table 2. Continued

Soybean Cultivar	Maturity Group	Row Spacing	Seeding Rate	Date Planted		Seed Quality	Seed Content[1]		EPVB[2]	EPVA[3]
							Protein	Oil		
		In.	Seeds/a	Mo	Day	Score[4]	------%-----		/b	/a
Weber 84	I	7	139,000	6	19	3	38.2	18.4	$6.88	$242.70
			336,000	6	19	3	39.0	17.5	$6.86	$197.00
		30	139,000	6	19	4	39.1	17.8	$6.92	$201.40
			336,000	6	19	3	38.2	18.2	$6.84	$175.10
Zane	III	7	139,000	6	19	3	38.8	18.2	$6.92	$239.20
			336,000	6	19	3	38.2	17.9	$6.81	$255.40
		30	139,000	6	19	4	38.9	17.7	$6.88	$174.20
			336,000	6	19	4	38.1	17.5	$6.75	$130.10
Crawford	IV	7	139,000	6	19	3	39.6	16.8	$6.85	$187.40
			336,000	6	19	3	39.3	16.9	$6.83	$142.20
		30	139,000	6	19	3	39.7	16.7	$6.85	$159.40
			336,000	6	19	3	39.8	16.4	$6.84	$155.40
Stafford	IV	7	139,000	6	19	2	37.4	17.6	$6.68	$197.60
			336,000	6	19	4	38.3	17.0	$6.71	$120.30
		30	139,000	6	19	3	38.5	17.0	$6.74	$167.50
			336,000	6	19	3	38.5	16.7	$6.72	$119.70
Bay	V	7	139,000	6	19	4	37.0	17.4	$6.61	$119.90
			336,000	6	19	4	37.7	17.5	$6.70	$ 64.60
		30	139,000	6	19	4	37.5	17.3	$6.65	$131.70
			336,000	6	19	4	37.2	17.2	$6.62	$ 76.30
				$LSD^{5}_{0.05}$		1	1.4	0.8	0.14	68.00

[1]Protein and oil content expressed on a 13 percent moisture content.
[2]EPVB -- Estimated processed value per bushel based on a 44.0 % protein meal price of $183.10 and a soybean oil price of $0.193/lb.
[3]EPVA -- Estimated processed value per acre calculated by multiplying the yield times the EPVB value.
[4]Score -- based on scale of 1 to 5; 1 - very good to 5 - very poor.
[5]LSD is calculated from single factor analysis, not the interaction of main effects.

COMPARISON OF EARLY MATURING AND FULL-SEASON SOYBEANS: AN ECONOMIC ANALYSIS[1]

Robert O. Burton, Jr.[2], Mario F. Crisostomo[2], George V. Granade, Allen M. Featherstone[2], and Guido van der Hoeven[2]

Summary

Economic analysis was based on biological data shown in the previous article. Soybeans from maturity groups 00 to V were planted in late April and mid-June using two different row spacings and seeding rates at Parsons, Kansas. Budgeting to determine returns above variable costs was used for each cultivar and planting date. Group I soybeans exhibited the highest returns and group III exhibited the second highest. These high returns were associated with April planting, 7-inch rows, and 139,000 seeds per acre.

Introduction

Diversification into early maturing soybeans could spread labor, machinery, crop management, and cash flow over a longer time period each year, enhancing returns and improving economic stability. Producers considering early maturing soybeans need information about their economic potential compared to traditional, full-season soybeans. This study summarizes returns above variable costs for early maturing and traditional soybeans with two planting dates, two row spacings, and two seeding rates.

Experimental Procedure

Budgeting was used to measure receipts minus variable costs (Table 1). Gross returns reflect differences in yields and soybean prices for different cultivars on different harvest dates. Yields are reported in the previous article. Assuming that soybeans were sold at harvest, the soybean price in each budget was based on the weekly cash bids for country elevators in the Kansas City, Kansas area for the week harvested. These prices are reported in USDA's Grain and Feed Market News and, in most cases, indicate a price advantage for soybeans sold prior to the traditional fall harvest.

Budgets also reflect variable cost differences for the two planting dates, row spacings, and seeding rates. Each soybean cultivar was planted in April and June, in 7-inch rows and 30-inch rows, and seeded at 139,000 and 336,000 seeds per acre. Seed costs for maturity groups 00 through I were higher than those for groups III through V, and a 2 cents per pound shipping charge was added for seeds not normally sold in southeastern Kansas. Machinery operations for soybeans planted in 7-inch rows included three field cultivations, herbicide spraying, planting with a drill, and combining. Machinery operations for soybeans planted in 30-inch rows included three field cultivations, herbicide spraying, planting

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with a planter, row cultivating, and combining. Thus, machinery costs were greater for soybeans planted in June because a row cultivation was used and planting was more expensive than drilling. Labor requirements were directly tied to machinery operations. Costs in all budgets were based on the 1989 sources footnoted in Table 1.

Results

For all yield and price situations considered, group I soybeans exhibited the highest returns and group III exhibited the second highest (Table 2). Based on 1989 yields and soybean prices, Weber 84, a group I soybean, had per acre returns above variable costs of $177.15, and Zane, a group III soybean, had returns above variable costs of $163.24. When 2-year average yields and 5-year average soybean prices were used, Weber 84 had returns of $117.93, and Zane had returns of $103.87. When 3-year average yields and 5-year average soybean prices were used, Hodgson 78, a group I soybean, had returns of $132.38, and Zane had returns of $125.46. These returns were achieved with April planting, 7-inch row spacing, and 139,000 seeds per acre.

Differences in costs of seeds should be considered when interpreting these results. Because early maturing soybean seeds were not available in southeastern Kansas, small quantities had to be ordered from outside the state. For example, actual costs of Weber 84 seeds, the least expensive early maturing soybean seeds, were 20 cents per pound plus 2 cents per pound shipping charge. Traditional soybean seeds are available in southeastern Kansas. Costs of group III, IV and V soybean seeds were 16 cents per pound, based on a $9.75 price per bushel obtained from a local seed distributor. Thus, budgeted seed costs per acre with 139,000 seeds were $7.94 for Weber 84 soybeans and $5.78 for Zane. Results of the budget analysis would change in favor of group I soybeans if these seeds could be obtained at costs similar to costs of group III, IV, and V seeds.

Because production of early-maturing soybeans is not a well established cultural practice in southeastern Kansas and research is still in progress, questions remain about input requirements, variability, harvesting problems, and seed quality. Research has not been performed to determine optimal fertilization rates for early-maturing soybeans. The number of years of data available is not enough to measure long-term variability. Diversification into early-maturing soybeans might reduce whole-farm income variability. Early-maturing soybeans are short and tend to pod closer to the ground; thus, farmers may have problems cutting low enough to get all the soybeans in the combine. However, opportunities to harvest early soybeans in August, when weather is typically dry, may be an advantage. Appearance of early-maturing soybeans suggests poor seed quality. If production of early-maturing soybeans increases significantly, dockage might occur.

Tillage operations and timing of soybean planting have implications for the effect of early-maturing soybeans on farm structure and the environment. April-planted soybeans require primary and secondary tillage performed in a narrow time period, but few machinery operations for other major crops are required during this time. Tillage operations for soybeans planted in June are performed during a longer time frame. Primary tillage occurs in April and May and secondary tillage in June prior to planting. With a combination of early and traditional soybeans, more acres might be operated by producers without increasing the machinery compliment. Thus, this technology could benefit farms of various sizes and likely would contribute to increased production of soybeans. Impacts on farm size will depend on the desires of individual producers and the opportunities

available to them. The early canopy coverage of early-maturing soybeans during the rainy part of spring should reduce sheet and rill water movement over fields. Thus, soil erosion might be reduced.

Such potential impacts on farm structure and the environment may become important in southeastern Kansas, if research continues to indicate that production of early-maturing soybeans is a viable alternative.

Table 1. Sample Budgets Illustrating Two Row Spacings, Two Seeding Rates, and Two Planting Dates for Weber 84, a Group I Soybean, Parsons, Kansas, 1989[a].

		7" Rows, 139,000 Seeds, Planted April 24			30" Rows, 336,000 Seeds, Planted June 19		
	Unit	Price	Quantity per acre	Value or cost	Price	Quantity per acre	Value or cost
1. Gross Receipts from Production	Bu.	$ 6.16	36.50	$224.84	$ 5.78	25.60	$147.97
2. Variable costs							
Seed	Lb	$ 0.22	36.10	$ 7.94	$ 0.22	87.27	$ 19.20
Phosphate	Lb.	$ 0.00	0.00	$ 0.00	$ 0.00	0.00	$ 0.00
Potash	Lb.	$ 0.00	0.00	$ 0.00	$ 0.00	0.00	$ 0.00
Herbicide				$ 17.89			$ 17.89
Insecticide				$ 0.00			$ 0.00
Labor	Hr.	$ 6.00	.99	$ 5.94	$ 6.0	1.34	$ 8.04
Machinery				$ 13.22			$ 15.42
Interest on ½ of variable cost	Dol.	$ 0.12	22.50	$ 2.70	$ 0.12	30.27	$ 3.63
TOTAL VARIABLE CO				$ 47.69			$ 64.18
3. Income above variable cost				$177.15			$ 83.79

[a]Yields and input requirements are based on the experiment in the previous article. Soybean prices are for the week of harvest based on the average of weekly cash bids for country elevators in the Kansas City, Kansas area from USDA's Grain and Feed Market News. Herbicide rates and prices are Dual @ 2 pts/A $12.50 and Lexone DF @ 1/4 lbs/A $5.39. Machinery variable costs (fuel, lubrication, and repairs) are based on information from Fuller, Earl I and Mark F. McGuire, "Minnesota Farm Machinery Economic Cost Estimates for 1989", Minnesota Extension Service, University of Minnesota, AG-FO-2308, revised 1989, with adjustments for southeastern Kansas. Machinery costs include charges for machinery operations used for crop production plus charges for a 400 bushel truck. Acres per hour for the 400 bushel truck are based on soybean yields of 24.57 bushels per acre. Lower yields would increase acres per hour and decrease costs per acre. Higher yields would decrease acres per hour and increase costs per acre. Because adjustments in costs would be small, acres per hour and costs per acre are not adjusted for yield differences. Wage and interest rate are from Tierney, William I, Jr. and James R. Mintert, "Prices for Forward Planning," KSU Farm Management Guide, MF-525, Revised September 1989.

Table 2. Incomes above Variable Costs of Selected Group 00, 0, I, III, IV, and V Soybeans Planted in April and June, Parsons, Kansas, 1989.

Soybean Cultivar	Maturity Group	Row Spacing	Seeding Rate	Date Planted		Incomes Above Variable Costs: 1989 Yield[a] and Price[b]	2-yr. Yield[a] 5-yr. Price[b]	3-yr. Yield[a] 5-yr. Price[b]
		In.	Seed/a	Mo	Day	- - - - - - $/a - - - - - -		
McCall	00	7	139,000	4	24	65.25	--	--
			336,000	4	24	67.51	40.73	79.62
		30	139,000	4	24	24.95	--	--
			336,000	4	24	(1.10)[c]	--	--
Dawson	0	7	139,000	4	24	72.30	--	--
			336,000	4	24	78.66	52.68	83.78
		30	139,000	4	24	86.65	--	--
			336,000	4	24	4.57	--	--
Hodgson 78	I	7	139,000	4	24	115.44	--	--
			336,000	4	24	117.76	110.35	132.38
		30	139,000	4	24	99.17	--	--
			336,000	4	24	37.14	--	--
Weber 84	I	7	139,000	4	24	177.15	--	--
			336,000	4	24	141.32	117.93	--
		30	139,000	4	24	144.25	--	--
			336,000	4	24	120.62	--	--
Zane	III	7	139,000	4	24	163.24	--	--
			336,000	4	24	141.02	103.87	125.42
		30	139,000	4	24	143.33	--	--
			336,000	4	24	17.12	--	--
Crawford	IV	7	139,000	4	24	70.87	--	--
			336,000	4	24	46.21	37.71	43.07
		30	139,000	4	24	72.92	--	--
			336,000	4	24	23.47	--	--
Stafford	IV	7	139,000	4	24	123.21	--	--
			336,000	4	24	77.01	66.36	--
		30	139,000	4	24	127.17	--	--
			336,000	4	24	111.95	--	--
Bay	V	7	139,000	4	24	21.27	--	--
			336,000	4	24	31.81	36.83	65.20
		30	139,000	4	24	32.54	--	--
			336,000	4	24	(5.52)[c]	--	--
McCall	00	7	139,000	6	19	139.16	--	--
			336,000	6	19	96.75	--	--
		30	139,000	6	19	75.09	65.63	67.66
			336,000	6	19	83.40	--	--
Dawson	0	7	139,000	6	19	138.38	--	--
			336,000	6	19	125.73	--	--
		30	139,000	6	19	92.82	67.81	64.63
			336,000	6	19	89.82	--	--

Table 2 (cont.). Incomes above Variable Costs of Selected Group 00, 0, I, III, IV and V Soybeans Planted in April and June, Parsons, Kansas, 1989.

Soybean Cultivar	Maturity Group	Row Spacing	Seeding Rate	Date Planted		Incomes Above Variable Costs		
						1989 Yield[a] and Price[b]	2-yr. Yield[a] 5-yr. Price[b]	3-yr. Yield[a] 5-yr. Price[b]
		In.	Seed/a	Mo	Day	- - - - - - - - - - - - - - $/a- - - - - - - - - - - -		
Hodgson 78	I	7	139,000	6	19	142.52	--	--
			336,000	6	19	133.54	--	--
		30	139,000	6	19	107.33	85.69	69.00
			336,000	6	19	105.20	--	--
Weber 84	I	7	139,000	6	19	156.34	--	--
			336,000	6	19	101.97	--	--
		30	139,000	6	19	112.17	84.83	--
			336,000	6	19	83.79	--	--
Zane	III	7	139,000	6	19	143.17	--	--
			336,000	6	19	126.32	--	--
		30	139,000	6	19	87.39	88.32	96.07
			336,000	6	19	47.16	--	--
Crawford	IV	7	139,000	6	19	109.41	--	--
			336,000	6	19	63.45	--	--
		30	139,000	6	19	78.43	60.06	75.69
			336,000	6	19	69.62	--	--
Stafford	IV	7	139,000	6	19	121.84	--	--
			336,000	6	19	47.06	--	--
		30	139,000	6	19	90.73	83.22	--
			336,000	6	19	41.94	--	--
Bay	V	7	139,000	6	19	56.87	--	--
			336,000	6	19	.93	--	--
		30	139,000	6	19	62.31	74.53	95.38
			336,000	6	19	6.57	--	--

[a] Yields are shown in the previous article.

[b] The 1989 prices are for the week of harvest based on the average of weekly cash bids for country elevators in the Kansas City, Kansas area from USDA's <u>Grain and Feed Market News</u>. The 5-year price is based on 1985-89 prices for the average month of harvest from Kansas Agricultural Statistics. The personal consumption expenditure portion of the implicit Gross National Product deflator was used to update the 1985-88 prices to a 1989 price level before averaging.

[c] Parentheses indicate a negative number.

SHORT-SEASON CORN HYBRID POPULATION

George V. Granade and Gary Kilgore[1]

Summary

Twenty corn hybrids were obtained and planted at two populations at the Parsons Field. Plots were thinned to target populations of 22,500 and 16,500 plants per acre. Yields ranged from 97 to 173 bu per acre. Cargill 6127, DeKalb DK 535, and Garrison SG-6909 at the high population were the top yielding hybrids.

Introduction

Dryland conditions may have critical effects on full-season corn, if rains do not come during the reproductive stage of growth. Corn that matures in 100 to 115 days planted at higher than normal population may have more potential than full-season corn. The objective of this study was to determine the best population for growing short-season corn.

Experimental Procedure

Eighteen short-season corn hybrids and two full-season corn hybrids were obtained, packaged, and planted on the Parsons Field on April 6. Plots were thinned to target populations of 22,500 and 16,500 on May 4. Corn was harvested from two 25-foot rows in early September. Stand, ears per plot, mid-silk date, lodging, dropped ears, yield, and test weight were recorded. Grain weight per ear was determine by dividing the ears per plot into the grain yield per plot.

Results

Corn yields and yield components are shown in Table 1. Yields averaged 141 bu per acre, with Cargill 6127, DeKalb DK 535, and Garrison SG-6909 being the top yielders. Above-normal rainfall during the reproductive stage was the reason for high yields. Test weights ranged from 54 to 59 lb per bushel. Lodging and ear drop were not problems for any hybrid. Population did vary with hybrid, and hybrids with higher populations had a higher yield.

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Table 1. Yield and Yield Components of Short-Season Corn Hybrids, Parsons, 1989.

Brand	Hybrid	Target Population	Yield	Harvest Moisture	Actual Population	Test Weight	Mid-Silk Date		Ear Number	Grain Weight
		Plants/a	Bu/a	%	Plant/a	Lb/bu	Mon	Day	/plant	Lb/ear
Cargill	3477	16,500	112	16.2	15,300	56.8	6	22	1.54	0.263
		22,500	129	16.7	21,100	56.3	6	22	1.17	0.292
Cargill	6127	16,500	126	17.5	15,500	58.2	6	26	1.43	0.315
		22,500	173	17.4	21,400	57.7	6	26	1.38	0.327
DeKalb	DK 535	16,500	151	17.7	16,600	55.4	6	25	1.55	0.329
		22,500	170	17.7	21,300	55.7	6	26	1.41	0.318
Garrison	SG-6909	16,500	142	19.0	15,500	54.7	6	27	1.62	0.323
		22,500	169	19.3	20,700	54.8	6	28	1.29	0.357
Garst	8599	16,500	148	17.8	16,700	55.0	6	26	1.85	0.268
		22,500	160	17.8	21,300	54.7	6	25	1.62	0.263
Garst	8708	16,500	121	17.9	16,200	56.3	6	24	1.58	0.266
		22,500	154	17.9	21,800	57.6	6	24	1.34	0.295
Golden Harvest	H-2327	16,500	133	17.0	16,700	56.8	6	22	1.45	0.309
		22,500	148	16.8	20,400	56.9	6	22	1.40	0.295
Golden Harvest	H-2404	16,500	131	17.0	16,400	58.0	6	21	1.64	0.274
		22,500	145	17.4	21,500	57.6	6	21	1.30	0.378
Hoegemeyer	2559	16,500	122	16.7	15,300	57.8	6	23	1.53	0.299
		22,500	132	17.0	20,000	57.8	6	23	1.31	0.285
Hoegemeyer	2617	16,500	122	17.3	15,700	56.4	6	23	1.30	0.337
		22,500	146	17.4	21,200	56.6	6	26	1.05	0.366
NC+	2771	16,500	146	17.8	16,600	57.6	6	23	1.63	0.305
		22,500	140	17.9	20,500	57.1	6	24	1.47	0.265
NC+	3088	16,500	143	17.4	16,500	56.2	6	26	1.53	0.323
		22,500	152	17.4	21,800	56.1	6	26	1.18	0.334
Northrup King	N 4350	16,500	144	16.5	16,400	56.6	6	24	1.80	0.274
		22,500	152	16.8	18,600	56.2	6	25	1.56	0.291
Northrup King	S 4474	16,500	97	16.9	14,300	56.6	6	25	1.11	0.342
		22,500	132	16.9	20,200	57.1	6	24	1.01	0.362
ORO	901 Exp.	16,500	139	17.1	15,700	58.4	6	24	1.85	0.270
		22,500	150	17.1	20,400	58.8	6	24	1.64	0.254
ORO	902 Exp.	16,500	136	17.2	15,000	58.0	6	25	1.75	0.291
		22,500	131	17.0	18,600	58.1	6	23	1.43	0.280

Table 1. Continued

Brand	Hybrid	Target Population	Yield	Harvest Moisture	Actual Population	Test Weight	Mid-Silk Date	Ear Number	Grain Weight
		Plants/a	Bu/a	%	Plant/a	Lb/bu	Mon Day	/plant	Lb/ear
Pioneer	3615	16,500	119	17.3	15,600	54.2	6 26	1.19	0.361
		22,500	130	17.7	18,000	54.7	6 26	1.17	0.356
Pioneer	3737	16,500	138	17.4	16,300	55.0	6 24	1.60	0.299
		22,500	149	17.2	18,800	55.5	6 24	1.46	0.317
Cargill	7877[2]	16,500	157	19.1	16,400	54.9	6 28	1.47	0.368
		22,500	167	19.6	18,500	54.9	6 27	1.40	0.377
Pioneer	3379[2]	16,500	150	19.1	14,300	56.2	6 27	1.74	0.346
		22,500	154	19.0	20,000	56.4	6 27	1.37	0.316
	$LSD^{3}_{0.05}$		26	0.5	3,200	0.8	2	0.19	0.047
	Test Mean		141	17.5	18,100	56.6	6 24	1.50	0.310

[1]Yield is based on 56 lb/bu and 15.5 percent moisture.
[2]Full season hybrid used for a check.
[3]LSD calculated from a single factor analysis, not the interaction of main effects.

Planted: April 6, 1989
Herbicide: 1.8 qt Bicep/a
Fertilizer: 220 lb of 6-24-24/a; 300 lb urea/a
Harvested: September 7, 1989

PHOSPHORUS, POTASSIUM, AND CHLORIDE EFFECTS ON SELECTED DISEASES IN SIX WHEAT CULTIVARS IN SOUTHEASTERN KANSAS[1]

George V. Granade, William G. Willis[2], Merle G. Eversmeyer[2], Daniel W. Sweeney, David A. Whitney[3], and Larry C. Bonczkowski[3]

Summary

Wheat diseases destroy 10 to 25 percent of Kansas wheat yield and reduce the quality of harvested grain. A study was established in the fall of 1987 to examine the effects of P, K, Cl, and the P - K interaction with and without Tilt on wheat diseases in six wheat cultivars. Yields were increased with each addition of P and K, whereas the incidence of leaf rust was decreased with K. Application of Tilt fungicide increased yield, whereas it decreased the percent of leaf rust.

Introduction

In Kansas, wheat diseases often destroy 10 to 25 percent of the wheat yield and reduce the quality of harvested grain. Depending on the year, the severity and incidence of the diseases change. Notable diseases for southeastern Kansas are leaf rust, speckle leaf blotch, and tan spot.

Addition of fertilizers has boosted yields, reduced lodging, and improved test weight. Research in the northwestern part of the United States has also indicated a decrease of disease incidence with certain fertilizer nutrients. Chloride has been shown to decrease take-all disease in wheat. The objectives of this study are (1) to examine the P, K, Cl, or the P - K interaction effects on the incidence of leaf rust, speckle leaf blotch, or tan spot in different wheat cultivars and (2) to determine whether fertility factors affect (a) wheat yield, (b) yield components, (c) protein content, and (d) plant nutrient concentrations.

Experimental Procedure

The study site (a Parson silt loam soil) was in soybeans from 1985 to 1987 and planted to wheat in the fall of 1987 and 1988. Eleven fertility levels were established with the soybean study and continued for the wheat study. Three P rates (0, 30, and 60 lb P_2O_5/a) in combination with three K rates (0, 40, and 80 lb K_2O/a) were broadcast by hand before planting. Two rates (0 and 64 lb/a) of Cl were also broadcasted by hand. Wheat cultivars planted were Agripro Thunderbird, Bounty BH 205, Caldwell, Karl, Newton, and TAM 107. At the boot growth stage, plots were split with one side receiving 'Tilt', a fungicide.

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[1] Research is partially funded by a grant from the Foundation for Agronomic Research

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At the boot stage, 44 inches of one row were harvested for determination of dry matter production and nutrient concentration. Before harvest, the number of heads per area was counted, and 20 heads were randomly selected from each split plot to determine kernels per head. Plant height, yield, test weight, and thousand kernel weight were also determined.

Results

The 1988 - 1989 growing season was execellent for wheat, with overall yields averaging 69 bu/a. Yield, test weight, kernels per head, kernel weight, and heads per m^2 were significantly influenced by P fertilization or interaction of P fertilization and cultivar (Table 1). Yield of all cultivars increased significantly with 30 lb P_2O_5/a. Test weight and kernel weight decreased with each addition of P, whereas kernels per head and heads per m^2 increased with P fertilization. Thus, yield increase was probably due to the increased number of kernels per head and heads per m^2.

Yield, kernel weight, heads per m^2, and disease rating for leaf rust were significantly affected by the interaction of applied K and cultivar or applied K (Table 2). TAM 107, Newton, and Bounty BH 205 had increases of 13, 15, and 29 percent with the addition of 40 lb K_2O/a, whereas the yield of Karl was not affected by K additions. Kernel weight and heads per m^2 increased with K fertilization. Disease rating for leaf rust decreased in all cultivars but Karl, with the addition of K fertilizer.

Plant concentration of N, P, and K; dry matter production; soil P; and soil K were significantly affected by the addition of P or K (Table 3). Plant N concentration decreased with each addition of P_2O_5 or K_2O. Plant P concentration increased with each increment of P_2O_5, but decreased with the addition of K_2O. Plant K concentration increased with increasing amounts of K_2O but decreased with the addition of P_2O_5. Dry matter production was increased with the addition of P_2O_5 and K_2O. Fertilization with P_2O_5 increased dry matter production 90 and 127 percent over the control, whereas the highest K_2O rate only increased dry matter 18 percent over the control. Soil P was increased with P fertilization, but soil K was decreased. Soil K was increased with K additions.

Chloride and/or the Cl by cultivar interaction significantly affected disease rating for leaf rust, Cl concentration, Cl uptake, and soil Cl (Table 4). Concentration of Cl, Cl uptake, and soil Cl were significantly increased with the addition of Cl. The incidence of disease for Newton was significantly decreased with Cl, whereas the other cultivars were not significantly affected.

Tilt, cultivar, and the interaction of Tilt and cultivar significantly affected yield, test weight, kernel weight, and disease rating of leaf rust (Table 5). Tilt increased yield, kernel weight, and the number of kernels per head, but decreased the percent of leaf rust on the flag leaf. Karl and Caldwell were the highest yielding cultivars, and AgriPro Thunderbird had the highest test weight and protein content. Newton and TAM 107 had the highest incidence of leaf rust. All cultivars yields were increased with the Tilt application; however, Newton and TAM 107 indicated the strongest response with increases of 18 and 22 percent, respectively. These increases were due to significant increases in kernel weight.

Table 1. Effect of Wheat Cultivar and P Application Rate on Yield, Yield Components, and Disease Rating, 1989.

Wheat Cultivar	Applied P_2O_5	Yield	Test Weight	Disease Rating[1]	Kernels per Head	Heads per m^2	Kernel Weight
	lb/a	bu/a	lb/bu	%			mg
Thunderbird	0	44.9	61.7	9	29.2	428	33.5
	30	78.4	59.6	7	30.8	741	31.6
	60	82.3	60.1	7	31.0	786	30.9
Bounty 205	0	43.7	59.1	25	27.3	427	35.3
	30	67.9	58.1	14	33.5	584	33.5
	60	69.1	57.3	12	30.0	687	31.6
Caldwell	0	57.1	58.4	7	39.8	502	26.9
	30	77.3	56.2	12	40.1	660	25.1
	60	80.6	56.6	5	37.8	780	24.6
Karl	0	55.3	60.4	27	25.6	528	33.5
	30	81.9	59.4	30	29.0	724	31.9
	60	85.9	59.0	25	28.5	857	30.5
Newton	0	52.6	60.2	73	31.7	434	32.5
	30	71.5	59.1	71	35.5	695	30.1
	60	75.4	58.7	60	36.3	774	28.6
TAM 107	0	55.2	60.7	58	24.8	579	36.5
	30	75.4	59.9	62	27.2	724	35.2
	60	81.5	58.7	57	26.3	819	34.2
LSD (.05)[2]		8.7	1.6	NS	4.3	NS	NS
Main effect							
	0	51.5	60.1	33	29.7	483	33.0
	30	75.4	58.7	33	32.7	688	31.3
	60	79.2	58.4	28	32.5	784	30.1
LSD (.05)		3.9	0.8	NS	1.6	56	0.7

[1] Disease rating was made on June 6, 1989 to determine the percent of leaf rust on the flag leaf.

[2] Calculated from interaction of main effects not from single factor analysis.

Table 2. Effect of Cultivar and K Fertilization on Wheat Yield, Yield Components, and Disease Rating, 1989.

Wheat Cultivar	Applied K_2O	Yield	Test Weight	Disease Rating[1]	Kernels per Head	Heads per m^2	Kernel Weight
	lb/a	bu/a	lb/bu	%			mg
Thunderbird	0	65.9	60.4	10	32.0	611	31.5
	40	69.1	60.7	9	29.9	650	32.3
	80	70.6	60.4	4	29.1	693	32.4
Bounty 205	0	50.5	57.8	32	32.4	530	33.1
	40	65.2	57.9	13	31.1	627	33.6
	80	64.9	58.8	6	32.3	541	33.7
Caldwell	0	66.9	56.6	13	40.2	697	24.5
	40	75.7	56.9	7	39.5	700	25.8
	80	72.5	57.6	5	37.9	545	26.3
Karl	0	74.2	59.6	28	28.3	713	31.0
	40	75.1	59.4	28	27.1	687	32.6
	80	74.0	59.8	26	27.7	710	32.4
Newton	0	60.2	58.7	81	34.4	626	29.4
	40	69.2	59.6	61	35.5	634	30.6
	80	70.0	59.6	63	33.6	642	31.2
TAM 107	0	65.5	59.2	65	26.4	729	33.4
	40	74.1	59.8	54	26.5	685	36.0
	80	72.6	60.2	57	25.3	707	36.4
LSD (.05)[2]		8.7	NS	18	NS	157	1.7
Main effect							
	0	63.9	58.7	38	32.3	651	30.5
	40	71.4	59.0	29	31.6	664	31.8
	80	70.8	59.4	27	31.0	640	32.1
LSD (.05)		3.9	NS	6	NS	NS	0.7

[1] Disease rating was made on June 6, 1989 to determine the percent of leaf rust on the flag leaf.

[2] Calculated from interaction of main effects not from single factor analysis.

Table 3. Effect of Application Rates on N, P, and K Concentration in Wheat, Dry Matter, and Soil P and K Levels, 1989.

Applied		Concentration in Plant			Dry	Soil	
P_2O_5	K_2O	N	P	K	Matter	P	K
----lb/a----		------------%-----------			lb/a	-----lb/a-----	
0	0	2.20	0.169	1.73	2010	12	135
	40	2.16	0.178	2.60	1940	12	165
	80	2.07	0.163	2.84	2440	12	210
30	0	2.21	0.233	1.46	3630	25	131
	40	1.85	0.208	2.20	4420	26	161
	80	1.88	0.204	2.66	4110	25	191
60	0	2.11	0.277	1.48	4370	51	130
	40	1.91	0.246	2.03	4910	48	155
	80	1.63	0.257	2.60	5230	47	194
	LSD (.05)[1]	NS	NS	NS	NS	NS	NS
Main Effects							
0		2.14	0.170	2.39	2130	12	170
30		1.98	0.215	2.11	4050	25	161
60		1.88	0.260	2.04	4840	49	160
	LSD (.05)	0.14	0.015	0.14	430	2	7
	0	2.17	0.226	1.56	3340	30	132
	40	1.97	0.210	2.28	3760	29	160
	80	1.86	0.208	2.70	3930	28	198
	LSD (.05)	0.14	0.015	0.14	430	NS	7

[1] Calculated from interaction of main effects not from single factor analysis.

Table 4. Cultivar and Cl Fertilization Effects on Wheat, 1989.

Wheat Cultivar	Applied Cl	Yield	Disease Rating[1]	Plant Cl Uptake	Plant Cl Concentration	Soil Cl
	lb/a	bu/a	%	lb/a	ppm	lb/a
Thunderbird	0	79.9	6	20.4	3,955	9.4
	64	82.4	2	56.2	10,185	15.8
Bounty 205	0	66.3	16	17.8	4,438	7.7
	64	67.4	8	38.4	11,805	15.4
Caldwell	0	80.8	5	19.0	3,528	8.2
	64	81.9	4	58.4	10,888	18.3
Karl	0	83.4	21	16.6	3,402	8.7
	64	87.4	17	56.6	10,322	15.3
Newton	0	73.9	71	22.0	4,933	9.0
	64	78.3	48	61.2	13,900	17.0
TAM 107	0	79.7	59	17.7	3,265	7.7
	64	81.3	60	55.4	10,487	15.3
LSD (.05)[2]		NS	18	NS	NS	NS
Main effect						
	0	77.3	30	18.9	3,920	8.4
	64	79.7	24	54.4	11,264	16.2
LSD (.05)		NS	NS	7.0	1,026	2.1

[1] Disease rating was made on June 6, 1989 to determine the percent of leaf rust on the flag leaf.

[2] Calculated from interaction of main effects not from single factor analysis.

Table 5. Effect of Cultivar and Tilt Fungicide on Wheat Yield, Yield Components, and Disease Rating, 1989.

Wheat Cultivar	Tilt	Yield	Test Weight	Kernel Weight	Disease Rating[1]
		bu/a	lb/bu	mg	%
Thunderbird	No	66.4	60.7	31.8	11
	Yes	70.7	60.2	32.4	5
Bounty 205	No	58.8	58.3	32.9	22
	Yes	61.6	58.0	34.1	12
Caldwell	No	69.0	56.9	25.4	11
	Yes	74.4	57.2	25.7	5
Karl	No	72.1	59.7	31.8	33
	Yes	76.7	59.5	32.2	22
Newton	No	60.9	58.9	29.2	79
	Yes	72.1	59.7	31.6	58
TAM 107	No	63.6	59.3	33.7	70
	Yes	77.8	60.2	36.8	49
LSD (.05)[2]		2.7	0.7	0.9	10
Main Effects					
Thunderbird		68.5	60.5	32.1	8
Bounty 205		60.2	58.2	33.5	17
Caldwell		71.7	57.1	25.5	8
Karl		74.4	59.6	32.0	27
Newton		66.5	59.3	30.4	68
TAM 107		70.7	59.7	35.3	59
LSD (.05)		2.2	0.4	0.5	6
	No	65.1	59.0	30.8	38
	Yes	72.2	59.1	32.1	25
LSD (.05)		1.2	NS	0.4	4

[1] Disease rating was made on June 6, 1989 to determine the percent of leaf rust on the flag leaf.

[2] Calculated from interaction of main effects not from single factor analysis.

SOYBEAN - CORN ROTATION EFFECTS ON CHARCOAL ROT

George V. Granade, Tim C. Todd[1], and Fred W. Schwenk[1]

Summary

Soybeans were grown in rotation following soybeans, corn, and wheat to examine the effect on the charcoal rot fungus (Macrophomina phaseolina) and yield. Levels of the fungus in the soil were determined before planting and after harvest. Root samples were taken at the R2 growth stage and every 2 weeks thereafter until maturity and tested for levels of the fungus. Levels of the fungus after harvest were higher from soybean - soybean or soybean - wheat - soybean than from corn - soybean, or soybean - corn, or corn - corn. In all treatments, the level of charcoal rot fungus was highest at the last two sampling dates. Corn yields did not significantly differ because of treatment. Yields of full-season soybeans were higher than those of double-cropped soybeans.

Introduction

Charcoal rot is a major disease in southeastern Kansas and recently has been estimated to reduce yields by as much as 50 percent in some fields in some years. Recent work has demonstrated that different biotypes (phenotypes) affect soybeans and corn. These biotypes are differentiated by their growth patterns in the laboratory on a material called chlorate medium. Their growth patterns have been designated as dense, feathery, or restricted. Experience has shown that isolates from corn are most commonly of the dense type, and isolates from soybean are most commonly of the feathery or restricted types.

A study was initiated in 1988 to examine the effect of various rotations of soybeans, corn, and wheat on levels and type of the charcoal rot fungus.

Experimental Procedure

Pioneer 3377 corn and Spencer soybeans were planted in April 21 and June 6, 1988, respectively, at the Columbus Field that had been in soybeans, milo, and sunflowers double-cropped after wheat during 1987. Karl wheat was planted in one plot on October 14, 1988, after soybean harvest. On April 7, 1989, Pioneer 3377 corn was planted in plots following either corn or soybeans. On May 31, 1989 Spencer soybeans were planted in plots following either soybeans or corn and on June 21, 1989, after wheat.

Soil samples were taken before planting and after harvest and tested for levels and types of the fungus. Root samples were taken from plots of corn and soybeans when the soybeans reached the R2 growth stage. Root samples were taken every 2 weeks thereafter until physiological maturity (R7) and also tested for

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levels and types of the fungus. Stand, plant height, yield, seed weight, and test weight were measured at the appropriate times.

Results

No significant differences were detected among plots sampled before planting, either in levels or types of fungus in 1989 (Table 1). By contrast, soil samples after harvest indicated highest populations of the fungus on plots that had been in soybeans that year (Table 1).

Fungal populations were low on the first two sampling dates but increased by the last two sampling dates (Table 2). Soybean plants had a higher population of the fungus than corn plants. There were no significant differences for phenotypes, except that the dense type was highest in the corn - corn system.

Corn yields did not significantly differ ampng treatments (Table 3). However, soybean yields were significantly higher in full-season than in double-cropped soybeans (Table 3). Although not significant, yields tended to be higher where the crops were rotated.

Table 1. Charcoal Rot Fungus Population in the Soil before planting and after harvest, Columbus, 1989.

1988	1989	Log of colonies/g	
Crop	Crop	Preplant	Harvest
Soybean	Soybean	2.144	2.426
Corn	Soybean	2.095	2.230
Soybean	Corn	2.146	2.308
Corn	Corn	2.141	2.248
Soybean	Wheat Soybean	2.412	2.454
	$LSD_{0.05}$		0.15

Table 2. Charcoal Rot Fungus Population in Soybean and Corn Roots during the Growing Season, Columbus, 1989.

1988 Crop	1989 Crop	Log of colonies/g July 7	July 20	August 3	August 18
Soybean	Soybean	0.80	1.85	2.21	2.48
Corn	Soybean	0.00	1.54	2.05	2.37
Soybean	Corn	0.00	0.00	0.75	1.00
Corn	Corn	0.00	0.50	0.22	1.23
Soybean	Wheat Soybean	0.00	0.90	1.98	2.61

$LSD_{0.05}$ for rotation within a date 1.08

Table 3. Yield and Yield Components for Soybeans and Corn, Columbus, 1989.

1988 Crop	1989 Crop	Yield	Seed Weight	Plant Height
		Bu/a	g/100 seeds	In
Soybean	Soybean	33.2	16.4	28
Corn	Soybean	38.1	16.5	30
Soybean	Wheat Soybean	18.8	15.1	18
	$LSD_{0.05}$	14.4	ns	5
			Plant Population Plants/a	Test Weight Lb/bu
Soybean	Corn	130	17,400	54.9
Corn	Corn	133	18,600	55.7

Pioneer 3377 corn was planted on April 7; fertilized with 220 lb of 6-24-24/a and 300 lb of urea; herbicide used was 1.8 qt Bicep/a. Spencer soybeans were planted on May 31; fertilized with 220 lb of 6-24-24/a; herbicide used was 0.33 lb Lexone + 1.5 pt Dual/a. Spencer soybeans were planted on June 21 after wheat.

COMPARISON OF CONVENTIONAL AND INTENSIVE WHEAT MANAGEMENT SYSTEMS

Kenneth Kelley

Summary

Timing of nitrogen fertilizer and foliar fungicide effects were compared in conventional and intensive wheat management systems at two locations in 1989. Even though the spring was drier than normal, record high grain yields were produced. Because of the dry conditions, yield losses associated with foliar leaf diseases did not develop. However, at the Parsons site, grain yield was significantly higher for selected cultivars with the intensive management system, which consisted of fall and late-winter N applications and a foliar fungicide treatment prior to wheat heading.

Introduction

The objective of intensive wheat management is to produce wheat as efficiently as possible using high-yielding cultivars, N fertilizer at two or more times during the growing season to optimize yield and protein, and a foliar fungicide to control leaf diseases. This research seeks to compare conventional and intensive management systems for the climatic conditions in southeastern Kansas.

Experimental Procedure

In 1989, 10 winter wheat cultivars were evaluated under conventional N management (75 lb N/a as a preplant, fall application) and an intensive N system (75 lb N/a applied in the fall + 50 lb N/a topdressed in late winter). Urea was the N fertilizer source. The presence or absence of a foliar fungicide (Tilt) was evaluated in both N systems. Tilt was applied in late April at 4 oz/a. Studies were located at the Parsons and Columbus Units.

Results

Record high yields were obtained at the Parsons Unit (85 bu/a) despite the dry conditions in April. Columbus was even drier, but yields still averaged 60 bu/a. Time of N application had a significant effect on grain yield and grain protein at both sites. Applying an additional 50 lb of N/a in late February increased yield an average of 5 and 10 bu/a over all varieties at Parsons and Columbus, respectively.

Because of the drier spring conditions in 1989, foliar leaf diseases did not affect yields to the extent that they would have in a wetter spring; however, there was a significant fungicide yield response for selected cultivars at Parsons (Table 1), where leaf rust developed in mid-May. Highest grain yield was obtained in the intensive management system with Tilt application and both fall and late winter N applications. Tilt did not increase yield for any cultivar at the Columbus site (Table 4), where leaf diseases were not present.

Plant analysis of the flag-leaf at Parsons showed that more N had been taken up by the plant when both fall and late winter N treatments were made, which also translated to more grain protein (Table 2). Analysis of grain yield components (Table 3) also revealed that the number of kernels per head and the number of heads per unit area were significantly higher when N was applied both in fall and late winter.

After the wheat harvest in 1990, 4 years of wheat management data will have been collected from the Parsons site and 3 years from Columbus. Recommendations can then be made with more confidence concerning the use of split N applications and fungicide for the wheat growing conditions of southeastern Kansas.

Table 1. Effects of Conventional and Intensive Wheat Management Systems on Yield and Test Weight of Winter Wheat, Parsons, 1989.

	Grain Yield					Test Weight				
	Fall - N		Fall + LW - N			Fall - N		Fall + LW - N		
Brand Cultivar	No Tilt	Tilt	No Tilt	Tilt	Avg.	No Tilt	Tilt	No Tilt	Tilt	Avg.
	----------- bu/A -----------					---------- lb/Bu -----------				
Agripro Victory	88.2	84.3	92.1	94.2	89.7	59.1	59.2	59.8	60.0	59.5
Arkan	82.9	81.2	82.1	91.2	84.3	59.1	59.0	59.9	60.3	59.6
Bounty 205	75.9	76.0	76.0	80.2	77.0	59.3	59.4	60.0	59.8	59.6
Caldwell	90.4	90.0	90.1	95.9	91.6	57.6	58.2	58.0	58.7	58.2
Century	78.9	87.2	81.3	92.6	85.0	60.2	60.7	60.2	60.8	60.5
Chisholm	82.6	87.1	82.1	93.1	86.2	59.6	59.9	60.1	60.9	60.1
Karl	84.5	82.6	89.4	94.4	87.7	59.4	59.5	60.3	60.7	60.0
McNair 1003	81.0	80.9	83.2	83.5	82.2	58.0	57.9	58.4	59.0	58.3
Pioneer 2157	72.5	74.4	80.5	82.4	77.5	61.8	61.4	61.9	61.9	61.8
Siouxland	84.9	85.2	85.6	94.4	87.5	59.8	59.9	60.7	60.9	60.3
Tam 107	82.5	81.0	76.3	95.7	83.9	59.1	59.8	59.2	60.7	59.7
(Means):	82.2	82.7	83.5	90.7	84.8	59.4	59.5	59.9	60.3	59.8

LSD: (0.05)	Grain Yield	Test Weight
Among management system means:	4.4	0.4
Among cultivar means:	2.9	0.2
Among cultivar for same management:	5.8	0.4
Among cultivar for different management:	7.1	0.5
C.V. (%)	4.3	0.4
F-test significance:		
Time of N	*	**
Fungicide	*	*
Time of N * Fungicide	*	NS
Variety	**	**
Variety * Time of N	NS	**
Variety * Fungicide	**	**
Variety * Time of N * Fungicide	NS	NS

Table 2. Effects of Conventional and Intensive Wheat Management Practices on Flag-Leaf N Concentration and Grain Protein, Parsons, 1989.

Brand Cultivar	Flag-leaf N Conc. Fall - N No Tilt	Fall - N Tilt	Fall + LW - N No Tilt	Fall + LW - N Tilt	Avg.	Grain Protein Fall - N No Tilt	Fall - N Tilt	Fall + LW - N No Tilt	Fall + LW - N Tilt	Avg.
	------------	% N	-----------			------------	%	------------		
Agripro Victory	2.66	2.33	3.02	3.08	2.77	11.0	11.2	12.0	12.7	11.7
Arkan	2.55	2.38	2.95	3.12	2.75	11.5	11.5	12.6	13.5	12.3
Bounty 205	2.70	2.51	3.23	3.28	2.93	11.4	11.2	12.7	13.2	12.1
Caldwell	2.71	2.63	3.37	3.39	3.03	10.1	9.8	11.4	11.3	10.7
Century	2.53	2.59	3.06	3.13	3.10	10.9	11.7	12.2	12.8	11.9
Chisholm	2.36	2.31	2.87	2.89	2.61	10.8	10.9	12.2	12.4	11.6
Karl	2.29	2.11	2.86	2.87	2.53	11.6	11.8	13.1	14.6	12.8
McNair 1003	2.61	2.50	3.14	3.35	2.90	11.6	11.5	12.2	13.5	12.2
Pioneer 2157	2.42	2.25	2.99	3.06	2.68	11.7	11.9	12.8	14.1	12.6
Siouxland	2.55	2.38	3.26	3.29	2.87	10.9	10.6	12.2	13.1	11.7
Tam 107	2.52	2.38	2.99	2.91	2.70	11.4	10.9	12.8	12.8	12.0
(Means):	2.54	2.40	3.07	3.12	2.78	11.2	11.2	12.4	13.1	12.0
LSD: (0.05)										
Among management systems means:					0.18					0.5
Among cultivar means:					0.11					0.3
Among cultivar for same management:					0.22					0.5
Among cultivar for different management:					0.28					0.7
C.V. (%)					5.10					3.5
F-test significance:										
Time of N					***					***
Fungicide					NS					NS
Time of N * Fungicide					NS					NS
Variety					***					***
Variety * Time of N					NS					NS
Variety * Fungicide					NS					*
Variety * Time of N * Fungicide					NS					NS

Table 3. Effects of Conventional and Intensive Wheat Management Systems on Wheat Yield Components, Parsons, 1989.

Brand Cultivar	Kernel Weight: Fall - N: No Tilt	Fall - N: Tilt	Fall + LW-N: No Tilt	Fall + LW-N: Tilt	Avg.	# of Kernels: Time of N: Fall	F+LW	Avg.	# of Heads: Time of N: Fall	F+LW	Avg
	---------- mg				---------	--- ker/hd		----	-- hds/m2		--
Agripro Victory	32.6	32.6	33.2	34.8	33.3	29.5	29.6	29.5	682	735	708
Arkan	29.3	30.9	29.3	31.7	30.3	25.9	29.1	27.5	746	899	823
Bounty 205	31.5	32.7	32.9	33.4	32.6	27.4	31.3	29.4	614	723	668
Caldwell	26.0	28.2	26.5	26.7	26.9	38.8	39.9	39.3	702	768	735
Century	28.9	30.2	26.3	32.0	29.4	25.3	31.1	28.2	870	737	804
Chisholm	32.3	34.4	30.5	33.5	32.7	26.2	29.6	27.9	702	738	720
Karl	31.5	32.1	31.1	31.4	31.5	25.1	29.4	27.2	809	744	776
McNair 1003	37.0	36.2	36.8	37.0	36.7	30.3	32.4	31.4	670	647	659
Pioneer 2157	29.8	31.6	28.9	29.0	29.8	28.5	32.0	30.2	691	781	736
Siouxland	30.4	31.6	30.0	30.6	30.7	26.1	31.1	28.6	766	774	770
Tam 107	31.5	33.8	29.8	36.6	32.9	32.6	31.2	31.9	739	743	741
(Means):	31.0	32.2	30.5	32.4	----	28.7	31.5	----	726	754	---
LSD: (0.05)											
Management systems:					1.5			1.2			41
Cultivars:					1.2			1.2			43
Among cultivar for same management:					2.4			2.4			86
Among cultivar for different mgnt:					2.6			1.8			65
C.V. (%)					4.6			7.2			5
F-test significance:											
Time of N					NS			***			NS
Fungicide					**			NS			NS
Time of N * Fungicide					NS			NS			NS
Variety					***			***			***
Variety * Time of N					NS			***			***
Variety * Fungicide					**			NS			***
Variety * Time of N * Fung					NS			NS			**

Table 4. Comparison of Winter Wheat Cultivars in Conventional and Intensive Management Systems, Columbus, 1989.

Brand Cultivar	Grain Yield Fall - N No Tilt	Grain Yield Fall - N Tilt	Grain Yield Fall + LW - N No Tilt	Grain Yield Fall + LW - N Tilt	Grain Yield Avg.	Test Weight Fall _ N No Tilt	Test Weight Fall _ N Tilt	Test Weight Fall + LW - N No Tilt	Test Weight Fall + LW - N Tilt	Test Weight Avg.
	-----------		bu/A		-----------	-----------		bu/A		-----------
AP Mesa	55.0	54.0	66.9	71.0	61.7	59.6	59.2	59.8	60.1	59.7
AP Thunderbird	55.8	52.5	64.9	62.6	59.0	59.5	58.8	60.2	59.7	59.6
Arkan	55.1	55.0	71.8	68.3	62.6	57.8	57.5	58.5	58.3	58.0
Caldwell	58.4	56.4	66.6	69.9	62.9	58.1	58.3	58.0	57.9	58.1
Century	54.1	52.9	64.0	64.7	58.9	60.3	59.8	60.9	61.1	60.5
Chisholm	53.1	50.5	64.4	67.9	59.0	59.1	59.0	59.7	59.8	59.4
Delange 7837	48.8	47.7	61.5	61.4	54.8	58.6	58.4	58.6	58.9	58.6
Karl	51.0	54.0	63.5	61.3	57.5	59.3	59.2	59.8	59.6	59.5
Pioneer 2551	51.3	46.2	66.3	63.3	56.8	57.8	56.7	57.9	58.0	57.6
Tam 107	58.3	58.7	69.6	72.5	64.8	58.9	58.5	59.0	59.3	58.9
(Means):	54.1	52.8	65.9	66.3	59.8	58.9	58.5	59.3	59.3	59.0

LSD: (0.05)	Grain Yield	Test Weight
Among management system means:	2.8	0.5
Among cultivar means:	2.0	0.3
Among cultivar for same management:	4.0	0.6
Among cultivar for different management:	4.7	0.3
C.V. (%):	4.1	0.6
F-test significance:		
Time of N	**	**
Fungicide	NS	NS
Time of N x Fungicide	NS	NS
Variety	***	***
Time of N x Variety	*	*
Fungicide x Variety	NS	NS
Time of N x Fungicide x Variety	NS	NS

Table 5. Effects of Conventional and Intensive Wheat Management Systems on Grain Protein and Wheat Head Density, Columbus Unit.

Brand Cultivar	Grain Protein (Time of N) Fall	Fall + LW	Avg.	# of Wheat Heads (Time of N) Fall	Fall + LW	Avg.
	---------- % ---------			------ hds/m2 -----		
AP Mesa	10.7	11.1	10.9	474	619	546
AP Thunderbird	10.6	12.0	11.3	441	635	538
Arkan	10.3	11.4	10.8	496	611	554
Caldwell	9.6	10.8	10.2	451	478	464
Century	10.3	11.7	11.0	461	608	534
Chisholm	10.1	10.9	10.5	437	465	451
DeLange 7837	10.7	11.8	11.2	485	544	514
Karl	12.1	13.0	12.5	523	597	560
Pioneer 2551	11.6	12.3	11.9	369	416	392
Tam 107	10.1	11.3	10.7	453	509	481
(Means)	10.6	11.6	11.1	459	548	504
LSD: (0.05)						
Among mangagement systems means:			0.6			39
Among cultivar means:			0.4			26
Among cultivar for same management:			0.8			53
Among cultivar for different management:			0.9			63
F-test Significance:						
Time of N			***			***
Fungicide			NS			NS
Time of N * Fungicide			NS			*
Cultivar			***			***
Time of N * Cultivar			NS			***
Fungicide * Cultivar			NS			**
Time of N * Fungicide * Cultivar			NS			***
C.V. (%)			4.3			6.4

EFFECT OF PREVIOUS CROP ON TIME AND RATE OF NITROGEN FOR WINTER WHEAT PRODUCTION

Kenneth Kelley

Summary

The previous crop (wheat, soybean, or milo) had a significant effect on wheat yield in 1989. Wheat yields were not significantly different when wheat followed wheat or soybeans, but yield was reduced by one-third when wheat followed grain sorghum. The applied fertilizer-N may have been temporarily immobilized in the milo stalk residue, which made it unavailable to the growing wheat plant.

Introduction

This research was initiated to evaluate how the previous crop (wheat, soybean, and grain sorghum) affects the utilization of applied nitrogen fertilizer for wheat and also determine the optimum time and rate of nitrogen, depending upon the previous crop.

Experimental Procedure

The experiment was a split-plot arrangement with the previous crop (wheat, soybeans, or milo) as the main plots and time and rate of nitrogen fertilizer as subplots. Nitrogen fertilizer was applied at four different times: 1) all in the fall, 2) all in late winter, 3) 1/2 in fall and 1/2 in late winter, and 4) 1/4 in fall, 1/2 in late winter, and 1/4 in early spring. N rates were 0, 40, 80, and 120 lb/A. Urea was the N source for all application times, except for the foliar N treatment in early spring, which consisted of liquid 28% N diluted with water. Soil type was a Parsons silt loam with 2.5% organic matter.

Results

The previous crop had a significant effect on wheat yield in 1989 (Table 1). Wheat following wheat or soybeans did not differ significantly in grain yield; however, wheat yield was significantly reduced when wheat followed grain sorghum. Evidently, nitrogen was temporarily immobilized in the milo stalk residue and was unavailable for the wheat crop. Increasing the N fertilizer rate helped increase wheat yield, but it was still below yields of the wheat or soybean rotation for the same N rates.

In the wheat - wheat system there was evidently adequate soil nitrogen already available for the growing wheat crop, since yield was reduced with increasing rates of N fertilizer. Previous N research on wheat at the Parsons Unit has shown similar yield reductions. Applying additional N beyond what the plant can utilize results in excessive vegetative growth, which tends to promote development of more leaf disease.

Soybeans as a legume crop can add N to the soil; however, when wheat follows soybeans in the rotation, our results confirm that there is not enough time in late fall or early spring for the soil microorganisms to break-down the fixed N from the soybean roots and make it available to the growing wheat plant.

Yield was not significantly affected by time of N application when averaged over all rotations. However, there was a significant previous crop by time of N application interaction, which indicates that the optimum time for N fertilizer may vary with previous crop. More data are needed before accurate recommendations can be made regarding the timing of N fertilizer for different crop rotations.

Table 1. Effect of Previous Crop on Time and Rate of Nitrogen for Winter Wheat, Southeast Ks. Branch Experiment Station.

Time and Rate of Nitrogen			Grain Yield Previous Crop				Test Weight Previous Crop			
F	LW	SPR	Wh	Soy	Milo	Avg.	Wh	Soy	Milo	Avg.
--- lb N/A ---			--------- bu/A ----------				--------- lb/bu ---------			
0	0	0	69.7	56.6	17.1	47.8	59.4	58.8	58.6	58.9
40	0	0	69.0	68.6	31.9	56.5	59.2	59.2	58.4	58.9
80	0	0	68.7	72.0	43.7	61.5	58.7	59.2	57.9	58.6
120	0	0	63.4	74.7	55.4	64.5	58.9	59.5	58.4	58.9
0	40	0	71.5	68.5	37.5	59.2	59.6	59.3	58.3	59.1
0	80	0	69.6	67.0	49.2	61.9	59.7	59.7	59.0	59.5
0	120	0	64.9	69.0	52.2	62.0	59.4	59.7	58.9	59.3
20	20	0	68.2	69.0	32.6	56.6	59.1	59.1	58.8	59.0
40	40	0	67.8	69.2	51.5	62.8	59.6	59.4	58.5	59.1
60	60	0	60.8	68.2	62.0	63.7	59.0	59.4	58.8	59.0
10	20	10	73.4	65.0	31.2	56.5	59.6	59.2	59.4	59.4
20	40	20	70.0	70.7	44.7	61.8	59.7	59.4	59.3	59.5
30	60	30	66.8	70.6	57.3	64.9	59.3	60.1	59.9	59.7
Means:										
Crop Rotation:										
Wheat						67.8				59.3
Soybean						69.4				59.4
Milo						45.8				58.8
LSD: (0.05)						4.6				NS
N Rate:										
40						57.2				59.1
80						62.0				59.2
120						63.8				59.3
LSD: (0.05)						1.1				0.2
N Time:										
Fall						60.8				58.8
Late winter						61.0				59.3
Fall + late winter						61.0				59.1
Fall + late winter + spring						61.1				59.5
LSD: (0.05)						NS				0.2

Variety: Chisholm. Planted Oct. 5, 1988.
Time of N application: F = fall, preplant (Oct. 3); LW = late winter (Mar. 8); SPR = early spring (May 1).

Table 2. Effect of Previous Crop and Time and Rate of Nitrogen on Plant N Concentration and Uptake for Winter Wheat, Parsons, 1989.

Time and Rate of Nitrogen			Leaf-N (GS-30) Previous Crop				Plant N Uptake Previous Crop			
F	LW	SPR	Wh	Soy	Milo	Avg.	Wh	Soy	Milo	Avg.
--- lb N/A ---			---------- % N ----------				-------- kg N/ha -------			
0	0	0	3.21	2.88	2.25	2.78	105	66	24	65
40	0	0	3.34	3.01	2.46	2.94	127	98	39	88
80	0	0	3.66	3.22	2.70	3.19	137	118	63	106
120	0	0	3.83	3.35	2.73	3.30	144	138	79	120
0	40	0	3.67	3.31	3.72	3.56	124	98	50	90
0	80	0	3.98	3.63	4.37	3.99	138	118	50	102
0	120	0	3.87	3.81	4.51	4.06	126	87	57	90
20	20	0	3.69	3.04	3.11	3.28	138	79	35	84
40	40	0	3.81	3.26	3.28	3.45	157	105	53	105
60	60	0	3.92	3.63	3.61	3.72	133	125	92	117
10	20	10	3.57	2.92	3.25	3.26	125	84	38	82
20	40	20	3.68	3.32	3.48	3.49	130	88	55	91
30	60	30	4.03	3.48	3.73	3.75	129	135	84	116
<u>Means</u>:			3.71	3.30	3.32		132	103	55	
Crop Rotation:										
Wheat						3.75				134
Soybean						3.33				106
Milo						3.41				58
LSD: (0.05)						0.07				5
N Rate:										
40						3.26				86
80						3.53				101
120						3.71				111
LSD: (0.05)						0.07				5
N Time:										
Fall						3.14				105
Late Winter						3.87				94
Fall + late winter						3.48				102
Fall + late winter + spring						3.49				96
LSD: (0.05)						0.08				5

Leaf N samples taken at Growth Stage - 30.
Plant N uptake determined from N concentration at flowering stage.

Table 3. Effect of Previous Crop and Time and Rate of Nitrogen on Grain Protein and Kernel Weight, Parsons, 1989.

Time and Rate of Nitrogen			Grain Protein				Kernel Weight			
			Previous Crop				Previous Crop			
F	LW	SPR	Wh	Soy	Milo	Avg.	Wh	Soy	Milo	Avg.
--- lb N/A---			----------- % ----------				----------- mg ----------			
0	0	0	12.4	11.2	11.5	11.7	30.7	32.5	32.6	31.9
40	0	0	12.6	11.8	9.8	11.4	30.0	30.8	32.3	31.1
80	0	0	13.3	11.9	9.6	11.6	29.0	30.9	32.9	30.9
120	0	0	12.8	12.6	9.5	11.6	29.0	30.3	33.1	30.8
0	40	0	12.9	11.5	9.7	11.4	30.3	32.8	33.7	32.3
0	80	0	13.9	12.3	9.8	12.0	29.4	32.6	35.1	32.3
0	120	0	13.9	13.1	10.5	12.5	30.4	30.9	34.5	32.0
20	20	0	12.9	11.2	9.9	11.3	29.8	32.6	34.4	32.3
40	40	0	13.6	12.3	9.5	11.8	30.1	31.6	33.3	31.7
60	60	0	13.9	13.1	10.3	12.4	28.8	29.4	32.5	30.2
10	20	10	13.1	11.7	11.1	12.0	30.6	32.5	35.1	32.7
20	40	20	13.1	12.4	11.1	12.2	32.0	32.2	36.4	33.5
30	60	30	14.3	14.0	12.2	13.5	29.2	32.3	35.9	32.5
Means:			13.3	12.2	10.3		29.9	31.6	34.0	
Crop Rotation:										
Wheat						13.4				29.9
Soybean						12.3				31.6
Milo						10.2				34.1
LSD: (0.05)						0.2				0.3
N Rate:										
40						11.5				32.1
80						11.9				32.1
120						12.5				31.4
LSD: (0.05)						0.2				0.3
N Time:										
Fall						11.5				30.9
Late winter						12.0				32.2
Fall + late winter						11.8				31.4
Fall + late winter + spring						12.5				32.9
LSD: (0.05)						0.2				0.4

Table 4. Effect of Previous Crop and Time and Rate of Nitrogen on Wheat Yield Components, Parsons, 1989.

Time and Rate of Nitrogen			Head Number Previous Crop				Kernel Number Previous Crop			
F	LW	SPR	Wh	Soy	Milo	Avg.	Wh	Soy	Milo	Avg.
--- lb N/A ---			------ hds/meter2-------				--------- ker/hd --------			
0	0	0	798	575	234	736	26.2	24.0	17.0	22.4
40	0	0	856	737	426	673	27.1	27.1	19.5	24.6
80	0	0	817	872	548	746	26.8	26.5	23.2	25.5
120	0	0	809	805	791	802	27.7	26.6	23.8	26.0
0	40	0	703	689	463	618	29.3	25.3	20.3	25.0
0	80	0	747	721	491	653	28.2	27.6	27.4	27.7
0	120	0	686	809	531	675	26.2	27.6	25.4	26.4
20	20	0	811	800	465	692	28.0	24.1	20.4	24.2
40	40	0	735	771	600	702	27.7	24.8	20.7	24.4
60	60	0	667	782	627	692	29.5	25.7	21.9	25.7
10	20	10	729	626	424	593	27.9	25.4	23.7	25.6
20	40	20	725	810	500	678	27.8	25.0	21.4	24.7
30	60	30	749	797	648	731	29.3	25.0	23.1	25.8
Means:			756	753	519		27.8	25.7	22.1	
Crop Rotation:										
Wheat						753				28.0
Soybean						768				25.9
Milo						543				22.6
LSD: (0.05)						19				0.8
N Rate:										
40						644				24.8
80						695				25.6
120						725				26.0
LSD: (0.05)						19				0.8
N Time:										
Fall						740				25.4
Late winter						649				26.3
Fall + late winter						695				24.7
Fall + late winter + spring						668				25.4
LSD: (0.05)						22				0.9

Table 5. Summary of Previous Crop and Nitrogen Effects.

Previous Crop	N Rate Time	Yield	TW	Prot.	Lf-N	N-upt	TKW	K/hd	# Hds
		bu/a	lb/bu	%	%	kg/ha	gr/1000		hd/m2
Wheat	0	69.7	59.4	12.4	3.21	105	30.7	26.2	798
	40	70.5	59.4	12.9	3.56	129	30.2	28.1	775
	80	69.0	59.4	13.5	3.78	140	30.1	27.6	756
	120	64.0	59.1	13.7	3.91	133	29.4	28.2	728
Soy	0	56.6	58.8	11.2	2.88	66	32.5	24.0	575
	40	67.8	59.2	11.5	3.07	89	32.2	25.5	713
	80	69.7	59.4	12.2	3.36	107	31.8	25.9	794
	120	70.6	59.7	13.2	3.57	121	30.7	26.2	798
Milo	0	17.1	58.6	11.5	2.25	24	32.6	17.0	234
	40	33.3	58.7	10.1	3.13	40	33.9	21.0	445
	80	47.3	58.7	10.0	3.45	55	34.4	23.2	535
	120	56.7	59.0	10.6	3.64	78	34.0	23.5	649
Wheat	F	67.0	59.4	12.9	3.61	136	29.4	27.2	827
	LW	68.6	59.6	13.6	3.84	129	30.0	27.9	712
	F+LW	65.6	59.2	13.5	3.81	143	29.5	28.4	738
	F+LW+SPR	70.1	59.5	13.5	3.76	128	30.6	28.3	734
Soy	F	71.8	59.3	12.1	3.19	117	30.7	26.7	805
	LW	68.2	59.5	12.3	3.58	101	32.1	26.8	740
	F+LW	68.8	59.3	12.2	3.31	103	29.5	24.8	784
	F+LW+SPR	68.8	59.5	12.7	3.24	102	30.6	25.1	744
Milo	F	43.6	58.2	9.7	2.63	60	32.7	22.2	588
	LW	46.3	58.7	10.1	4.20	52	34.4	24.3	495
	F+LW	48.7	58.7	9.8	3.33	60	33.4	21.0	564
	F+LW+SPR	44.4	59.5	11.4	3.49	59	35.8	22.7	524
F-test Significance:									
Crop rotation		***	NS	**	***	***	***	***	***
Time - N		NS	***	***	***	***	***	**	***
Rate - N		***	NS	***	***	***	***	*	***
Time x Rate - N		*	NS	***	NS	***	***	*	***
CR x N rate		***	*	***	NS	***	**	*	***
CR x N time		***	**	***	***	*	**	**	NS
CR x NR x NT		***	NS	NS	NS	***	***	*	***
C.V. (%)		4.5	0.8	3.7	4.8	11.5	2.6	7.6	6.7

WHEAT AND SOYBEAN CROPPING SEQUENCES COMPARED[1]

Kenneth Kelley

Summary

Three different wheat and soybean crop rotations have been compared over a 9-year period. Yield of double-crop soybeans has averaged 25% less than that of comparable full-season soybeans, although yields have varied considerably over the period. In comparisons involving full-season soybeans, early maturing cultivars have produced higher yields than later maturing cultivars for the past 2 years, although seed quality has been poor. Highest wheat yield has occurred when wheat followed wheat rather than soybeans. Wheat following continuous double-crop soybeans has been the lowest.

Introduction

In southeastern Kansas, producers often rotate wheat after soybean or plant double-crop soybeans following wheat harvest. Management practices of one crop, therefore, may affect the production of the next crop. The objectives of this study were to evaluate the effects of double-cropping and the risk factors associated with a particular wheat and soybean crop rotation.

Experimental Procedure

Beginning in 1981, three different wheat and soybean cropping rotations were established at the Parsons Unit: 1) [wheat - double-crop soybean], 2) [wheat - double-crop soybean] - soybean, and 3) full-season soybean following 2 years of wheat. Wheat straw was burned and then disced prior to planting double-crop soybean. Prior to 1988, soybean varieties were selected from maturity groups IV and V for double-crop and full-season soybeans, respectively. Beginning in 1988, maturity groups I, III, IV, and V were compared in the [wheat - double-crop soybean] - soybean rotation. Group I maturity was planted in 7-inch row spacing, whereas the other maturity groups were planted in 30-inch row spacing. When wheat has winter-killed or was not planted in the fall because of wet soil conditions, spring oats were planted in late winter. Fertilizers (70 lb N/a, 50 lb P_2O_5/a, and 50 lb K_2O/a) were applied only to the wheat crop.

Results

Table 1 shows the yearly soybean yields for the three different wheat and soybean rotations. Soybean yields in the continuous double-crop rotation and when double-cropping occurs every 2 years have been nearly equal. Full-season soybean yield following 2 years of wheat has been higher than soybean yield following double-crop soybeans, partly because of the additional

[1]This research was funded by the Kansas Soybean Commission.

fertilizer applied to wheat.

Wheat yield as affected by the different crop rotations is shown in Table 2. Yields are only shown for the past 2 years, because climatic conditions during the mid 1980's were not very favorable for growing wheat. Highest yield has occurred when wheat followed wheat rather than double-crop or full-season soybeans. Wheat yield in the continuous double-cropping rotation has been the lowest. More wheat data are needed before accurate recommendations can be made regarding the effects of the soybean rotations on wheat yield.

Where maturity groups I, III, IV, and V are compared (Tables 3 and 4) in the [wheat - doublecrop soybean] - soybean rotation, highest soybean yield has occurred in the past 2 years with the early maturing Group I cultivar (Weber 84). However, seed quality has been very poor for maturity Group I. In 1989, cool conditions during late August affected the growth and development of soybean seed for the late-maturing cultivars, which caused many blank seed pods and significant reductions in yields.

Table 1. Effects of Wheat and Soybean Cropping Rotations on Soybean Yield, Parsons Unit.

Crop Rotation	Soybean Yield 1981	1982	1983	1984	1985	1986	1987	1988	1989	9-yr Avg.
	bu/A									
[Wh - Soy]	18.7	23.6	17.9	2.1	33.2	19.9	19.5	9.1	27.6	19.1
[Wh - Soy] - Soy	18.0	23.0	16.9	2.0	31.6	17.6	19.3	8.4	28.0	18.3
[Wh - Soy] - Soy	25.8	24.3	15.5	11.1	32.6	21.2	35.4	22.7	28.3	24.1
Wh - Wh - Soy	25.7	24.9	14.5	12.8	32.1	23.9	42.6	25.1	29.8	25.7
LSD: (0.05)	3.7	NS	NS	2.9	NS	3.8	2.5	1.5	1.7	--

Full-season and double-crop soybeans were planted on the same dates in 1982, 1985, and 1989.

Table 2. Comparison of Wheat Yield among Wheat and Soybean Crop Rotations, Parsons Unit.

Wheat - Soybean Rotation	Wheat Yield 1989	1988	2-yr Avg.
	bu/A		
Wheat - Double-crop Soy	50.3	49.5	49.9
[Wheat - Double-crop Soy] - Fullseason Soybean	64.8	53.0	58.9
Wheat - Wheat - Soybean	64.3	60.5	62.4
Wheat - Wheat - Soybean	68.6	61.6	65.1
LSD: (0.05)	5.8	5.1	----

Table 3. Comparison of Soybean Maturity Groups in a Full-Season Soybean Rotation, Parsons Unit.

Variety	Maturity Group	Fullseason Soybean Yield		
		1989	1988	2-yr Avg.
		--------- bu/A --------------		
Weber 84	I	31.5	31.8	31.7
Resnik	III	30.8	24.0	27.4
Stafford	IV	28.8	26.9	27.9
Hutcheson	V	28.3	22.7	25.5
LSD: (0.05)		1.7	1.5	----

Rotation is [Wheat - double-crop soybean] - full-season soybean.

Table 4. Comparison of Soybean Maturity Groups in a Double-crop Soybean Rotation, Parsons Unit.

Variety	Maturity Group	Double-crop Soybean Yield		
		1989	1988	2-yr Avg.
		--------- bu/A --------------		
Weber 84	I	28.7	2.0	15.4
Resnik	III	28.9	2.2	15.6
Stafford	IV	28.0	8.4	15.2
Hutcheson	V	22.8	6.5	14.7
LSD: (0.05)		1.7	1.5	----

Rotation is [Wheat - double-crop soybean] - full-season soybean.

ECONOMIC COMPARISONS OF WHEAT AND SOYBEAN CROPPING SEQUENCES[2]

Robert O. Burton, Jr.[2], Mario F. Crisostomo[3], and Kenneth W. Kelley

Summary

Economic comparisons of three crop rotations were based on budgeting and on experimental data shown in the previous article of this report. Income based on 1989 yields and prices or average yields and prices favor a 1-year sequence of wheat followed by double-crop soybeans. Four soybean maturity groups were considered in the two-year rotation containing wheat, double-crop soybeans, and full-season soybeans. Group I full-season soybeans were more profitable than soybeans from traditional maturity groups. Because of high seed costs for group I, the budget analysis for double-crop soybeans favored group III.

Introduction

Farmers producing wheat and soybeans in southeastern Kansas select a cropping sequence in order to manage soil fertility, control weeds, and maximize income. An ongoing experiment at the Parsons Unit of the Southeast Kansas Branch Experiment Station provides biological data about alternative cropping sequences. The purpose of this study is to provide information about economic returns associated with these alternative sequences.

Experimental Procedures

Budgeting was used to calculate incomes about variable costs for each crop in three crop sequences (Table 1): a 1-year sequence of wheat and double-crop soybeans; a 2-year sequence of wheat, double-crop soybeans, and full-season soybeans; and a 3-year sequence of 2 years of wheat followed by full-season soybeans. Output prices were for the month of harvest, June for wheat; October for soybean maturity groups III, IV, V and double-crop group I; and August for full-season soybean maturity group I. Seed costs for maturity group I were actual costs plus a shipping charge. Other soybean seed costs were from a seed distributor in southeastern Kansas. Fertilizer prices were the same for all wheat, and interest rate was the same for all crops. No fertilizer was applied on soybeans. Yields and machinery operations differed according to the crop sequence (Table 2). For purposes of this study, labor was included as a variable cost. Incomes above variable costs for each crop were added to provide total income for each sequence; these totals were then divided by the number of years required to complete a sequence to provide average annual incomes for each sequence. Incomes above variable costs were calculated based on 1989 yields and prices for both wheat and soybeans and

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[2]This research was partially funded by the Kansas Soybean Commission.

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also on 1988-89 average annual yields for wheat, 1981-89 average annual yields for soybeans, and an average 1985-89 price. The 1985-88 prices were converted to a 1989 price level before averaging.

Results

Results indicate that double-cropping wheat and soybeans every year is most profitable and that no double-cropping is least profitable (Table 3). Comparisons of 1989 results with results based on average data indicate that returns were unusually high in 1989. Although both 1989 and average data favor double-cropping, this result will not hold every year. For example, in last year's report of progress, budgeting based on 1988 yields and projected prices published in 1988 showed double-cropping every year to be least profitable and no double-cropping to be most profitable. Moreover, some producers will not have adequate labor and machinery to double-crop every year, especially when weather limits the number of days on which machinery operations may be performed during harvest and planting seasons.

One strategy for managing labor and machinery constraints during critical seasons is to use early maturing soybeans. In 1988 and 1989, four maturity groups were considered in the two-year rotation containing wheat, double-crop soybeans, and full-season soybeans. Full-season soybean yields were highest for group I, and double-crop yields were almost equal for groups I, III, and IV (see previous report). For full-season soybeans, group I had the highest returns (Table 4). For double-crop soybeans, group III had the highest returns (Table 5).

Budgeting results for double-cropping alternative maturity groups differ from yield results because of seed costs. In this experiment, group I soybeans were drilled in 7-inch rows at 90 pounds of seed per acre. Budgeted costs of group I soybean seeds were 20 cents per pound plus a 2 cents per pound shipping charge. Group III soybeans were planted in 30-inch rows at 45 pounds of seed per acre. Costs of group III soybean seeds were 16 cents per pound, based on a price of $9.75 per bushel. Thus, budgeted seed costs were $7.20 per acre for group III soybeans and $19.80 per acre for group I. Results of the budget analysis would change in favor of group I soybeans, if the seeding rate could be lowered or if seeds could be obtained at costs similar to those of group III seeds.

In 1989, weather conditions delayed harvest of group I double-crop soybeans until October. Earlier harvest probably would favor group I, because soybeans harvested prior to the traditional harvest season typically have a price advantage.

Table 1. Sample Budgets for Two-year Crop Sequence of Wheat, Double-crop Soybeans, and Full-season Soybeans.

		Wheat			Double-crop Soybeans			Full-season Soybeans		
	Unit	Price[a]	Quantity per Acre[b]	Value or Cost	Price[a]	Quantity per Acre[b]	Value or Cost	Price[a]	Quantity Per Acre[b]	Value or Cost
1. Gross Receipts from Production	Bu.	$3.86	64.80	$250.13	$5.18	28.00	$145.04	$5.18	28.30	$146.59
2. Variable Costs										
Seed	Lbs.	0.10	75.00	7.50	0.16	60.00	9.60	0.16	60.00	9.60
Nitrogen	Lbs.	0.26	70.00	18.20	-	-	0.00	-	-	0.00
Phosphate	Lbs.	0.24	50.00	12.00	-	-	0.00	-	-	0.00
Potash	Lbs.	0.13	50.00	6.50	-	-	0.00	-	-	0.00
Herbicide		-	-	0.00	-	-	21.05	-	-	21.05
Labor	Hrs.	6.00	1.28	7.68	6.00	1.44	8.64	6.00	1.60	9.60
Machinery				15.89			14.69			16.57
Interest on ½ of variable cost	Dol.	0.12	33.89	4.07	0.12	26.99	3.24	0.12	28.41	3.41
Total Variable Cost				71.84			57.22			60.23
3. Income above variable costs				178.29			87.82			86.36

[a]Wheat and soybean prices are for the month of harvest from Kansas Agricultural Statistics, Topeka, Kansas. Input costs other than machinery and soybean seed costs are projections from Figurski, Leo and John R. Schlender, Soybean Production in Eastern Kansas and Continuous Cropped Winter Wheat in Eastern Kansas, KSU Farm Management Guides MF-570 and MF-572, revised September 1989. Machinery variable costs (fuel, lubrication, and repairs) and labor requirements are based on information from Fuller, Earl I and Mark F. McGuire, Minnesota Farm Machinery Economic Cost Estimates for 1989, Minnesota Extension Service, University of Minnesota, AG-FO-2308, revised 1989, with adjustments for Southeastern Kansas. Soybean seed costs are from a seed distributor in Southeastern Kansas.

[b]Yields, seed, and fertilizer are 1989 data from Kenneth Kelley at the Southeast Kansas Branch Experiment Station.

Table 2. Typical Average Machinery Operations per Acre Used in Budgets for Crops in Alternative Crop Sequences.

Machinery Operations	Wheat Following Wheat	Wheat Following Double-crop or Full-season Soybeans	Double-crop Soybeans Following Wheat	Full-season Soybeans Following Wheat	Full-season Soybeans Following Doublecrop Soybeans
	-Number of Times over the Field-				
Burn Wheat Straw			1.00		
Moldboard Plow	0.50				
Chisel Plow				1.00	1.00
Disk	2.50	1.00	1.00	3.00	2.00
Fertilizer Buggy	1.00	1.00			
Field Cultivate	1.25	1.00			
Field Cultivate with Herbicide			1.00	1.00	1.00
Plant[a]	1.00	1.00	1.00	1.00	1.00
Herbicide Application			0.50	0.50	0.50
Row Cultivate				0.50	0.50
Combine	1.00	1.00	1.00	1.00	1.00
	-Acre/Truck Load-				
Medium Truck[b]	6.09	6.09	16.28	16.28	16.28
	-Acres/hour-				
Light Truck	3.50	3.50	3.50	3.50	3.50
	-Dollars/Acre-				
Machinery Variable Costs[c]	20.62	15.89	14.69	17.83	16.57

[a]Group I soybeans are planted with a grain drill and, therefore, have machinery variable costs about $1.00 less than soybeans planted with a planter.

[b]Acres per truck load for a 400 bushel truck are based on yields of 24.57 bushels per acre for soybeans and 65.63 bushels per acre for wheat. Lower yields would increase acres per truckload and decrease costs per acre and vice versa. Because adjustments in costs would be small, acres per truck load and costs per acre are not adjusted for yield differences.

[c]Variable costs include fuel, lubrication, repairs, and $2.50 per acre rental charge for the fertilizer buggy.

Table 3. Incomes above Variable Costs for Alternative Cropping Sequences Containing Wheat, Double-crop Soybeans, and/or Full-season Soybeans at Parsons, Kansas[a]

Crops and Crop Sequences[b]	Incomes above Variable Costs[d]: 1989 Yields and Output Prices[e]	1988-1989 Average Wheat and 1981-89 Average Soybean Yields, 1985-89 Average Output Prices[f]
	- - - - - - -Dollars/Acre- - - - - - -	
[W-DCSB]		
W	122.32	84.85
DCSB	85.75	53.37
Annual Average[c]	208.07	138.22
[W-DCSB]-FSSB		
W	178.29	113.11
DCSB	87.82	48.74
FSSB	86.36	79.31
Annual Average[c]	176.24	120.58
W-W-FSSB		
W Year 1	176.36	124.10
W Year 2	185.34	124.95
FSSB	89.55	83.99
Annual Average[c]	150.42	111.01

[a] Incomes are based on agronomic data shown in the previous article.

[b] Abbreviations are as follows W = wheat; DCSB = double-crop soybeans, FSSB = full-season soybeans. Brackets indicate wheat and double-crop soybeans harvested the same year.

[c] Annual average income is the total income for the crop sequence divided by the number of years required to complete the sequence.

[d] Input costs are based on the same price level for all budgets. See Table 1 for sources.

[e] Source of 1989 wheat and soybean prices for the month of harvest is Kansas Agricultural Statistics, Topeka, KS.

[f] Source of average 1985-89 prices for the month of harvest is Kansas Agricultural Statistics. Prices were updated to a 1989 price level using the personal consumption expenditure (PCE) portion of the implicit GNP price deflation before averaging.

Table 4. Incomes above Variable Costs for Soybean Maturity Groups: Full-Season Soybeans in a Two-Year Rotation, Parsons, Kansas[a].

		Income Above Variable Costs for Full-season Soybeans			
		1989 Soybean Price[b]		5-yr. Avg. Soybean Price[b]	
Variety	Maturity Group	1989 Yield[c]	2-yr. Avg. Yield[c]	1989 Yield[c]	2-yr. Avg. Yield[c]
Weber 84	I	114.45	115.61	134.92	136.22
Resnik	III	101.85	84.24	120.64	100.96
Stafford	IV	91.49	86.83	109.06	103.85
Hutcheson	V	90.60	76.10	107.87	91.66

[a]Rotation is [wheat-double-crop soybeans] - full-season soybeans.

[b]Prices are for the 1989 month of harvest, August for group I and October for groups III, IV, and V. Prices for 1985-88 were updated to a 1989 price level to calculate a 5-year average. The personal consumption expenditure portion of the implicit GNP price deflator was used to update prices.

[c]Yields are shown in the previous article.

Table 5. Incomes above Variable Costs for Soybean Maturity Groups: Double-crop Soybeans in a Two-Year Rotation, Parsons, Kansas[a].

		Income Above Variable Costs for Double-crop Soybeans			
		1989 Soybean Price[b]		5-yr. Avg. Soybean Price[b]	
Variety	Maturity Group	1989 Yield[c]	2-yr. Avg. Yield[c]	1989 Yield[c]	2-yr. Avg. Yield[c]
Weber 84	I	82.48	13.58	99.98	22.98
Resnik	III	95.03	26.13	112.66	35.65
Stafford	IV	90.37	24.07	107.45	33.34
Hutcheson	V	65.12	23.17	79.03	32.13

[a]Rotation is [wheat-double-crop soybeans] - full-season soybeans.

[b]Prices are for the 1989 month of harvest, October for groups I, III, IV,and V. Prices for 1985-88 were updated to a 1989 price level to calculate a 5-year average. The personal compsumption expenditure portion of the implicit GNP price deflator was used to update prices.

[c]Yields are shown in the previous article.

EFFECTS OF CROPPING SEQUENCE ON SOYBEAN YIELDS[1]

Kenneth Kelley

Summary

When full-season soybeans follow grain sorghum, wheat, or a wheat - double-crop rotation, soybean yields over an 8-year period have not been affected significantly by the crop rotation. However, when soybeans follow soybeans, grain yield is reduced significantly. In 1989, soybean cyst nematode (SCN) was found to be present in one series of continuous soybeans, which reduced yield more than the previous 10% reduction that was associated with a monoculture.

Introduction

Soybeans are the major cash crop for many farmers in southeastern Kansas. Typically, they are grown in several cropping sequences with wheat and grain sorghum or in a doublecropping rotation with wheat. More information is needed to determine the long-term agronomic effects of cropping sequences on soybean yield.

Experimental Procedure

In 1979, four cropping systems were initiated at the Columbus Unit: 1) [wheat - double-crop soybean] - soybeans, 2) wheat - fallow - soybeans (lespedeza was added to the wheat beginning in 1988), 3) grain sorghum - soybeans, and 4) continuous soybeans. Full-season soybean yields were compared across all four cropping systems in even-numbered years. Beginning in 1984, an identical study was started adjacent to the initial site so that full-season yields could also be compared in odd-numbered years. All rotations received the same amount of phosphorus and potassium fertilizer (80 lb/a), which was applied to the crop preceeding full-season soybeans.

Results

Full-season soybean yields over the 8-year period are shown in Table 1. In 1989, soybean yield was significantly higher when soybeans followed a wheat and lespedeza rotation. Soybeans following grain sorghum or doublecrop soybeans produced nearly the same yield. However, yield was substantially reduced in continuous soybean because of the soybean cyst nematode. However, soil tests did not reveal the presence of the nematode in any of the rotations at this time. Also, the nematode was not confirmed in the original test area, which has been in continuous soybeans for 10 years.

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[1]This research was funded by the Kansas Soybean Commission.

Table 1. Effects of Long-term Cropping Sequences on Soybean Yield, Columbus.

Cropping Sequence	Soybean Yield 1980 **	1982 **	1984 **	1985	1986 **	1987	1988 **	1989	8-yr Avg.
	bu/A								
Soybean following Wheat - doublecrop Soy	12.6	28.0	11.8	31.9	21.9	30.7	31.3	27.0	24.4
Soybeans following Grain Sorghum	13.3	30.4	10.8	30.9	23.6	31.5	30.1	27.5	24.8
Soybeans following Wheat-Fallow (1980-87)	12.8	31.9	12.0	29.5	23.9	33.2			26.2
Wheat - Lespedeza (1988-89)							32.8	33.4	
Soybeans following Soybeans	10.3	27.2	12.1	27.9	21.8	28.2	25.2	20.7	21.7
LSD: (0.05)	1.0	3.0	NS	3.2	1.8	3.8	3.0	4.5	---

Beginning in 1984, an identical study was started adjacent to the initial site so that full-season yield effects could be compared each year. The original study compares full-season soybeans during even years (**), while the later site compares soybean yield in odd years.
Lespedeza was included in the rotation starting in 1988.
In 1989, soybean cyst nematode was detected in the continuous soybean rotation that was started in 1984, but not in the initial site.

COMPARISONS OF TILLAGE METHODS FOR DOUBLE-CROP SOYBEANS[1] AND SUBSEQUENT EFFECTS ON FULL-SEASON SOYBEANS

Kenneth Kelley

Summary

Comparisons among four soybean double-crop tillage methods (plow, burn - disc, disc, and burn - chisel - disc) showed that plowing under the wheat stubble gave the highest yield over a 7-year period. Full-season soybeans that follow in the rotation have not been significantly affected by any of the double-crop tillage methods.

Introduction

Producers in southeastern Kansas typically grow double-crop soybeans after wheat, when soil moisture and time permit. Various tillage methods are used, depending partly on the type of equipment that is available. The primary goals of double-cropping are to plant soybeans as quickly as possible after wheat harvest and produce acceptable grain yields as economically as possible. However, the long-term effects from doublecrop tillage methods have not been thoroughly evaluated for shallow, claypan soils.

Experimental Procedure

Since 1982, four tillage methods have been compared for double-crop soybeans after wheat harvest at the Columbus Unit. Tillage methods are: 1) plow under stubble, 2) burn stubble and then disc, 3) disc stubble, and 4) no-till for 3 years and now burn stubble and then chisel. The tillage study is alternated each year between two different sites, so that the double-crop tillage methods can be compared yearly when the crop rotation is [wheat - double-crop soybean] - followed by full-season soybean. All plots are chiseled in the spring following doublecrop soybeans. Fertilizer is applied only to the wheat crop.

Results

Comparisons among double-crop tillage methods (Table 1) show that plowing the stubble under has produced the highest soybean yield over a 7-yr period. Burning the stubble has been the same as leaving most of the stubble on the soil surface (disc tillage), except when soil moisture was limited. Then, burning the stubble resulted in significantly lower double-crop soybean yields.

The subsequent effect of double-crop tillage methods on full-season soybean yield is shown in Table 2. The previous tillage method has not significantly affected yield. Wheat that follows full-season soybeans also has not shown any effect from the previous double-crop tillage methods.

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[1]This research was funded by the Kansas Soybean Commission.

Yearly soil tests have not shown any major changes in soil nutrients since the establishment of the study. Soil bulk density measurements show that no significant changes in soil structure have occurred.

The study will be continued for several more years to evaluate the long-term effects of various doublecrop tillage methods.

Table 1. Comparison of Double-crop Tillage Methods on Soybean Yield, Columbus.

Double-crop Tillage Method	Soybean Yield 1982	1983	1985	1986	1987	1988	1989	7-yr Avg.
	---------------------- bu/A							----------------------
Plow	26.1	25.2	32.9	20.2	18.7	14.6	27.9	23.7
Burn - disc	25.8	24.2	32.1	14.7	9.8	10.5	23.3	20.0
Disc (2X)	26.6	23.2	30.3	15.2	12.8	19.2	22.6	21.4
No-till	26.3	20.5	24.7	----	----	----	----	----
Burn - chisel	----	----	----	15.3	14.4	14.3	22.1	----
LSD 0.05:	NS	3.6	4.9	1.3	2.8	3.0	1.2	----

No yield data in 1984 because of poor stands and summer drought conditions.

Table 2. Effects of Double-crop Tillage Method on Subsequent Yield of Full-Season Soybeans, Columbus.

Double-crop Tillage Method	Full-Season Soybean Yield 1985	1986	1987	1988	1989	5-yr Avg.
	-------------------- bu/A					--------------------
Plow - disc	32.1	25.8	30.7	26.3	34.1	29.8
Burn - disc	32.5	26.0	29.0	26.3	33.0	29.4
Disc (2X)	32.2	24.7	29.3	25.1	31.8	28.6
Burn - chisel - disc	33.3	25.7	30.8	25.7	32.7	29.6
LSD 0.05:	NS	NS	NS	NS	NS	----

Cropping sequence is [wheat - double-crop soybean] - full-season soybean. All plots are chiseled in the spring, so the tillage method represents only the double-crop tillage effect from the previous year.

EFFECTS OF PHOSPHORUS AND POTASSIUM FERTILIZER WHEN SOYBEANS FOLLOW SOYEANS

Kenneth Kelley

Summary

Soybean yields were not significantly affected by preplant applications of phosphorus and potassium fertilizer in Cherokee County, where soils were testing medium in available P and low in exchangeable K and the previous crop was soybeans.

Introduction

Soybeans are considered poor responders to direct fertilizer applications. In southeast Kansas, soybeans are often grown in rotation with wheat or a row-crop, such as grain sorghum or corn. When grown in rotation with another crop, soybeans are seldom fertilized, because they can utilize the residual fertility from the previous crop. However, this research was initiated to determine if soybeans respond to direct fertilizer applications when following soybeans, which occurs quite often.

Experimental Procedure

Fertilizer has been applied at different off-stations sites in Cherokee County for the past 2 years, where the previous crop had been soybeans. All locations have tested medium in available P and low in exchangeable K. The fertilizer treatments were incorporated with a field cultivator prior to soybean planting.

Results

Fertility responses in 1988 and 1989 are shown in Table 1. Grain yield at all locations did not show a significant response to direct fertilizer application.

Table 1. Effects of Phosphorus and Potassium Fertility Applications on Soybeans, Cherokee County.

Fertilizer P	Fertilizer K	1989 Yield	Seed Weight	1988 Yield Site-1	1988 Yield Site-2	2-Yr Avg.
lb/A		bu/A	gr/100	--------- bu/A	---------	
0	0	29.2	11.0	23.5	35.5	29.4
40	0	31.0	11.6	22.4	37.3	30.2
80	0	30.8	10.0	25.6	37.1	31.2
0	40	32.5	11.7	24.4	37.9	31.6
0	80	31.0	11.3	23.3	38.3	30.9
40	40	32.8	11.4	22.6	37.9	31.1
40	80	33.3	11.6	26.0	39.3	32.9
80	40	32.4	12.1	22.5	37.4	30.8
80	80	31.7	10.9	22.9	38.5	31.0
LSD: (0.05)		NS	NS	NS	NS	NS
C.V. (%)		7.2	7.9			

Initial soil test data:
1989: ph = 6.6, avail. P = 29 lb/A, exch. K = 142 lb/A
1988: (Site 1) - ph = 6.8, avail. P = 26 lb/A, exch. K = 110 lb/A
(Site 2) - pH = 6.7, avail. P = 40 lb/A, exch. K = 110 lb/A
All fertilizer was broadcast preplant and incorporated.

COMPARISON OF SOYBEAN HERBICIDES AT FULL AND REDUCED RATES

Kenneth Kelley

Summary

Soybean herbicides were compared at recommended and reduced rates for weed control when applied preplant incorporated, preemerge, and postemerge. Soybean yields were not significantly reduced when lower herbicide rates were applied postemerge, especially if one cultivation followed the herbicide application. However, when reduced rates were applied preplant and preemerge, there was significant variation in weed control and subsequent yield with the various herbicide treatments.

Introduction

With the recent public awareness of and concern for herbicide use in agricultural production, there is renewed interest in evaluating reduced herbicide rates. This research was initiated to evaluate the effect of using lower herbicide rates for the weed spectrum of southeastern Kansas.

Experimental Procedure

In 1989, herbicide studies were conducted at the Parsons and Columbus Units comparing recommended and reduced herbicide rates. Soybeans were grown in 30-inch row spacing. The predominant weed species at Parsons were smooth pigweed and large crabgrass, whereas cocklebur was the main weed competition at Columbus. Cultivation was included as a variable at Parsons, but not at Columbus.

Results

At the Parsons Unit (Tables 1 and 2), reducing the herbicide rate with Canopy preplant and preemerge treatments significantly increased yield because soil pH was greater than 7.0 at this site, which is higher than the label permits for Canopy application. Reduced herbicide rates with Scepter preplant applications also tended to increase soybean yield. However, lower weed control resulted when rates were reduced for Sencor and Command treatments, but yield was not significantly affected if plots were cultivated. Reducing the postemerge rates of Classic and Pursuit did not reduce yield.

At the Columbus Unit (Table 3) where soil pH was below 7.0, reducing the preplant Canopy rate significantly reduced cocklebur control and soybean yield. However, for the preplant Scepter treatment, reducing the rate increased yield and cocklebur control was not affected. Yields were reduced somewhat with lower preemerge rates of Canopy and Scepter where plots were not cultivated. Reducing postemerge rates of Basagran, Classic, or Scepter tended to lower soybean yield in the absence of cultivation, but the difference was not statistically significant.

More research data are needed with various weed populations before reduced herbicide rates can be recommended. Current results indicate that it may be feasible to use reduced postemerge rates, if herbicide is applied early when weeds are small and actively growing and if one cultivation occurs 7 to 10 days after herbicide application.

Table 1. Comparisons of Full and Reduced Herbicide Rates and Application Methods for Weed Control in Soybeans.

Herbicide	Rate	Cultiv.	When Applied	Yield	Weed Control Bl	Weed Control Gr	Ht.
	lb. a.i./A			bu/A	-- % --		in.
Lasso + Canopy	2.0 + 0.28	No	PRE	38.1	98	98	29
		Yes	PRE	37.9	98	98	28
Lasso + Canopy	1.0 + 0.14	No	PRE	39.6	90	90	32
		Yes	PRE	42.8	98	98	32
Dual + Scepter	1.5 + 0.125	No	PRE	36.1	98	98	29
		Yes	PRE	39.4	91	90	29
Dual + Scepter	0.75 + 0.063	No	PRE	39.8	95	95	33
		Yes	PRE	39.9	98	98	36
Prowl + Pursuit	0.75 + 0.063	No	PPI + EP	41.2	95	92	33
		Yes	PPI + EP	43.4	98	98	36
Prowl + Pursuit	0.38 + 0.031	No	PPI + EP	40.0	87	80	35
		Yes	PPI + EP	44.7	93	92	38
Treflan + Classic	0.75 + 0.008	No	PPI + EP	40.9	94	83	36
		Yes	PPI + EP	41.1	94	93	35
Treflan + Classic	0.38 + 0.004	No	PPI + EP	40.2	87	80	35
		Yes	PPI + EP	41.1	95	95	39
Cultivation Only		---	---	38.7	67	70	39
No Herbicide		---	---	21.9	0	0	34
LSD (0.05):				4.9	5	7	4
Means:							
Lasso + Canopy				39.6	96	96	30
Dual + Sencor				38.8	95	95	32
Prowl + Pursuit				42.3	93	90	36
Treflan + Classic				40.8	93	88	36
LSD (0.05):				2.5	2	3	2
Full herbicide rate				39.8	96	94	32
Reduced herbicide rate				41.0	93	91	35
LSD (0.05):				NS	2	2	2
No cultivation				39.5	93	90	33
Cultivated				41.3	96	95	34
LSD (0.05):				1.7	2	2	NS

When applied: PPI = preplant incorporated (5/31), PRE = preemergent (5/31)
EP = early postemergent (6/28).
Variety: Bay, planted 5/31/89; cultivated (6/30).
Weed species: smooth pigweed (broadleaf, Bl) and crabgrass (grassy, Gr).
Soil pH = 7.0; soil type = Parsons silt loam, 1.5 % O.M.

Table 2. Comparisons of Full and Reduced Herbicide Rates when Soil-Applied for Weed Control in Soybeans.

Herbicide	Rate	Cultiv.	When Applied	Yield	Weed Control Bl	Weed Control Gr	Ht.
	lb a.i./A			bu/A	-- % --		in.
Prowl + Scepter	0.75 + 0.125	No	PPI	38.9	98	98	33
		Yes	PPI	39.5	98	98	37
Prowl + Scepter	0.38 + 0.063	No	PPI	40.1	95	93	35
		Yes	PPI	41.2	98	98	40
Treflan + Canopy	0.75 + 0.28	No	PPI	35.8	98	98	30
		Yes	PPI	34.3	98	98	31
Treflan + Canopy	0.38 + 0.14	No	PPI	40.7	89	89	35
		Yes	PPI	41.3	98	98	39
Command + Treflan	0.50 + 0.75	No	PPI	41.4	87	88	40
		Yes	PPI	44.1	94	95	42
Command + Treflan	0.25 + 0.38	No	PPI	39.5	75	73	40
		Yes	PPI	40.8	80	78	42
Treflan + Sencor	0.75 + 0.38	No	PPI	42.4	83	85	39
		Yes	PPI	43.9	98	98	41
Treflan + Sencor	0.38 + 0.19	No	PPI	37.8	63	67	40
		Yes	PPI	42.2	88	90	42
Cultivation Only		--	---	38.6	70	73	41
No Herbicide		--	---	24.5	0	0	38
LSD (0.05):				6.0	10	10	4
Means:							
Prowl + Scepter				39.9	97	97	36
Treflan + Canopy				38.0	96	96	34
Command + Treflan				41.5	84	84	41
Treflan + Sencor				41.6	83	85	41
LSD (0.05):				NS	4	4	2
Full herbicide rate				40.0	94	95	36
Reduced herbicide rate				40.5	86	86	39
LSD (0.05):				NS	3	3	1
No cultivation				39.6	86	87	36
Cultivated				40.9	94	94	39
LSD (0.05):				NS	3	3	1

When applied: PPI = preplant incorporated (5/31).
Variety: Bay, planted 5/31; cultivated 6/30.
Weed species: smooth pigweed (broadleaf, Bl) and crabgrass (grassy, Gl).
Soil pH = 6.7; soil type = Parsons silt loam, 1.5% O.M.

Table 3. Comparisons of Full and Reduced Herbicide Rates for Cocklebur Control on Soybeans.

Herbicide	Rate	When Applied	Yield	Weed Control	Crop Injury
	lb. a.i./A		bu/A	%	
Prowl + Scepter	0.75 + 0.125	PPI	23.9	97	1.7
Prowl + Scepter	0.50 + 0.094	PPI	28.0	93	1.5
Treflan + Canopy	0.75 + 0.28	PPI	26.6	92	1.4
Treflan + Canopy	0.50 + 0.188	PPI	18.6	65	1.3
Dual + Scepter	1.5 + 0.125	PRE	27.1	95	1.4
Dual + Scepter	1.0 + 0.094	PRE	24.7	88	1.4
Lasso + Canopy	1.5 + 0.28	PRE	30.2	90	1.3
Lasso + Canopy	1.0 + 0.188	PRE	26.1	83	1.4
Treflan + Basagran	0.75 + 0.5	PPI + EP	28.7	97	1.3
Treflan + Basagran + 2,4-DB	0.5 + 0.25 + 0.03	PPI + EP	27.3	94	1.4
Lasso + Classic	1.5 + 0.008	PRE + EP	31.9	98	1.3
Lasso + Classic + 2,4-DB	1.0 + 0.004 + 0.03	PRE + EP	28.5	96	1.5
Prowl + Scepter	0.75 + 0.063	PPI + EP	30.0	97	1.3
Prowl + Scepter + 2,4-DB	0.5 + 0.031 + 0.03	PPI + EP	28.2	92	1.5
Cultivation Only	---	---	25.3	62	1.0
No Herbicide	---	---	14.7	0	1.0
LSD (0.05):			4.1	10	0.2
Means:					
Prowl + Scepter			26.0	95	1.6
Treflan + Canopy			22.6	78	1.4
Dual + Scepter			25.9	92	1.4
Lasso + Canopy			28.1	87	1.3
Treflan + Classic			28.0	96	1.4
Lasso + Classic			30.2	97	1.4
Prowl + Scepter			29.1	94	1.4
LSD (0.05):			2.9	7	NS
Full herbicide rate			28.3	95	1.4
Reduced herbicide rate			25.9	87	1.4
LSD (0.05):			1.5	4	NS

When applied: PPI = preplant incorporated (6/9), PRE = preemergent (6/21)
EP = early postemergent (7/5).
Variety: Pershing, planted 6/21.
All postemergent herbicide treatments also received 1 qt/A of 28% N.
Plots were not cultivated.
Crop injury rating: 1 = no injury and 10 = all plants dead.

COMPARISONS OF HERBICIDES AND APPLICATION METHODS FOR WEED CONTROL IN SOYBEANS

Kenneth Kelley

Summary

Preplant incorporated, preemergent, and postemergent applications of herbicides were compared for broadleaf and grass weed control in soybeans. Nearly all herbicide treatments provided good to excellent weed control. However, one timely cultivation following herbicide application was beneficial for the control of late-emerging cockleburs, regardless of application method.

Introduction

Weed control is one of the major factors affecting soybean yields in southeastern Kansas. In general, broadleaf weed competition is more of a problem for soybean producers than annual grasses during most years. This research seeks to compare soybean herbicides, application methods, and rates for weed control in soybean production.

Experimental Procedure

Preplant incorporated, preemergent, and postemergent herbicide treatments were compared at four different sites for soybeans with cocklebur, velvetleaf, smooth pigweed, and crabgrass weed competition. Preplant incorporated treatments were incorporated with a field cultivator equipped with a 3-bar tine-mulcher. Postemerge herbicides were applied approximately 2 to 3 weeks after planting. Soil type was a Parsons silt loam with 1.4% organic matter.

Results

Where cocklebur was the main weed competitor (site 1, Table 1), one cultivation following the herbicide application provided significantly better weed control than no cultivation for all application methods. In 1989, moisture conditions were ideal for late-emerging weeds. Treatments involving Scepter gave somewhat better full-season cocklebur control than those using Canopy. Cocklebur control was not significantly influenced by application method in 1989.

Velvetleaf was the primary weed competition at site 2, although cocklebur also was present. All of the herbicide treatments gave good to excellent velvetleaf control for the entire growing season, regardless of the application method (Table 2).

Preplant incorporated and premergent application methods were compared with different herbicide combinations at site 3 (Table 3). With light to moderate smooth pigweed and cocklebur competition, there was no significant difference in weed control among application methods or herbicides.

Soybean herbicides also were compared for crabgrass control at site 3 (Table 4). All herbicide treatments gave good to excellent crabgrass control, regardless of the application method. However, for annual grass control, preplant and preemergent herbicide treatments would be more cost effective than postemerge applications, which are primarily promoted for special grass problems, such as shattercane and johnsongrass.

Table 1. Comparisons of Soybean Herbicides and Cultivation Effects on Weed Control in Soybeans.

Herbicide	Rate	When Applied	Yield No Culv	Yield Culv	Broadleaf Weed Control Early No Culv	Broadleaf Weed Control Late No Culv	Broadleaf Weed Control Late Culv	Crop Injury
	lb. a.i./A		-- bu/A --		----- % -----			
Lasso + Scepter	2.0 + 0.125	EPP	27.9	31.2	96	88	95	1.5
Treflan + Canopy	0.75 + 0.28	EPP	25.7	31.8	89	80	90	1.4
Squadron	0.875	EPP	26.4	32.5	95	86	95	1.5
Lasso + Scepter	2.0 + 0.125	S.PPI	28.7	31.2	94	87	96	1.4
Lasso + Canopy	1.5 + 0.28	S.PPI	32.4	34.5	92	82	92	1.4
Salute + Scepter	1.125 + 0.063	S.PPI	28.6	32.2	91	80	96	1.4
Squadron	0.875	S.PPI	24.6	31.4	92	86	95	1.5
Lasso + Scepter	2.0 + 0.125	PRE	29.4	33.7	88	84	92	1.4
Lasso + Canopy	1.5 + 0.28	PRE	31.3	34.3	95	82	91	1.5
Squadron	0.875	PRE	27.3	31.5	89	83	90	1.4
Turbo + Scepter	2.0 + 0.063	PRE	30.0	33.0	93	84	96	1.3
Salute + (Basagran)	1.125 + 0.5	PPI + EP	26.5	36.4	95	75	92	1.5
Salute + (Scepter)	1.125 + 0.063	PPI + EP	30.9	34.3	88	80	90	1.4
Prowl + (Pursuit)	0.75 + 0.063	PPI + EP	30.8	33.1	96	80	96	1.5
Prowl + (Scepter)	0.75 + 0.125	PPI + EP	27.5	33.4	88	80	90	1.5
Classic + Pinnacle (Treflan 0.75 # - PPI)	0.004 + 0.004	EP	26.2	32.3	98	75	98	2.5
No Herbicide	-----	---	14.4	25.2	0	0	0	1.0
LSD (0.05):								
For any herbicide comparison:			4.5			4		0.1
For herbicide within cultivation:			3.8			3		---

When applied: EPP = early preplant (6/9), S.PPI = shallow preplant (6/21), PRE = preemergent (6/21), EP = early postemergent (7/5).
Variety: Pershing, planted 6/21; cultivated 7/10.
Soil pH = 6.2; soil type = Parsons silt loam, 1.3% O.M.
Crop injury rating: 1 = no injury and 10 = all plants dead.
Weed species: Major weed competition from common cocklebur.

Table 2. Comparisons of Soybean Herbicides for Broadleaf Weed Control.

Herbicide	Rate	When Applied	Yield	Weed Control	Crop Injury
	lb. a.i./A		bu/A	%	
Treflan + Canopy	0.75 + 0.28	EPP	29.4	97	1.8
Commence	0.75	EPP	35.6	88	1.1
Pursuit (+)	0.94	EPP	35.7	97	1.1
Squadron	0.875	EPP	31.4	93	1.6
Lasso + Canopy	1.5 + 0.28	S.PPI	32.1	96	1.4
Command	0.50	S.PPI	36.6	93	1.1
Lasso + Pursuit	1.5 + 0.063	S.PPI	34.6	94	1.2
Scepter + Command	0.094 + 0.125	S.PPI	31.8	96	1.2
Lasso + Canopy	1.5 + 0.28	PRE	32.2	97	1.4
Dual + Pursuit	1.5 + 0.063	PRE	34.3	93	1.3
Treflan + Sencor	0.75 + 0.25 +0.25	PPI + PRE	32.7	93	1.4
Treflan + Basagran + N	0.75 + 0.5 + 1.25%	PPI + EP	35.5	93	1.5
Treflan + Pinnacle + N	0.75 + 0.004 + 1.25%	PPI + EP	31.5	96	2.1
Prowl + Pursuit + N	0.75 + 0.063 + 1.25%	PPI + EP	34.6	96	1.4
No Herbicide	-----	---	19.2	0	1.0
LSD (0.05):			4.7	5	0.3

When applied: EPP = early preplant (6/9), PPI = preplant incorporated (6/21)
S.PPI = shallow preplant (6/21), PRE = preemergent (6/21),
EP = early postemergent (7/5).
Variety: Pershing, planted 6/21.
Major broadleaf weed species: Velvetleaf and common cocklebur.
Soil pH = 6.8; soil type = Parsons silt loam, 1.4% O.M.
Crop injury rating: 6/28 and 7/10; 1= no injury and 10 = all plants dead.

Table 3. Comparisons of Soybean Herbicides and Application Methods for Weed Control.

Herbicide	Rate	When		Weed Control		Crop
		Applied	Yield	Bl	Gr	Injury
	lb. a.i./A		bu/A	--- %	---	
Salute + Scepter	1.125 + 0.063	PPI	34.8	92	95	1.5
Commence	1.31	PPI	36.6	88	88	1.2
Sonalan + Preview	0.75 + 0.33	PPI	34.8	90	87	1.5
Squadron	0.875	PPI	32.4	96	98	1.9
Treflan + Canopy	0.75 + 0.28	PPI	36.0	93	91	1.5
Lasso + Canopy	1.5 + 0.28	S. PPI	37.0	93	97	1.5
Lasso + Scepter	2.0 + 0.125	S. PPI	33.5	97	98	1.8
Dual + Canopy	1.5 + 0.28	PRE	36.4	98	98	1.4
Dual + Preview	1.5 + 0.33	PRE	37.4	92	98	1.3
Lasso + Lorox (+)	1.5 + 1.0	PRE	36.7	90	96	1.4
Turbo	2.0	PRE	35.5	87	98	1.2
Cultivation Only	---	---	36.1	90	90	1.0
No Herbicide	---	---	27.9	0	0	1.0
LSD (0.05):			2.8	4	4	0.2

When applied: PPI = preplant incorporated (6/21), S. PPI = shallow preplant incorporated (6/21), and PRE = preemergent (6/21).
Weed species: Smooth pigweed and common cocklebur (broadleaf, Bl) annual crabgrass (grassy, Gr).
Crop injury rating: 1 = no injury and 10 = all plants dead.
Soil pH = 6.6; soil type = Parsons silt loam, 1.5% O.M.
Variety: Pershing, planted 6/21.

Table 4. Comparisons of Soybean Herbicides for Annual Grass Control.

Herbicide	Rate	When Applied	Yield	Grass Control	Crop Injury
	lb. a.i./A		bu/A	%	
Commence	1.31	PPI	32.8	93	1.2
Prowl	0.75	PPI	31.7	89	1.3
Sonalan	0.75	PPI	32.4	87	1.3
Treflan	0.75	PPI	33.4	94	1.3
Freedom	2.25	S. PPI	32.9	98	1.3
Lasso	2.00	S. PPI	34.5	94	1.3
Dual	2.00	S. PPI	34.1	98	1.4
Assure	0.10	POST	34.0	98	1.1
Fusilade 2000	0.188	POST	34.5	98	1.2
Poast	0.188	POST	32.8	96	1.2
Verdict	0.125	POST	33.0	98	1.1
Pursuit	0.063	POST	31.6	98	1.2
No Herbicide	---	---	19.7	0	1.0
LSD (0.05):			2.6	5	0.1

Classic applied at 0.5 oz/A to all plots for broadleaf weed control (7/28).
When applied: PPI = preplant incorporated (6/21), S. PPI = shallow preplant incorporated (6/21), POST = postemergent (7/10).
Variety: Pershing, planted 6/21.
Weed competition was annual crabgrass.
Crop injury rating: 1 = no injury and 10 = all plants dead.

EFFECTS OF POSTEMERGENT SPRAY ADDITIVES ON BROADLEAF WEED CONTROL IN SOYBEANS

Kenneth Kelley

Summary

When climatic conditions were excellent for postemergent spraying in 1989, adding spray additives to the tankmix did not have a significant effect on broadleaf weed control.

Introduction

Postemergent soybean herbicides often are applied in southeastern Kansas to control broadleaf weeds. The effect various spray additives has in the herbicide tankmix is not fully known for some of the newer herbicides. Climatic conditions at the time of spraying may also influence the activity of some herbicide tankmixes.

Experimental Procedure

Five postermergent herbicides were compared either alone or in a tankmix with selected spray additive treatments consisting of 28% nitrogen, AG-98 surfactant, and 2,4-DB (Butyrac 200). However, addition of 2,4-DB is not currently labelled for all postemergent tankmixes.

Results

The addition of different additive treatments to postemergent herbicides and tankmixes did not significantly affect smooth pigweed and cocklebur control in 1989, when climatic conditions were excellent for postemergent spraying. Adding 2,4-DB to a Blazer + Basagran tankmix improved moringglory control; however, 2,4-DB gave more soybean injury for all treatments and tended to reduce soybean yield in some instances.

Table 1. Effects of Postemerge Additives on Broadleaf Weed Control with Selected Postemergent Soybean Herbicides.

Herbicide	Additive	Yield	Weed Control	Crop Injury
		bu/A	%	
Classic + Pinnacle	28% N	37.9	93	1.4
Classic + Pinnacle	AG-98 Surf.	35.6	95	2.7
Classic + Pinnacle	28% N + AG-98 Surf.	36.4	95	3.0
Classic + Pinnacle	28% N + AG-98 Surf.+ 2,4-DB	34.0	95	3.7
Pursuit	28% N	38.5	95	1.1
Pursuit	AG-98 Surf.	40.3	95	1.2
Pursuit	28% N + AG-98 Surf.	38.5	95	1.3
Pursuit	28% N + AG-98 Surf. + 2,4-DB	36.1	96	1.9
Basagran + Blazer	28% N	36.9	95	2.1
Basagran + Blazer	AG-98 Surf.	39.8	95	2.1
Basagran + Blazer	28% N + AG-98 Surf.	38.3	95	2.8
Basagran + Blazer	28% N + AG-98 Surf. + 2,4-DB	37.3	96	3.5
No Herbicide	-----	26.1	0	1.0
LSD (0.05):		3.3	2	0.4
Means:				
Classic + Pinnacle		36.0	95	2.7
Pursuit		38.4	95	1.4
Basagran + Blazer		38.1	95	2.6
LSD (0.05):		1.3	NS	0.2
28% N		37.8	94	1.6
AG-98 Surf.		38.6	95	2.0
28% N + AG-98 Surf.		37.7	95	2.4
28% N + AG-98 Surf. + 2,4-DB		35.8	96	3.0
LSD (0.05):		1.5	NS	0.2

Additive rate: 28% N = 1 qt/A; AG-98 Surf. = 0.25% vol./vol.; 2,4-DB = 2 oz/A.
Herbicide rate: Classic (0.25 oz/a) + Pinnacle (0.25 oz/a); Pursuit (4 oz/a); Basagran (1 pt/a) + Blazer (1 pt/a).
Weed species: Common cocklebur, smooth pigweed, and ivyleaf morningglory.
Soil pH = 6.6; soil type = Parsons silt loam with 1.3% O.M.
Variety: Pershing, planted 6/21.
Early postemergent treatments were applied 7/10.
Crop injury rating: 7/15; 1 = no injury and 10 = all plants dead.
Poast applied for annual grass control (1 pt/A).

COMPARISONS OF GRAIN SORGHUM HERBICIDES FOR WEED CONTROL

Kenneth Kelley

Summary

Comparisons among grain sorghum herbicides showed good to excellent broadleaf weed control, regardless of application method. Grass control was more dependent upon specific herbicide treatments, and yields were directly related to the degree of grass control.

Introduction

Grain sorghum is an important grain and feed crop for many producers in southeastern Kansas. It is often grown in rotation with wheat and soybeans, which helps in breaking up the weed cycle that often exists when a monoculture of continuous milo is grown. The use of safened seed treatment also has allowed a wider choice of herbicides to be used for annual grass control. The objective of this research is to evaluate grain sorghum herbicides and tankmixes for weed control and crop injury effects.

Experimental Procedure

Grain sorghum herbicides and tankmixes were applied as preplant incorporated, preemergent, and postemergent treatments at the Parsons Unit in 1989. Preplant treatments were incorporated with a field cultivator equipped with a 3-bar tine-mulcher. Soil type was a Parsons silt loam, with 1.5% organic matter.

Results

All herbicide treatments provided good to excellent broadleaf weed control (Table 1). Crabgrass and fall panicum control was more variable among herbicide treatments. Grain sorghum yields were generally related to the degree of grass control among herbicide treatments. Grain yield was reduced approximately 40% with one cultivation in the absence of any herbicide application.

Table 1. Comparisons of Grain Sorghum Herbicides for Weed Control.

Herbicide Treatment	Rate	When Applied	Yield	Weed Control B-leaf	Weed Control Grass
	lb. a.i./A		bu/A	-- % --	
AAtrex	1.5	PPI	77.8	95	60
Bicep	2.7	PPI	99.0	97	92
Lariat + AAtrex	2.5 + 0.5	PPI	94.0	93	88
Lasso + AAtrex	1.5 + 1.25	PPI	94.9	97	87
AAtrex	1.5	PRE	93.2	98	78
Bicep	2.7	PRE	104.0	98	98
Lariat + AAtrex	2.5 + 0.5	PRE	101.3	98	96
Lasso + AAtrex	1.5 + 1.25	PRE	100.2	98	96
Ramrod + AAtrex	3.0 + 1.25	PRE	99.0	98	85
Buctril/Atrazine (1.5# Lasso - S. PPI)	0.75	EP	103.6	98	92
Buctril/Atrazine + Banvel (1.5# Lasso - S. PPI)	0.75 + 0.03	EP	99.0	98	97
Buctril + Banvel (1.5# Lasso - S. PPI)	0.25 + 0.03	EP	106.1	98	90
Buctril (1.5 # Lasso - S. PPI)	0.38	EP	100.6	97	88
2,4-D Amine (1.5# Dual - S. PPI)	0.38	EP	97.7	95	96
Banvel (1.5# Dual - S. PPI)	0.25	EP	95.6	97	97
2,4-D Amine + Buctril (1.5# Dual - S. PPI)	0.25 + 0.25	EP	102.5	98	97
Banvel + AAtrex (1.5# Dual - S. PPI)	0.25 + 0.5	EP	105.9	97	98
Laddok + Crop Oil (1.5# Dual - S. PPI)	1.0 + 1.25%	EP	101.1	98	96
AAtrex + Crop Oil (1.5# Dual - S. PPI)	2.0 + 1.25%	EP	104.6	98	97
AAtrex + Crop Oil + Cultiv.	2.0 + 1.25%	EP	103.9	98	80
Cultivation Only	---	--	61.7	50	40
No Herbicide	---	--	54.5	0	0
LSD (0.05):			10.8	4	5

When applied: PPI = preplant incorporated (5/4), S. PPI = shallow preplant, (5/4) PRE = preemergent (5/5), EP = early postemergent (6/2)
Hybrid: Pioneer 8500 (safened seed), planted (5/4).
Major weed competition was smooth pigweed (broadleaf, B-leaf) and crabgrass and fall panicum (grass).
Soil type: Parsons silt loam, 1.5% O.M.

PERFORMANCE EVALUATION OF GRAIN SORGHUM HYBRIDS

Kenneth Kelley and Ted Walter[2]

Summary

Seventy-three grain sorghum hybrids were evaluated for agronomic performance. Average grain yield was 130 bu/a. Complete test results are compiled in the 1989 Kansas Sorghum Performance Tests, Report of Progress 586.

Introduction

Grain sorghum is an important feed crop in southeastern Kansas, especially on the shallow, upland soils. Corn yields are often reduced there because of the normally dry conditions during July, when corn is tasseling and filling grain. Performance tests provide farmers, extension workers, and private research and sales personnel with unbiased agronomic information on many hybrids marketed in Kansas.

Experimental Procedure

Seventy-three grain sorghum hybrids were evaluated in 1989 at the Parsons Unit. Planting date was May 5, and harvest date was September 27.

Results

Test averaged 130 bu/a, with a range in yield from 102 to 147 bu/a. Moisture conditions were ideal during the 1989 growing season for growth and grain development. Complete test results are compiled in the 1989 Kansas Sorghum Performance Test Report of Progress 586, which is available in local county extension offices.

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[2]Department of Agronomy

Table 1. Annual Weather Summary for Parsons - 1989

1989 Data

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
AVE. MAX	48.6	35.1	57.8	69.3	75.5	80.5	86.9	85.8	74.1	70.4	58.8	34.9	65.0
AVE. MIN	28.1	17.4	33.8	46.8	54.5	61.6	66.6	65.6	52.5	45.9	33.0	11.5	43.3
MEAN	38.4	26.3	45.8	58.1	65.0	71.1	76.7	75.7	63.3	58.2	45.9	23.2	54.1
PRECIP	1.38	1.13	2.33	.27	6.76	4.49	3.99	5.45	3.07	5.47	.00	.17	34.51
SNOW	0	2	4.5	0	0	0	0	0	0	0	0	5	11.5
HEAT DD	826.	1123	599	272	103	14.5	0	0	155.	254.	578.	1254	5177.
COOL DD	0	0	4	64.5	104	197.	364	333	104.	41.5	4.5	0	1216.
RAIN DAYS	5	6	7	3	8	11	9	12	6	5	0	3	75
MIN <= 10	0	10	0	0	0	0	0	0	0	0	0	12	22
MAX >= 90	0	0	0	0	0	3	11	8	1	0	0	0	23
MIN <= 32	23	27	16	3	0	0	0	0	1	5	14	30	119

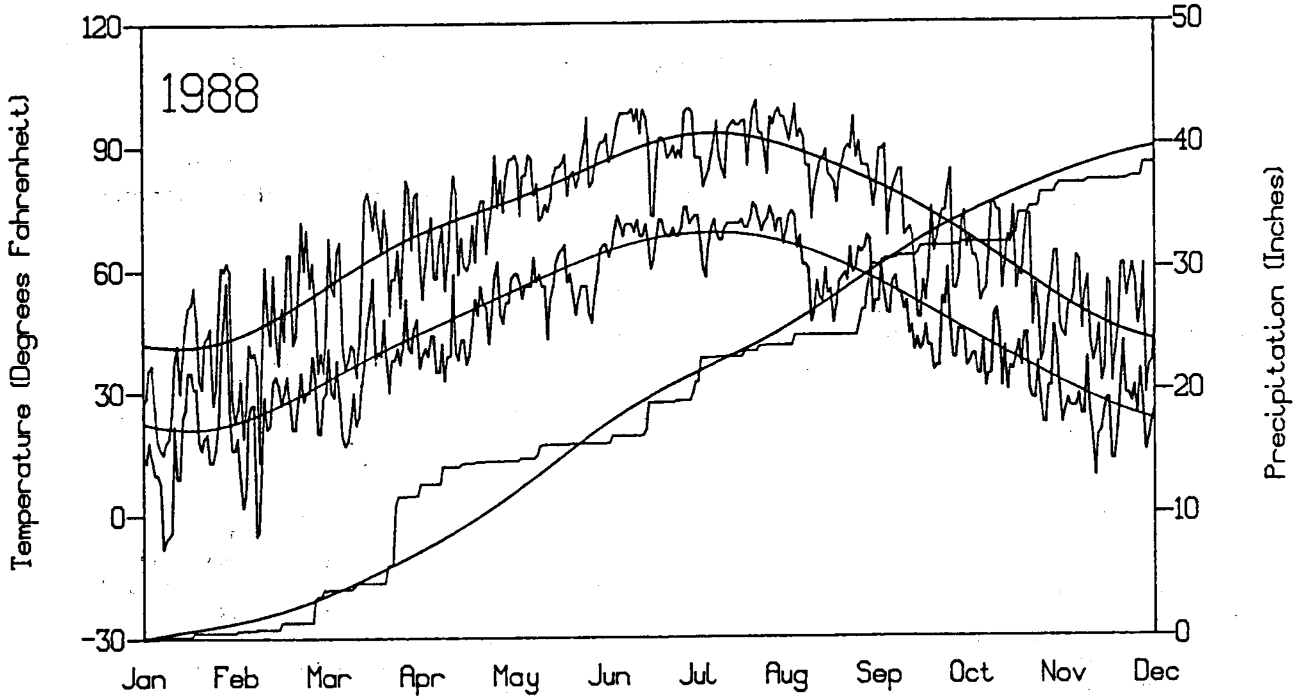
NORMAL VALUES (1951-1980 Average)

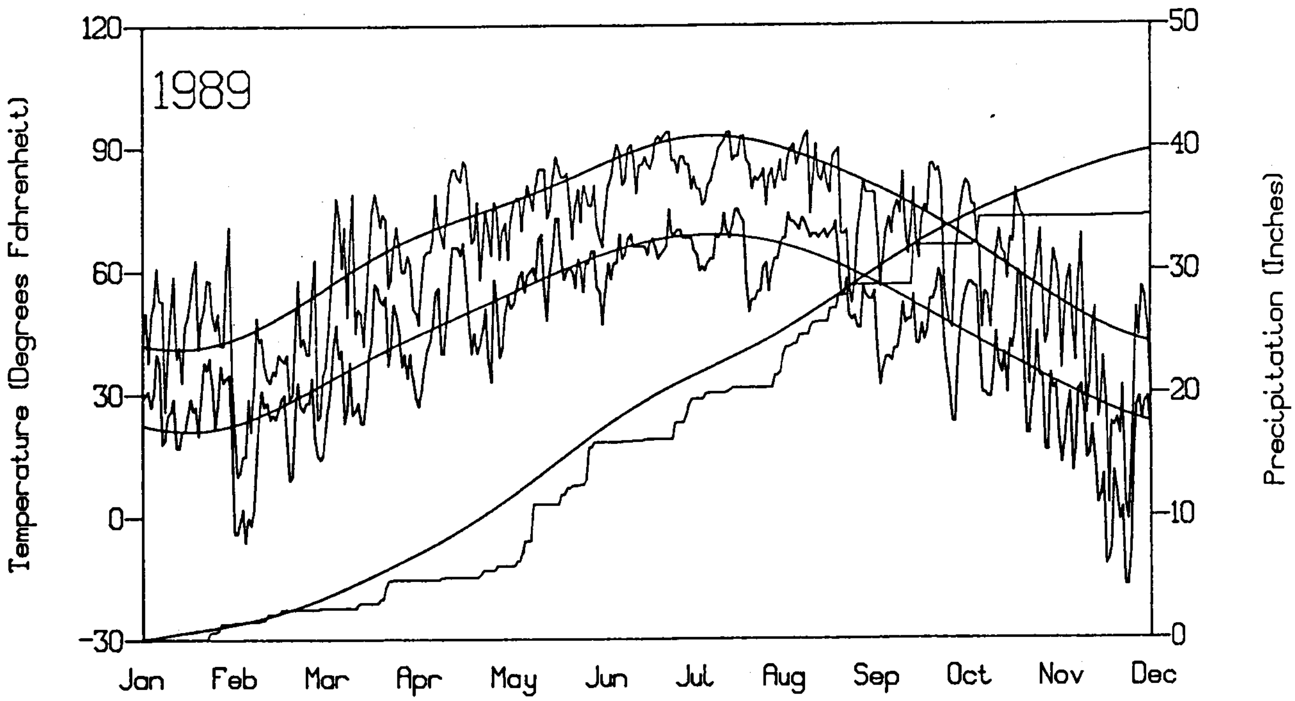
	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
AVE. MAX	42.8	49.3	58.6	70.8	78.8	87.2	93.1	92.2	84	73.6	57.9	47.3	69.6
AVE. MIN	22.6	27.6	35.5	47.2	56.5	64.9	69.5	67.6	60.3	49	36.8	27.8	47.1
MEAN	32.7	38.5	47.1	59	67.7	76.1	81.3	79.9	72.1	61.3	47.4	37.6	58.4
PRECIP	1.22	1.34	2.98	3.72	5.18	4.80	3.65	3.43	4.53	3.47	2.54	1.65	38.51
SNOW	2	3	1.5	0	0	0	0	0	0	0	2	0	8.5
HEAT DD	1001	742	565	209	59	6	0	0	24	173	528	849	4156
COOL DD	0	0	10	29	143	339	505	462	237	58	0	0	1783

1989 DEPARTURES FROM NORMAL

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
AVE. MAX	5.81	-14.	-.76	-1.5	-3.3	-6.7	-6.2	-6.4	-9.9	-3.2	.933	-12.	-4.60
AVE. MIN	5.53	-10.	-1.7	-.37	-2.0	-3.3	-2.9	-2.0	-7.8	-3.1	-3.8	-16.	-3.81
MEAN	5.67	-12.	-1.3	-.92	-2.7	-5.0	-4.6	-4.2	-8.8	-3.1	-1.5	-14.	-4.25
PRECIP	.16	-.21	-.65	-3.5	1.58	-.31	.34	2.02	-1.5	2	-2.5	-1.5	-4
SNOW	-2	-1	3	0	0	0	0	0	0	0	-2	5	3
HEAT DD	-176	381	34	63	44	8.5	0	0	131.	80.5	49.5	405	1021.
COOL DD	0	0	-6	35.5	-39	-143	-141	-129	-134	-17.	4.5	0	-568.

DD=Degree Days


1988
Temperature (Degrees Fahrenheit)
Precipitation (Inches)
120
90
60
30
0
-30
50
40
30
20
10
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec


1989
Temperature (Degrees Fahrenheit)
Precipitation (Inches)
120
90
60
30
0
-30
50
40
30
20
10
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

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Biozyme Enterprises, Inc., St. Joseph, MO
Buffalo Farm Equipment Co., Columbus, NE
Cargill Seed Co., Minneapolis, MN
Casterline Seeds, Dodge City, KS
CIBA-Geigy Corp., Greensboro, NC
Circle Seed Farms, McCune, KS
Coker's Pedigreed Seed Co., Bay, AR
Columbus Chamber of Commerce, Columbus, KS
Coopers Animal Health, Kansas City, MO
Coover Bros. Feed, Galesburg, KS
Countryside Farm & Home, Parsons, KS
DeKalb-Pfizer Genetics, Lubbock, TX
DeLange Seed Co., Girard, KS
Dow Chemical Co., Midland, MI
DuPont Agrichemical Co., Wilmington, DE
Eagle Seeds, Weiner, AR
Elanco Products Co., Indianapolis, IN
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Germain's Seed Co., Fresno, CA
Terry Green, Mound Valley, KS
Great Plains Research, Apex, NC
Joe Hall, Columbus, KS
Hillcrest Farms, Havana, KS
Hoffmann LaRoche, Inc., Nutley, NJ
ICI Americas, Inc., Wilmington, DE
International Seed, Inc., Halsey, OR
Jacob Hartz Seed Co., Stuggart, AR
Jacques Seed Co., Prescott, WI
Johnson Seed Co., Mound Valley, KS
Kansas Soybean Commission, Topeka, KS
Kerley Enterprises, Inc., Phoenix, AZ
Markley Seed Farms, Dennis, KS
Martin Farms, Columbus, KS
Mears Fertilizer Co., El Dorado, KS
Merschman Seeds, West Point, IA
Mobay Chemical Corp., Kansas City, MO
Monsanto Agricultural Products, St. Louis, MO
National Fertilizer Solutions Assn., St. Louis, MO
Northrup King Seed Co., Richardson, TX
PAG Seeds, Minneapolis, MN
Parsons Chamber of Commerce, Parsons, KS
Alice M. Parscale, Monett, MO
Parsons Livestock Market, Parsons, KS
Pfizer, Inc., Lee's Summit, MO
Pioneer Hi-Bred International, Johnston, IA
Pitman-Moore, Terre Haute, IN
Richard Porter, Reading, KS
Potash-Phosphate Institute, Atlanta, GA
PPG Industries, Inc., Pittsburgh, PA
Prince Agri Products, Quincy, IL
Richard Proehl, McCune, KS
R & F Farm Supply, Erie, KS
Rhone-Poulenc, Inc. Monmouth Junction, NJ
SCS Plant Materials Center, Manhattan, KS
Dee Shaffer, Columbus, KS
Simmons Industries, Southwest City, MO
Star Seed, Beloit, KS
Stauffer Seed, Phillips, NE
Stine Seed Farm, Inc., Adel, IA
Syntex Agribusiness, Inc., Des Moines, IA
Taylor-Evans Seed Co., Tulia, TX
Terra Internationa, Inc., Champaign, IL
Texas Sulphur Products Co., Borger, TX
The Sulphur Institute, Washington, D.C.
Triumph Seed Co., Ralls, TX
Ted Wary, Columbus, KS
W-L Research, Inc., Highland, MD

NOTE

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

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