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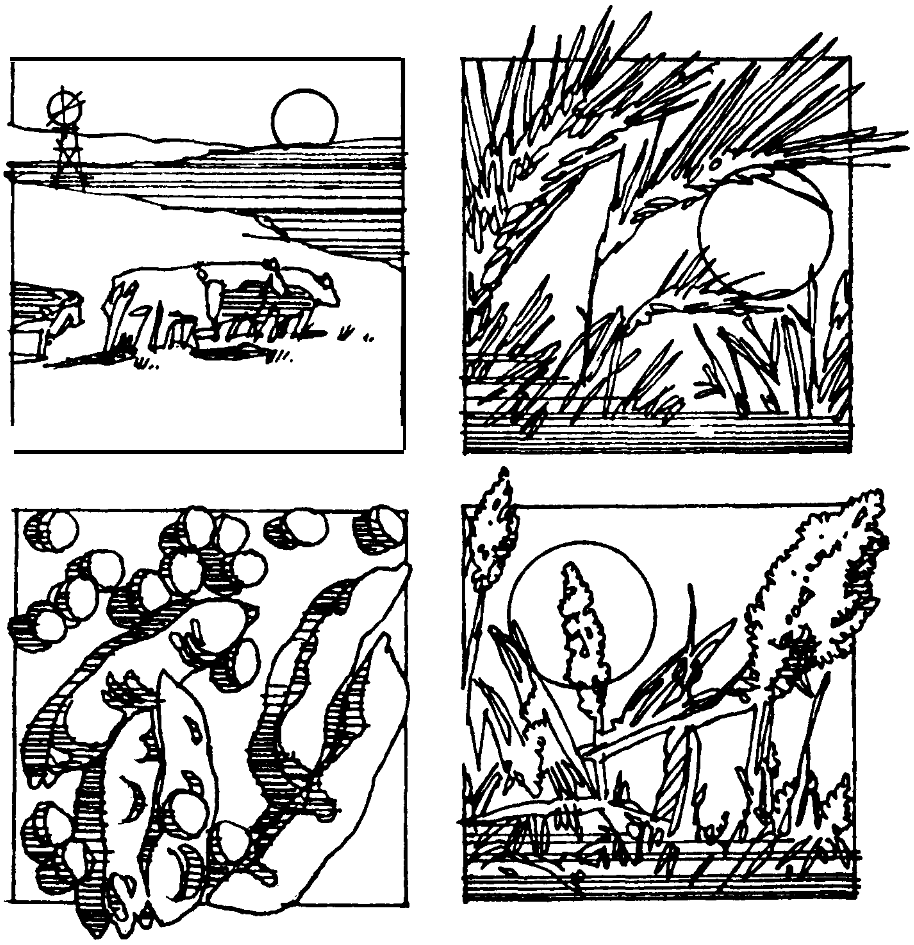
1993 AGRICULTURAL RESEARCH



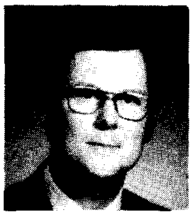
Report of Progress 681

Agricultural Experiment Station

Kansas State University, Manhattan

Marc A. Johnson, Director

SOUTHEAST KANSAS BRANCH STATION



LYLE LOMAS, Station Head, received B.S. and M.S. degrees in Animal Husbandry from the University of Missouri and a Ph.D. degree in Animal Husbandry from Michigan State University. He provides leadership for research and is responsible for Station administration. Lyle joined the staff in 1979 as Animal Scientist. His research interests are beef cattle nutrition, production, and management.

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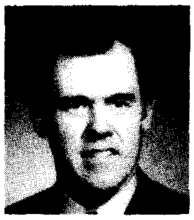

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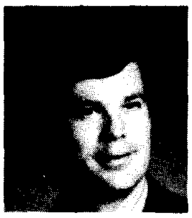

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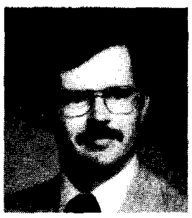

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NOTE

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Contribution No. 93-390-S from the Kansas Agricultural Experiment Station.

GRAZING AND SUBSEQUENT FEEDLOT PERFORMANCE BY STEERS OFFERED DIFFERENT LEVELS OF GROUND GRAIN SORGHUM WHILE GRAZING *ACREMONIUM COENOPHIALUM*-INFECTED TALL FESCUE[1]

Kenneth P. Coffey, Arthur S. Freeman[2], and Joseph. L. Moyer

Summary

One hundred twenty-six crossbred steers and 63 crossbred heifers (704 lb avg BW) were used to evaluate the effects of energy supplementation during grazing of *Acremonium coenophialum*-infected tall fescue on grazing and subsequent feedlot performance. Grazing daily gain increased linearly ($P<.05$) with increasing level of ground grain sorghum. During the grazing period, grain was converted at a rate of 7.6 and 8.6 lb of supplemental grain per lb of additional gain from supplemental grain sorghum at levels of .25 and .5% of BW, respectively. Subsequent feedlot performance and feed efficiency were not affected by pasture phase grain supplementation. Based on the data from this 3-year study, supplementation with grain sorghum during early-intensive grazing on tall fescue pastures appears to be a sound management practice to improve pasture performance without negatively affecting feedlot performance. However, low pasture gains across all treatments should be noted.

Introduction

Grain sorghum has been used to improve rate of gain of grazing cattle. In many instances, cattle offered supplemental grain during a grazing period exhibit reduced performance and efficiency during a subsequent feedlot period. It is well documented that higher levels of supplemental grain reduce forage intake. Therefore, offering grain supplements to cattle grazing *Acremonium coenophialum*-infected tall fescue should dilute the toxic effects of the fescue and thereby have a dramatic effect on animal performance. However, subsequent effects on feedlot performance are uncertain. This study was conducted for 3 years to evaluate the effects of supplementation with different levels of ground grain sorghum on pasture and subsequent feedlot performance by stocker cattle grazing *Acremonium*-infected tall fescue pastures.

Experimental Procedure

Grazing Phase. One hundred eighty crossbred yearling steers and 90 crossbred yearling heifers were used in a 3-yr grazing experiment to determine the effects of different levels of supplemental ground grain sorghum on performance of stocker cattle grazing *Acremonium*-infected fescue. During each grazing season, 90 cattle were vaccinated against IBR, BVD, PI_3, five strains of leptospirosis, seven clostridial strains, pinkeye and BRSV; were dewormed; and received an insecticide ear tag, then co-mingled for 7 d on a mixed pasture of endophyte-free fescue, bromegrass, and native grass. Cattle were then allotted by weights measured on two consecutive days and transported

[1]Appreciation is expressed to Steve Clark, Havana, KS and Richard Porter, Reading, KS for use of experimental cattle.

[2]Animal Scientist, Southwest Research-Extension Center, Garden City, KS.

to one of nine 5-acre *A. coenophialum*-infected tall fescue pastures (70% of the plants infected), where they grazed for an average of 62 d. Pastures were randomly allotted such that steers grazing each of the nine pastures were assigned to a control or were offered ground grain sorghum (GS) at levels of .25 and .5% of body weight daily (three pastures each). The remaining 27 head each year were used to control excess forage production on the experimental pastures. Water and mineral blocks containing monensin were provided free-choice. Grain levels were adjusted according to interim weights measured at 21-d intervals.

Pastures were fertilized with 80 lb of nitrogen, 40 lb of phosphate, and 40 lb of potash as potassium chloride.

Ending weight was measured without prior removal from pasture and water. Following the ending weights, cattle were moved to *Acremonium*-free pastures for a 5 to 7-d period to equalize gut fill. Cattle were weighed, then transported overnight to the Southwest Research - Extension Center, Garden City, KS for the feedlot phase of the trial. Cattle were weighed and processed within 24 h of arrival, including an estrogenic implant; treatment for internal and external parasites; and vaccinations against IBR, BVD, PI_3, leptospirosis (5 strains), clostridial (7-way), and *Hemophilus somnus*. Cattle were offered a finishing ration for an average of 130 d then slaughtered at the Finney Co. IBP plant; carcass data were collected following a 24-h chill.

Results and Discussion

Pasture gain increased linearly ($P<.05$) with increasing grain level (Table 1). Assuming this linear increase in gain, grain conversion was such that each lb of supplemental grain produced .12 lb in additional gain. For the first .25% of BW in supplemental grain sorghum, 7.6 lb of grain sorghum was required to produce each lb of additional gain, whereas the additional .25% of grain sorghum to reach a level of .5% of BW was converted at a rate of 9.8 lb of grain sorghum per lb of additional gain. Thus, the overall conversion of grain sorghum offered at .5% of BW was 8.6 lb of supplemental grain sorghum per lb of additional gain during the pasture phase.

A point of concern, though, is the low level of gain by all treatment groups. Two-thirds to three-fourths of the total seasonal dry matter production from tall fescue generally occurs by early June. Gains by steers stocked at 1 head per acre during the period between early April and early June typically exceed 2 lb per d. Therefore, one should be able to stock fescue pastures at a higher rate, thereby better utilizing the forage during a time of high production and quality and achieve acceptable gains. This was not the case in this experiment. Furthermore, the level of gain observed in this 3-yr study is similar to that from other studies in which the stocking rate was increased in the spring in an attempt to utilize the burst of forage growth.

Feedlot dry matter intake, gain, and feed conversion were not affected by previous grain sorghum supplementation level. Carcass measurements were likewise not affected by previous treatment (Table 2).

Therefore, supplementation with grain sorghum during a program of early-intensive grazing on *Acremonium*-infected fescue pastures appears to efficiently improve stocker gains without having a negative impact on subsequent feedlot performance. However, the practice of grazing stocker cattle at a stocking rate of 2 head per acre for a 60 - 80 d period in the spring should be discouraged because of overall poor levels of gain.

Table 1. Effect of Grain Sorghum Supplementation Level during the Pasture Phase on Grazing and Subsequent Feedlot Performance by Steers Grazing *A. coenophialum*-infected Tall Fescue Pastures

Item	Control	Grain Level, % of Body Weight .25	.5
		------------ lb ------------	
Pasture phase			
Initial wt.	705	701	704
Final wt.[a]	748	759	772
Pasture gain[a]	43	57	68
Daily gain[a]	.70	.93	1.12
Grain consumption[b]	0	1.8	3.7
Grain conversion, lb/lb	-	7.6	8.6
Feedlot phase			
Initial wt.	700	710	721
Final wt.	1167	1178	1185
Gain	467	468	464
Daily gain	3.59	3.60	3.57
Dry matter intake	20.8	20.7	21.0
Feed efficiency	5.78	5.75	5.81

[a]Linear increase (P<.05).
[b]Linear increase (P<.01).

Table 2. Effect of Grain Sorghum Supplementation Level during the Pasture Phase on Subsequent Carcass Characteristics by Steers Previously Grazing *A. coenophialum*-Infected Tall Fescue Pastures

Characteristic	Control	Grain Level, % of Body Weight .25	.5
Hot carcass wt. lb.	723	730	739
Dressing %	62.0	61.9	62.4
Ribeye area, in^2	13.4	13.0	13.3
Backfat, in.	.40	.44	.44
USDA yield grade	2.4	2.7	2.7
USDA quality grade	Ch^-	Ch^-	Ch^-

PERFORMANCE OF STEERS GRAZING SMOOTH BROMEGRASS PASTURES AND OFFERED DIFFERENT LEVELS OF SUPPLEMENTAL GROUND GRAIN SORGHUM[1]

Kenneth P. Coffey and Joseph L. Moyer

Summary

Crossbred steer calves (658 lb avg BW) grazing smooth bromegrass pastures were offered no supplement (0) or ground grain sorghum at levels of either .25 or .5% of BW. Gains increased linearly (P<.10) as the level of grain sorghum increased. However, additional gain resulting from supplementation was not sufficient to offset the cost of the supplemental grain. Therefore, the practice of offering supplemental grain sorghum to growing stocker cattle grazing smooth bromegrass pastures was economically questionable in this instance.

Introduction

Smooth bromegrass is a highly productive cool season perennial forage that is noted for its high quality during the spring and for its ability to produce high animal gains. The protein content of nitrogen fertilized bromegrass is typically high in the spring grazing period but declines as the forage reaches reproductive maturity. Previous research has shown benefits of supplemental grain for cattle grazing lush cool-season forages. However, excessive grain supplementation typically results in a substitution of grain for forage consumption. This experiment was conducted to evaluate the performance of steers offered supplemental grain sorghum while grazing smooth bromegrass pastures and to evaluate the conversion of the supplemental grain sorghum to additional gain.

Experimental Procedure

Twenty-seven, fall-born, Simmental × Angus, crossbred, steer calves were weaned and placed on smooth bromegrass pastures for a 14-d acclimation period beginning on April 8. Calves were implanted with zeranol; vaccinated against IBR, BVD, PI_3, BRSV, and leptospirosis; and dewormed with oxfendazole at the time of weaning and had previously been vaccinated against seven strains of clostridial organisms. Steers were weighed on the mornings of April 21 and 22 without prior removal from pasture and water and randomly allotted to one of three groups of nine head each. One group of steers was offered no supplemental grain sorghum (0), whereas the other groups were offered grain sorghum at a level of either .25 or .5% of BW. Steers were weighed monthly throughout a 135-d grazing period, and grain levels were adjusted accordingly. Steers were weighed without prior removal from pasture or water on September 3 and 4 to end the experiment.

Pastures were fertilized with 120 lb nitrogen, 40 lb phosphate, and 40 lb potash in early February prior to grazing.

Results and Discussion

Steer weight gains increased in a linear (P<.10) manner as the level of supplemental grain sorghum was increased (Table 1). On the average, each 100 lb of supplemental grain sorghum

[1]Appreciation is expressed to Pitman-Moore, Inc., Terra Haute, IN for providing zeranol and to Syntex Animal Health for providing oxfendazole used in this study.

increased steer gain by 10.8 lb. At this conversion rate, the additional gain produced did not offset the cost of the supplemental grain cost and thus the cost of gain tended to be higher for cattle offered the supplemental grain sorghum.

Table 1. Effect of Grain Sorghum Supplementation Level on Performance by Steers Grazing Smooth Bromegrass Pastures

Item	Control	Grain Level, % of Body Weight .25	.5
Initial wt., lb	658	658	658
Final wt., lb	883	903	931
Gain, lb[a]	225	245	274
Daily gain, lb[a]	1.67	1.81	2.03
Grain consumption, lb/day	0	1.67	3.33
Grain conversion, lb/lb	0	11.3	9.3
Cost of gain, $/cwt[b]	$29.94	$30.93	$30.77

[a]Linear effect of grain supplementation ($P<.10$); $R^2 = .98$.
[b]Costs include the following: $5.48/hd processing, $32.33/acre fertilizer, $18.00/cwt mineral, 10% interest on calf and feed costs.

GRAZING AND SUBSEQUENT FEEDLOT PERFORMANCE OF STEERS GRAZING FESCUE OR FESCUE-LADINO CLOVER PASTURES AT DIFFERENT SPRING STOCKING RATES[1]

Kenneth P. Coffey and Joseph L. Moyer

Summary

One hundred sixty-two mixed breed steers (622 lb avg BW) were grazed at different stocking rates on pastures of *Acremonium coenophialum*-infected tall fescue (IF) or IF overseeded with ladino clover (IFL) for an avg of 72 d in the spring. Gains by steers grazing IF declined by 50% as stocking rate was increased from 1.2 to 3.2 head per acre. Gains by steers grazing IFL declined by 33% as stocking rate was increased from 1.0 to 2.8 head per acre. At similar stocking rates, steers grazing IF tended to gain more than steers grazing IFL. Therefore, grazing IF pastures at heavier stocking rates in the spring to increase forage utilization may result in substantial reductions in animal gain. Furthermore, grazing IFL pastures at higher stocking rates in the spring may reduce available forage to the extent that cattle will have to be removed prior to the time when ladino clover exerts its greatest benefit.

Introduction

Two-thirds to three-fourths of the total seasonal dry matter production from tall fescue generally occurs by early June. Gains by steers stocked at 1 head per acre have typically exceeded 2 lb/d during the period between early April and early June. Therefore, one should be able to stock fescue pastures at a higher rate and better utilize the forage during a time of high production and quality and achieve acceptable gains. However, in previous studies in which stocker cattle were grazed at 2 head/acre between early April and early June, gains have consistently been half of what was expected. This study was conducted to determine the effects of spring stocking rate on gain by stocker cattle grazing IF or IFL pastures and their subsequent feedlot performance.

Experimental Procedure

A total of 162 mixed-breed stocker steers was weighed on March 28 and 29, 1991, and April 21 and 22, 1992 and divided into light- and heavy-weight groups. Following routine vaccinations against IBR, BVD, PI_3, leptospirosis (5 strains), and seven clostridial strains and deworming (oxfendazole), heavier steers were randomly allotted by weight into eight groups of five head each. These groups were then randomly assigned to graze either IF or IFL pastures at one of four stocking rates. Stocking rates were randomly allotted to four 5-acre pastures of each forage type, and the same stocking rate was applied to the same pasture in both years. Steers from the light-weight block were used as needed to create the different stocking rates. Steers were stocked continuously on the respective pastures until June 18 and 19, 1991 and June 22 and 23, 1992. Steers were weighed on those days, then the five-head groups were then transported to Mound Valley, KS and placed in the SEKES feedlot facility. Feedlot processing included deworming (oxfendazole), implanting (Synovex-S®), and vaccinating against seven clostridial strains and *Haemophilus somnus*.

[1]Appreciation is expressed to Syntex Animal Health, West Des Moines, IA for providing oxfendazole and Synovex-S and to Steve Clark for use of experimental animals.

Steers were offered a finishing ration for 149 (1991) or 153 (1992) d, and original pasture allotment was maintained so that feed efficiency data could be collected. Following the feedlot period, steers were transported to Emporia, KS and slaughtered at a commercial slaughter facility. Carcass data was collected following a 24-h chill. Lighter weight steers were placed on bermudagrass pastures during the summer, then re-allotted and grazed on the IF or IFL pastures during a fall-grazing experiment.

Pastures were fertilized each fall with 40 lb each of nitrogen, phosphate, and potash. During the spring, IF pastures received an additional 80 lb of nitrogen, but IFL pastures were not fertilized.

Results and Discussion

Gain by steers grazing IF pastures tended (P<.15) to be higher than those by steers grazing IFL pastures (Table 1). This response is opposite to that previously observed in other experiments in which the cattle grazed for longer periods of time. This is probably due to the seasonal growth patterns of ladino clover. Ladino clover tends to begin its growth later in the spring than fescue and continues to grow more into the summer. Therefore, the cattle were removed prior to the time when ladino clover exerts it maximum benefit, and, thus, the study in effect compared nitrogen fertilized vs. nonfertilized fescue.

Increasing the stocking rate on IF pastures substantially reduced (P<.05) animal performance. Gain by steers grazing at 3.2 head/acre was only 49.6% of gain by steers grazing at 1.2 head/acre. Gains by steer grazing at 1.2 head/acre were only slightly lower than expected, based on observations of gains during similar grazing periods from previous studies. Furthermore, gains by steers grazing at 1.8 to 2.4 head/acre also closely mimicked the response observed in other experiments in which the cattle were double-stocked during the spring in order to more efficiently utilize the burst of forage produced by fescue. Because of rapidly declining individual animal gain as stocking rate was increased on IF pastures, gain/acre remained relatively constant through a stocking rate of 2.4 head per acre. Individual animal gain by steers stocked at 3.2 head/acre was similar to that by steers stocked at 2.4 head/acre. Therefore, lack decline in animal performance at the increased stocking rate produced an increase in gain/acre at the highest stocking rate. Cost of production tended to increase with increasing stocking rate, presumably because of the increased number of animals and low overall animal gains.

Stocking rate increases had a smaller effect on gain by steers grazing IFL pastures than by those grazing IF pastures. Although gain by steers grazing at 2.8 head/acre was only 67.1% of that by steers grazing at 1.0 head/acre, this reduction in gain was only observed after the stocking rate exceeded 2.2 head/acre. At stocking rates of 2.2 or below, no effect of increasing stocking rate was observed on animal gain. Therefore, gain/acre increased and cost of gain decreased with increasing stocking rate up to 2.2 head/acre. However, one should note the low gains by all groups grazing IFL compared with those grazing IF.

Feedlot gain and intake were not affected (P<.10) by previous stocking rate or forage, although gain by steers previously grazing IF increased numerically with previous stocking rate. However, both a quadratic effect and a forage × stocking rate interaction were observed (P < .10) for feed efficiency. Within cattle previously grazing IF, the amount of feed required to produce each pound of gain declined as previous stocking rate increased through 2.4 head/acre, then tended to increase. This was achieved by the tendency for increased gain with similar feed intake. Within steers previously grazing IFL, feed:gain ratios were similar between those previously stocked at 1.0 and 1.6 head/acre but increased as previous stocking rate increased above 1.6 head/acre. Feedlot cost of gain directly reflected trends observed for feed efficiency. Carcass measurements were not affected by previous stocking rate (Table 2).

Considering the data in this study, one should seriously question the practice of increasing the stocking rate on fescue or fescue-clover pastures during the spring. This could lead to substantial reductions in performance of cattle grazing IF and would reduce forage availability of IFL pastures so that grazing would be limited during the time when ladino clover would exert its greatest benefit.

Table 1. Performance by Steers Grazing Fescue or Fescue-Ladino Clover Pastures at Different Spring Stocking Rates

	Stocking Rate on Fescue				Stocking rate on Fescue - ladino			
Item	1.2	1.8	2.4	3.2	1.0	1.6	2.2	2.8
Pasture phase								
Initial wt., lb.	619	619	619	622	620	618	619	617
Final wt., lb.[a]	742	701	682	671	698	687	700	681
Gain, lb.[b]	123	82	63	61	79	68	81	53
Daily gain, lb.[a]	1.74	1.15	.89	.88	1.14	.97	1.18	.82
Graz. days/acre[b]	85.8	128.8	171.4	228.7	71.5	114.6	157.2	180.8
Gain/acre, lb.[b]	147.1	146.8	151.6	194.8	78.65	109.2	177.5	148.0
$/cwt. gain[c]	36.43	45.81	53.95	51.97	48.89	47.03	38.22	53.51
Feedlot phase								
Final wt, lb.	1181	1166	1153	1158	1149	1209	1152	1177
Gain, lb.	439	465	471	475	459	522	451	495
Daily gain, lb.	2.91	3.09	3.12	3.14	3.04	3.46	2.99	3.28
DM intake, lb/d	21.5	20.7	20.12	22.2	20.1	22.7	21.1	24.0
Feed:gain[de]	7.43	6.77	6.50	7.12	6.63	6.60	7.09	7.34
Feed cost, $	189.20	181.45	176.35	193.85	176.65	198.70	184.8	209.45
Feed cost, $/cwt gain	43.05	39.20	37.65	41.20	38.55	38.20	41.05	42.35

[a]Linear effect of stocking rate (P<.10).
[b]Linear effect of stocking rate (P<.05).
[c]Costs included the following: $5.48 processing, $14.38/acre for fertilizer and seed cost on IFL, $24.30/acre for fertilizer on fescue, $18.00/cwt for mineral, 10% interest on calf and fertilizer costs.
[d]Interaction between forage type and the linear effect of stocking rate (P<.10).
[e]Quadratic effect of stocking rate (P=.06).

Table 2. Carcass Characteristics of Steers Previously Grazed on Fescue or Fescue-Ladino Clover Pastures at Different Spring Stocking Rates

	Stocking Rate on Fescue				Stocking Rate on Fescue - ladino			
Characteristic	1.2	1.8	2.4	3.2	1.0	1.6	2.2	2.8
Hot carcass wt., lb	708	691	682	685	678	730	693	691
Back fat, in	.26	.35	.28	.22	.34	.32	.30	.28
Ribeye area, in^2	15.0	14.2	14.1	13.3	13.4	14.0	14.5	13.7
Marbling score[a]	428	516	458	486	485	574	446	428
USDA Yield Grade	1.3	1.8	1.7	1.5	1.8	1.9	1.5	1.4

[a] 400-499 = SelectE; 500-599 = Select$^+$; etc.

EFFECT OF SPRING STOCKING RATE ON FALL STEER GRAZING PERFORMANCE ON FESCUE OR FESCUE-LADINO CLOVER PASTURES[1]

Kenneth P. Coffey and Joseph L. Moyer

Summary

Sixty-four mixed-breed steers (713 lb avg BW) were grazed on fescue (IF) or fescue-ladino clover (IFL) pastures for an average of 107 d during the fall and early winter. Pastures had previously been grazed at different stocking rates for an average of 72 d in the spring. Steers grazing IFL were heavier (P<.05) at the end of the grazing period and gained more weight per head (P<.01) and per acre (P<.05) than steers grazing IF pastures. Grazing days per acre tended (P=.12) to be greater for IF than from IFL pastures. Spring stocking rate had no effect on fall gains or carrying capacity. Therefore, stocking rate that gives maximum return in the spring should be considered. Furthermore, grazing on accumulated fescue regrowth with ladino clover appears to be considerably more advantageous than grazing on accumulated regrowth fescue alone.

Introduction

Tall fescue is the predominant cool season forage in southeastern Kansas and much of the southeastern U.S.. Its use during the summer months is somewhat limited by poor yield and quality which results in poor animal performance. However, fall-regrowth fescue is typically of high quality, especially if fertilization is adequate. In a grazing program in which fescue pastures are used only during the spring and fall, proper stocking rate becomes a concern because of spring animal gains and subsequent fall carrying capacity. This experiment was conducted to determine the effect of a wide range of stocking rates during the spring on gain and carrying capacity during a fall grazing period on fescue and fescue-ladino clover pastures.

Experimental Procedure

A total of 81 mixed-breed stocker steers was weighed on October 10 and 11, 1991, and September 3 and 4, 1992, dewormed with oxfendazole, and allotted by weight into eight groups of four head each year. These groups were then randomly assigned to graze either IF or IFL pastures that had been grazed during the spring at one of four stocking rates. Extra steers were used as needed to equalize forage availability using a put-and-take grazing program. Steers were grazed on the respective pastures until January 7 of both years.

Pastures were fertilized each fall with 40 lb each of nitrogen, phosphate, and potash. During the spring, IF pastures received an additional 80 lb of nitrogen, but IFL pastures were not fertilized.

Results and Discussion

Gain by steers grazing IFL pastures averaged 44 lb or 72.9% greater (P<.01) than gain by steers grazing IF pastures (Table 1). Fescue pastures tended (P=.12) to be able to be grazed 11 animal d longer than IFL pastures. However, gain/acre was 59.1% greater (P<.05) from IFL than from IF.

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[1]Appreciation is expressed to Syntex Animal Health, West Des Moines, IA for providing oxfendazole and to Steve Clark, Havana, KS for use of experimental cattle.

Previous stocking rate did not statistically affect fall gains or carrying capacity. However, visual appraisal of the data from IFL pastures would lead us to conclude that heavier spring stocking rates might be more beneficial to fall gains. This is a reasonable assumption since increasing the stocking rate during the spring on IFL pastures should give ladino clover a greater competitive edge.

Considering the data from this and the previous report, one might conclude that grazing IFL pastures at a stocking rate of approximately 2.0 - 2.2 head/acre followed by grazing in the fall at .9 to 1.0 head/acre would maximize animal performance relative to economic input on this forage type. However, this conclusion would differ on IF pastures since stocking rate had no apparent effect on fall grazing performance.

Table 1. Performance by Steers Grazing Fescue or Fescue-Ladino Clover Pastures that Had Different Spring Stocking Rates

	Spring Stocking Rate on Fescue				Spring Stocking Rate on Fescue - ladino			
Item	1.2	1.8	2.4	3.2	1.0	1.6	2.2	2.8
Initial wt., lb.	714	713	713	719	710	711	707	716
Final wt., lb.[a]	779	755	778	790	798	815	809	831
Gain, lb.[a]	65	42	65	72	88	105	101	116
Daily gain, lb.[a]	.62	.38	.66	.69	.82	.99	.96	1.09
Graz. days/acre	110.4	123.5	110.3	101.7	106.1	110.3	97.3	97.3
Gain/acre, lb.[b]	68.0	46.9	68.4	68.3	87.6	108.7	92.0	105.8

[a]Means for cattle grazing fescue or fescue-ladino clover pastures differed ($P < .01$).
[b]Means for cattle grazing fescue or fescue-ladino clover pastures differed ($P < .05$).

VARIATION IN WEIGHTS OF STEERS CAUSED BY WEIGHING TIME

Kenneth P. Coffey and Frank K. Brazle[1]

Summary

Thirty-seven crossbred steers were weighed at 15, 75, 135, or 195 minutes after morning grazing began to determine how increasing the time between initiation of grazing and weighing affects steer weights. Steers generally began grazing at approximately 0700 each day of the study. Steer weights were greater ($P<.05$) at 195 than at 15 or 75 minutes after grazing began. Weights measured at 135 minutes did not differ ($P<.10$) from weights measured at the earlier or later times. Therefore, removal of cattle from pastures prior to their morning grazing period may reduce their weights and fill when they are transported for sale.

Introduction

Cattle typically graze during 2-4 distinct periods during the day, depending on the forage type. The morning grazing period is generally the longest, and we assume that forage consumption during this grazing period is greatest. Therefore, this grazing period is probably the most important. This experiment was conducted to help determine the magnitude of impact that removal of cattle from pastures during the early morning hours could have on their weights.

Experimental Procedure

Thirty-nine crossbred steer calves (823 lb avg BW) that grazed smooth bromegrass pastures during the spring and summer months were comingled and weighed in the morning of September 24 following a 16-hour removal from feed and water. The steers were then allotted into three groups of nine head and one group of 10 head. The groups were placed on one of four smooth bromegrass pastures. Steers were then weighed without prior removal from pasture or water on September 28 and 30 and October 2 and 5. On each day of weighing, each group of steers was weighed only once at either 0715, 0815, 0915, or 1015. Also, each group of steers was weighed at a different time on each weigh day. Grazing initiated at approximately 0700 on each of these days, but 0715 was as early as the animals could be observed well enough to remove them from pasture by horseback. Thus, these times were chosen to represent the approximate time of grazing initiation or 1, 2, or 3 hours following the initiation of grazing. All cattle were comingled and weighed on October 7 following a 16-hour removal from feed and water.

Results and Discussion

Steer weights were greater ($P<.05$) at 195 minutes after grazing initiated than at 15 or 75 minutes after grazing initiated (Table 1). Change in weight from the average of the beginning and ending shrunk weights increased linearly ($P<.05$) as time after grazing initiation increased. However, the magnitude of increase was only 5.6 lb/hour of grazing. From a management prospective, cattle brought in 3 hours after grazing initiated would be heavier than those brought in at daybreak. This could translate into more total pounds sold, if cattle were loaded and sold at a

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nearby location. Using the data from this study, if one considers the scenario of selling the cattle directly off of pasture at daybreak with a pencil shrink of 3%, the same cattle gathered 3 h later would either weigh 16 lbs more, or would have to be pencil shrunk 4.8% rather than 3% to attain the same sale weight. This differential could amount to over 900 lb on a typical pot-load of cattle of the size used in this experiment. Therefore, time of weighing can have a significant impact on the dollar return for grazing cattle.

Table 1. Effect of Time of Weighing on Weight and Gain by Stocker Steers Grazing Smooth Bromegrass Pastures

	Time after Grazing Initiation, min			
Item	15	75	135	195
Avg. shrunk weight		823		
Steer weight, lb.	862[a]	864[a]	872[ab]	878[b]
Gain from shrunk weight[c]	39	41	49	55

[a,b]Means within a row differ (P < .05).
[c]Linear effect of time of weighing (P < .05).

EFFECTS OF *ASPERGILLUS ORYZAE* FERMENTATION EXTRACT ON INTAKE, DIGESTION, AND DIGESTIVE CHARACTERISTICS OF HEIFERS OFFERED *ACREMONIUM COENOPHIALUM*-INFECTED AND NON-INFECTED FESCUE HAY[1]

Kenneth P. Coffey, Frank K. Brazle[2], and Joseph L. Moyer

Summary

Four Tarentaise heifers (1109 lb avg BW) each fitted with a rumen cannula were used in a metabolism study to determine the effects of supplementation with *Aspergillus oryzae* fermentation extract (Amaferm; A) on digestion of *Acremonium coenophialum*-free (FF) or *Acremonium*-infected (IF) hay (70% of the plants infected) diets fed ad libitum. Heifers were housed in individual stanchions in a metabolism facility, where ambient temperatures were controlled to range between 80 and 90E F daily to mimic summer conditions. Total feces and urine were collected for 5 d following a 21-d dietary adaptation period. Nylon bags were incubated in the rumen for 6, 12, 18, 24, 48, 72, and 96 h. Dry matter intakes (% BW) were 24% greater ($P < .01$) from heifers offered FF than from heifers offered IF. Heifers offered A consumed 4% more ($P = .09$) DM than those offered C. Ruminal neutral detergent fiber (NDF) disappearance of IF was greater ($P<.05$) than that of FF at 48, 72, and 96 h of incubation. The digestible NDF fraction of IF forage was greater ($P < .05$) and the indigestible NDF fraction tended ($P<.10$) to be lower than that of FF. Ruminal disappearance of NDF was not affected by supplementation with A. Ruminal pH, lactate, and volatile fatty acids (VFA) did not differ ($P>.10$) between forages or supplements. Nitrogen balance was not affected by forage or supplement. Therefore, *A. coenophialum* exerts its major effect on forage intake, but may also reduce total-tract fiber digestibility in certain situations. Under the conditions employed in this experiment, *Aspergillus oryzae* fermentation extract increased forage intake but had no effect on forage digestibility.

Introduction

Tall fescue infected with the endophytic fungus *Acremonium coenophialum* causes many adverse effects in cattle consuming it. These effects include reduced intake and gain and increased temperature. Many products have been tried in an attempt to offset these problems, but to date, most have been ineffective. *Aspergillus oryzae* fermentation extract has increased in vivo dry matter and acid-detergent fiber digestibility, rumen cellulolytic bacteria, in vitro total VFA production, and in vitro digestion of *A. coenophialum*-infected fescue and tended to reduce rectal temperature in heat-stressed dairy cows. Its effects on in vivo digestibility of low-quality fescue diets have not been documented.

Experimental Procedures

Four ruminally cannulated Tarentaise heifers were used in a digestion study to compare *Acremonium coenophialum*-infected (IF) or *Acremonium*-free (FF) fescue hay diets in combination with a soybean hull-based control supplement (C; Table 1) or the basal supplement with 3 g/d of *Aspergillus oryzae* fermentation

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[1]This experiment was supported by a grant from Biozyme, Inc., St. Joseph, MO.

[2]Southeast Kansas Area Extension Livestock Specialist, Chanute, KS.

extract (Amaferm; A). Hays were ground to pass through a 4 in. screen using a tub grinder and offered ad libitum. Experimental periods included of a 7-d preliminary adaptation period, in which the heifers were offered a large-round bale of the respective forage in drylot and offered the respective supplements in individual pens at 0700 daily. Then heifers were placed in individual stalls in a metabolism facility for a 21-d adaptation period followed by 5 d of total fecal and urine collection. During this time, each heifer was offered 2 lb of her respective supplement at 0700 and had ad libitum access to her respective hay. Water was provided ad libitum via individual bowl-type automatic waterers, and water consumption was measured throughout the intake and collection periods.

At 0700 on day 1 of total collection, nylon bags containing the forages offered to the respective heifers were placed in polyester mesh sacks and suspended in the rumens of the heifers. The bags were removed after 6, 12, 18, 24, 48, 72, and 96 h of incubation. Dry matter and NDF content of the residue were determined. On the last day of total collection, rumen samples were collected at and 2, 4, 6, 8, 10, and 12 hours after the morning feeding, and ruminal pH, ammonia, VFA and lactate were measured.

At the end of the collection period, heifers were removed from the metabolism facility, weighed, and commingled in a drylot, and offered FF or prairie hay. After 5 d, the heifers were again separated into drylots by forage type for the 7-d preliminary adaptation period.

Results and Discussion

No statistical forage × treatment interactions were detected ($P<.05$). Consumption of FF (% of BW) was greater ($P<.01$) than that of IF, and dry matter (DM) intake tended ($P=.09$) to be greater by heifers offered A than by those offered C (Table 2). Dry matter, NDF, acid-detergent fiber, and nitrogen digestibility and retention did not differ between IF and FF or between A and C. Ruminal DM disappearance of IF was greater ($P<.05$) than that of FF at 48, 72, and 96 h of incubation and tended ($P<.10$) to be greater at 12 and 24 h of incubation (Table 3). The digestible DM fraction of IF forage was greater ($P<.01$) and the indigestible and soluble DM fractions were lower ($P<.01$) than those of FF. Ruminal NDF disappearance of IF was greater ($P<.05$) than that of FF at 48, 72, and 96 h of incubation. The digestible NDF fraction of IF forage was greater ($P<.05$) and the indigestible and soluble NDF fractions were lower ($P<.05$) than those of FF. Ruminal disappearance of DM and NDF at specific times and the digestible and soluble DM and NDF fractions did not differ between supplements. Ruminal rates of DM and NDF disappearance did not differ ($P>.10$) between forages or supplements. Ruminal pH, VFA, and lactate were not affected ($P<.10$) by forage or supplement (Table 4).

Therefore, *A. coenophialum* exerts its major effect on forage intake. In a similar experiment, *A. coenophialum* infection reduced total-tract fiber digestion. Under the conditions employed in this experiment, *Aspergillus oryzae* fermentation extract tended to enhance forage intake but had no effect on fiber digestion or ruminal measurements.

Table 1. Composition of Supplement and *A. coenophialum*-infected (IF) and *A. coenophialum*-Free (FF) Hays Offered to Heifers

Ingredient	Percent
Soybean hulls	93.45
Soybean oil	1.00
Trace mineral premix[a]	3.75
Dicalcium phosphate	.65
Vitamin A,D,E premix[b]	1.15

	Supplement	FF	IF
Crude protein, %	12.3	6.6[d]	8.1[c]
Neutral-detergent fiber, %	59.5	72.5	72.7
Acid-detergent fiber, %	37.7	39.9	40.1
Acid-detergent lignin, %	1.75	4.2	4.1

[a]Contains 4% Zn, 2% Mn, 2% Fe, .16% Cu, .04% I, .04% Co in 85% min. NaCl.
[b]Contains 1,000,000 IU/lb Vit. A, 500,000 IU/lb Vit. D, and 1,000 IU/lb Vit. E.
[c,d]Means for hay nutrient composition with uncommon superscripts differ (P < .01).

Table 2. Intake and Digestibility of *A. coenophialum*-Infected (IF) and *A. coenophialum*-Free (FF) Fescue Hay Diets Supplemented with *Aspergillus oryzae* Fermentation Extract

	Forage[a]		Treatment[b]	
Item	FF	IF	C	A
DM intake, lb/d	14.8[c]	12.0[d]	13.1	13.7
DM intake, % BW	1.34[c]	1.08[d]	1.19[e]	1.24[f]
DM digestion, %	54.4	52.9	54.3	53.0
NDF digestion, %	53.7	52.7	53.4	53.0
ADF digestion, %	55.5	53.5	54.4	54.5
N digestion, %	50.1	52.5	51.5	51.0
N retained, g/d	9.9	2.4	4.1	8.2
N retained, % of N intake	11.7	1.4	3.2	9.9
N retained, % of digest. N	20.4	.6	3.1	17.8
Water consumption, l/d	32.2	30.2	30.9	31.5

[a]FF = *Acremonium*-free; IF = 70 % of the plants infected with *A. coenophialum*.
[b]C = Control supplement; A = supplement containing 3g/d *Aspergillus oryzae* fermentation extract.
[c,d]Means within a row and main effect differ (P < .01).
[e,f]Means within a row and main effect differ (P < .10).

Table 3. Ruminal Disappearance of *A. coenophialum*-Infected (IF) and *A. coenophialum*-Free (FF) Fescue Hay Diets Supplemented with *Aspergillus oryzae* Fermentation Extract

Item	Forage[a]		Treatment[b]	
	FF	IF	C	A
Incubation time	DM disappearance, %			
6	6.9	7.4	7.0	7.3
12	19.0[d]	21.3[c]	20.5	19.8
18	26.0[d]	28.7[c]	27.3	27.4
24	32.4[d]	34.8[c]	33.7	33.6
48	45.7[f]	50.2[e]	47.6	48.3
72	52.1[f]	56.3[e]	54.0	54.5
96	55.9[f]	60.2[e]	58.0	58.1
	NDF disappearance, %			
6	6.9	7.1	7.0	6.9
12	18.0	19.8	19.5	18.3
18	25.6	28.0	27.1	26.5
24	33.2	35.3	34.6	33.8
48	47.2[h]	51.2[g]	49.0	49.4
72	53.6[f]	57.7[e]	55.4	55.9
96	58.0[f]	61.4[e]	59.5	59.9
DM				
f_d, %[i]	41.3[f]	45.4[e]	44.4	43.3
f_i, %[j]	31.4[e]	29.3[f]	30.6	30.1
f_s, %[k]	27.3[e]	25.3[f]	26.0	26.6
k_d, h^{-1} [l]	.038	.040	.039	.040
k_l, h^{-1} [m]	.77	.37	.78	.37
T_{max}, h [n]	5.2	6.1	5.0[h]	6.3[g]
NDF				
f_d, %	52.2[f]	57.1[e]	54.5	54.7
f_i, %	36.3[g]	34.2[h]	35.8[c]	34.7[d]
f_s, %	11.5[e]	8.8[f]	9.7	10.6
k_d, h^{-1}	.038	.040	.040	.038
k_l, h^{-1}	.54	.63	.55	.61
T_{max}, h	6.4	6.5	6.1	6.9

[a]FF = *Acremonium*-free; IF = 70 % of the plants infected with *A. coenophialum*.
[b]C = Control supplement; A = supplement containing 3g/d *Aspergillus oryzae* fermentation extract.
[c,d]Means within a row and main effect differ (P < .10).
[e,f]Means within a row and main effect differ (P < .01).
[g,h]Means within a row and main effect differ (P < .05).
[i]Potentially digestible fraction.
[j]Indigestible fraction.
[k]Soluble fraction.
[l]Fractional digestion rate constant.
[m]Fractional lag rate constant.
[n]Time of maximum rate of disappearance of substrate.

Table 4. Ruminal pH, Ammonia, Lactate, and Volatile Fatty Acids of Heifers Offered Diets of Endophyte-Infected (IF) or Endophyte-Free (FF) Fescue Hay Supplemented with *Aspergillus oryzae* Fermentation Extract

	Forage[a]		Treatment[b]	
Item	FF	IF	C	A
Mean pH	6.69	6.63	6.64	6.68
Ammonia, ppm[c]	461.9	484.1	441.7	504.3
Lactate, ppm	196.1	189.3	197.5	187.9
	---------------- mmole/l ----------------			
Acetic	49.0	47.1	49.5	46.6
Propionic	18.3	16.0	17.6	16.8
Isobutyric	2.9	2.6	2.7	2.9
Butyric	6.0	5.5	5.9	5.6
Isovaleric	2.1	2.0	2.0	2.2
Valeric	.6	.5	.5	.5
Total VFA[d]	78.9	73.8	78.2	74.5
	---------------- mole/100 mole ----------------			
Acetic	64.9	64.8	64.7	64.9
Propionic	20.9	20.9	21.2	20.7
Isobutyric	3.1	3.3	3.1	3.2
Butyric	7.9	7.7	7.8	7.9
Isovaleric	2.5	2.6	2.5	2.6
Valeric	.7	.7	.7	.7

[a]FF = *Acremonium*-free; IF = 70% of the plants infected with *A. coenophialum*.
[b]C = Control supplement; A = supplement containing 3g/d *Aspergillus oryzae* fermentation extract.
[c]Treatment × time interaction (P < .01).
[d]Forage × treatment interaction (P = .08).

EFFECTS OF LAIDLOMYCIN PROPIONATE ON INTAKE, DIGESTION, AND DIGESTIVE CHARACTERISTICS OF HEIFERS OFFERED *ACREMONIUM COENOPHIALUM*-INFECTED AND NONINFECTED FESCUE HAY[1]

Kenneth P. Coffey, Joseph L. Moyer, and Frank K. Brazle[2]

Summary

Four Tarentaise heifers (1020 lb avg BW) each fitted with a rumen cannula were used in a metabolism study to determine the effects of supplementation with laidlomycin propionate (LP) on digestion of *Acremonium coenophialum*-free (FF) or *Acremonium*-infected (IF) hay (70% of the plants infected) diets fed ad libitum. Heifers were housed in individual stanchions in a metabolism facility where ambient temperatures were controlled to range between 80 and 90E F daily to mimic summer conditions. Total feces and urine were collected for 5 d following a 21-d dietary adaptation period. Nylon bags were incubated in the rumen for 6, 12, 18, 24, 48, 72, and 96 h. Dry matter (DM) intakes (% BW) were 18.9% greater (P<.01) from heifers offered FF than from those offered IF. Heifers offered LP consumed 10.6% less (P<.05) DM than those offered C. Digestibility of neutral-detergent fiber (NDF) from FF tended to be greater (P<.10) and digestibility of acid-detergent fiber (ADF) was greater (P<.01) from FF than from IF. Conversely, nitrogen digestibility of IF was greater (P<.05) than that of FF. Acid detergent fiber digestibility of diets supplemented with LP was lower (P<.05) than that of diets supplemented with C. Ruminal NDF disappearance of IF was greater (P<.05) than that of FF at 72 and 96 h of incubation and tended (P<.10) to be greater at 48 h of incubation. The digestible NDF fraction of IF forage was greater (P<.01) and the indigestible NDF fraction was lower (P<.01) than those of FF. The soluble NDF fraction of FF was greater (P<.05) than that of IF. The indigestible NDF fractions of diets supplemented with LP were higher than those of diets supplemented with C, but the digestible and soluble NDF fractions did not differ between supplements. Heifers offered FF had greater (P<.05) concentrations of propionic acid and total volatile fatty acids (VFA) than those offered IF, and heifers offered LP had greater (P<.05) concentrations of propionic acid and total volatile fatty acids (VFA) than those offered C. Therefore, *A. coenophialum* exerts its major effect on forage intake, but may also reduce fiber digestibility in certain situations. Under the conditions employed in this experiment, laidlomycin propionate depressed forage intake and ADF digestion and increased the ruminal indigestible NDF fraction, but increased propionic acid and total VFA concentrations.

Introduction

Tall fescue infected with the endophytic fungus *Acremonium coenophialum* causes many adverse effects in cattle consuming it. These effects include reduced intake and gain, and increased temperature. Many products have been tried in an attempt to offset these problems, but to date, most have been ineffective. Ionophores have been used to improve performance of cattle in both feedlot and grazing situations. Laidlomycin propionate, a new ionophore, has proven efficacy

[1]This study was supported by a grant from Syntex Animal Health, Palo Alto, CA.

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for improving gain and feed conversion by feedlot cattle. Other studies have shown improvements in gain by grazing cattle supplemented with laidlomycin. Its effects on digestibility of low-quality fescue diets have not been documented.

Experimental Procedure

Four ruminally cannulated Tarentaise heifers were used in a digestion study to compare *Acremonium coenophialum*-infected (IF) or *Acremonium*-free (FF) fescue hay diets in combination with a grain sorghum-based control supplement (C; Table 1) or the basal supplement with 50 mg/d of laidlomycin propionate (LP). Hays were ground to pass through a 4 in. screen using a tub grinder and offered ad libitum. Experimental periods included a 7-d preliminary adaptation period in which the heifers were offered a large-round bale of the respective forage in drylot and offered the respective supplements in individual pens at 0700 daily. Heifers were then placed in individual stalls in a metabolism facility for a 21-d adaptation period followed by 5 d of total fecal and urine collection. During this time, each heifer was offered 2 lb of her respective supplement at 0700 and had ad libitum access to her respective hay. Water was provided ad libitum via individual bowl-type automatic waterers, and water consumption was measured throughout the intake and collection periods.

At 0700 on day 1 of total collection, nylon bags containing the forages offered to the respective heifers were placed in polyester mesh sacks and suspended in the rumens of the heifers. The bags were removed after 6, 12, 18, 24, 48, 72, and 96 h of incubation. Dry matter and NDF content of the residue were determined. On the last day of total collection rumen samples were collected at and 2, 4, 6, 8,10, and 12 hours after the morning feeding, and ruminal ammonia and VFA were measured.

At the end of the collection period, heifers were removed from the metabolism facility, weighed, and commingled in a drylot, and offered FF or prairie hay. After 5 d, the heifers were again separated into drylots by forage type for the 7-d preliminary adaptation period.

Results and Discussion

No statistical forage × treatment interactions were detected ($P<.05$). Dry matter intake was 2.4 lb/d greater ($P<.01$) from FF than IF, but DM digestibility did not differ between forages (Table 2). Digestibilities of NDF and ADF of FF were greater ($P<.10$ and .01, respectively) than those of IF. Conversely, nitrogen digestibility of IF was greater ($P<.05$) than that of FF. Acid detergent fiber digestibility was lower ($P<.05$) for diets supplemented with LP than those supplemented with C. Nitrogen balance was not affected by forage or supplement.

Ruminal NDF disappearance of IF was greater ($P<.01$) than that of FF at 72 and 96 h of incubation and tended ($P<.10$) to be greater at 48 h of incubation (Table 3). The digestible NDF fraction of IF forage was greater ($P < .01$) and the indigestible NDF fraction was lower ($P < .01$) than those of FF. The soluble NDF fraction of FF tended ($P < .10$) to be greater than that of IF. The indigestible NDF fractions of diets supplemented with LP were higher than those of diets supplemented with C, but the digestible and soluble NDF fractions did not differ between supplements. Rates of ruminal DM and NDF disappearance did not differ ($P>.10$) between forages or supplements.

Heifers offered FF had higher ($P<.05$) concentrations of propionic and isobutyric acids and total VFA than heifers offered IF (Table 4). Heifers offered LP had higher ($P<.05$) concentrations of propionic acid and total VFA and a lower molar proportion of butyric acid than heifers offered C. Rumen ammonia and lactate did not differ between forages or treatments.

Therefore, *A. coenophialum* exerts its major effect on forage intake, but may also reduce fiber digestibility in certain situations. Under the conditions employed in this experiment, laidlomycin propionate depressed forage intake and ADF digestion and increased the indigestible NDF fraction of the low quality forage diets, but enhanced rumen VFA production and altered VFA concentrations toward a more favorable VFA profile.

Table 1. Composition of Supplement and *A. coenophialum*-Infected (IF) and *A. coenophialum*-Free (FF) Hays Offered to Heifers

Ingredient	Percent
Grain sorghum	93.45
Soybean oil	1.00
Trace mineral premix[a]	3.75
Dicalcium phosphate	.65
Vitamin A,D,E premix[b]	1.15

	Supplement	FF	IF
Crude protein, %	10.8	6.6[d]	8.1[c]
Neutral-detergent fiber, %	26.6	72.5	72.7
Acid-detergent fiber, %	6.3	39.9	40.1
Acid-detergent lignin, %	1.4	4.2	4.1

[a]Contains 4% Zn, 2% Mn, 2% Fe, .16% Cu, .04% I, .04% Co in 85% min. NaCl.
[b]Contains 1,000,000 IU/lb Vit. A, 500,000 IU/lb Vit. D, and 1,000 IU/lb Vit. E.
[c,d]Means for hay nutrient composition with uncommon superscripts differ ($P < .01$).

Table 2. Intake and Digestibility of *A. coenophialum*-Infected (IF) and *A. coenophialum*-Free (FF) Fescue Hay Diets Supplemented with Laidlomycin Propionate

Item	Forage[a] FF	Forage[a] IF	Treatment[b] C	Treatment[b] LP
DM intake, lb/d	14.6[c]	12.2[d]	14.3[e]	12.5[f]
DM intake, % BW	1.5[c]	1.2[d]	1.4[e]	1.3[f]
DM digestion, %	53.5	52.0	53.2	52.3
NDF digestion, %	48.7[g]	46.3[h]	48.4	46.6
ADF digestion, %	49.5[e]	46.4[f]	48.8[e]	47.1[f]
N digestion, %	42.1[f]	48.2[e]	45.8	44.5
N retained, g/d	5.2	6.1	7.7	4.1
N retained, % of N intake	6.4	8.0	8.4	6.0
N retained, % of digest. N	12.2	16.1	16.8	11.6
Water consumption, l/d	31.4[e]	29.7[f]	32.0[c]	29.1[d]

[a]FF = Endophyte-free; IF = 70% of the plants infected with *A. coenophialum*.
[b]C = Control supplement; LP = supplement containing 50 mg/d of laidlomycin propionate.
[c,d]Means within a row and main effect differ ($P < .01$).
[e,f]Means within a row and main effect differ ($P < .05$).
[g,h]Means within a row and main effect differ ($P < .10$).

Table 3. Ruminal Disappearance of *A. coenophialum*-Infected (IF) and *A. coenophialum*-Free (FF) Fescue Hay Diets Supplemented with Laidlomycin Propionate

	Forage[a]		Treatment[b]	
	FF	IF	C	LP
Incubation time	DM disappearance, %			
6	5.7	6.7	6.8	5.6
12	17.1[d]	19.7[c]	19.3	17.6
18	24.9[d]	27.4[c]	26.5	25.9
24	31.2[d]	33.2[c]	32.4	32.0
48	44.6[f]	47.2[e]	46.4	45.4
72	50.6[h]	54.7[g]	53.3	52.0
96	54.3[h]	58.9[g]	57.5[e]	55.7[f]
	NDF disappearance, %			
6	5.1	7.7	6.1	6.7
12	16.2	18.9	18.0	17.2
18	25.0	26.9	26.0	25.8
24	31.4	33.8	32.6	32.6
48	45.7[d]	48.2[c]	47.3	46.7
72	52.1[h]	55.9[g]	54.4	53.6
96	55.9[h]	60.3[g]	59.0[e]	57.2[f]
DM				
f_d, %[i]	39.9[h]	44.8[g]	43.2[e]	41.5[f]
f_i, %[j]	32.9[g]	30.1[h]	30.8[h]	32.2[g]
f_s, %[k]	27.2[g]	25.2[h]	26.1	26.3
k_d, h^{-1} [l]	.042[c]	.037[d]	.038	.042
k_l, h^{-1} [m]	.35	.97	.97	.34
T_{max}, h [n]	7.3[c]	4.8[d]	5.0[d]	7.1[c]
NDF				
f_d, %	50.0[h]	56.9[g]	54.3	52.3
f_i, %	38.0[g]	35.3[h]	35.7[h]	37.7[g]
f_s, %	12.2[e]	7.7[f]	10.1	9.6
k_d, h^{-1}	.041	.036	.037	.040
k_l, h^{-1}	.35	.54	.54	.35
T_{max}, h	7.7	6.1	6.0[d]	7.9[c]

[a]FF =*A. coenophialum*-free; IF = 70% of the plants infected with *A. coenophialum*.
[b]C = Control supplement; LP = supplement containing 50 mg/d of laidlomycin propionate.
[c,d]Means within a row and main effect differ (P < .10).
[e,f]Means within a row and main effect differ (P < .05).
[g,h]Means within a row and main effect differ (P < .01).
[i]Potentially digestible fraction.
[j]Indigestible fraction.
[k]Soluble fraction.
[l]Fractional digestion rate constant.
[m]Fractional lag rate constant.
[n]Time of maximum disappearance of substrate.

Table 4. Ruminal Ammonia, Lactate, and Volatile Fatty Acids of Heifers Offered Diets of *A. coenophialum*-Infected (IF) and *A. coenophialum*-Free (FF) Fescue Hay Supplemented with Laidlomycin Propionate

Item	Forage[a] FF	Forage[a] IF	Treatment[b] C	Treatment[b] LP
Ammonia, ppm	441.1	509.9	493.7	457.3
Lactate, ppm	194.2	196.9	204.9	186.2
	----------------	mmole/l	----------------	
Acetic	46.6	42.1	41.8[d]	45.8[c]
Propionic	13.6[e]	11.4[f]	11.3[f]	13.8[e]
Isobutyric	.5[f]	.6[e]	.5	.5
Butyric	7.3	6.7	7.3	6.6
Isovaleric	.6	.6	.6	.6
Valeric	.4	.4	.4	.4
Total VFA	67.8[e]	61.7[f]	61.9[f]	67.7[e]
	----------------	mole/100 mole	----------------	
Acetic	66.1	67.4	66.0	67.4
Propionic	20.4[e]	18.5[f]	18.5[f]	20.4[e]
Isobutyric	.8[d]	.9[c]	.9[c]	.8[d]
Butyric	11.4	11.6	12.9[e]	10.0[f]
Isovaleric	.9	1.1	1.1	.3
Valeric	.5	.6	.6	.5

[a]FF = *A. coenophialum*-free; IF = 70% of the plants infected with *A. coenophialum*.
[b]C = Control supplement; LP = supplement containing 50 mg/d of laidlomycin propionate.
[c,d]Means within a row and main effect differ (P<.10).
[e,f]Means within a row and main effect differ (P<.05).

ALFALFA VARIETY PERFORMANCE IN SOUTHEASTERN KANSAS

Joseph L. Moyer

Summary

Alfalfa yields for 1992 included five cuttings. For the year, 'DK 135' yielded less than 9 other cultivars. Over the 3-year period, 'Garst 636' has tended to produce more than 'Riley'.

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.

Experimental Procedure

The 15-line test was seeded (12 lb/acre) in April, 1990 at the Mound Valley Unit. Plots were fertilized with 20-50-200 lb/acre of N-P_2O_5-K_2O on 2 March, 1992. Five harvests were obtained during this wetter-than-normal year (see weather summary), despite losing much of cut 4 from an infestation of blister beetles. Plots were clipped on 22 July to restore uniformity.

Results and Discussion

Forage yields of each of the five cuttings, total 1992 production, and 3-year totals are shown in Table 1. The moist late May and early June conditions produced atypically higher yields in cut 2 than in cut 1. Moist July conditions could have produced more August forage than normal, except for the severe blister beetle infestation that defoliated about 1/3 of the plots, requiring that all plots be clipped.

Cut 1 yield was higher from '5432' than from nine other cultivars. Only 'Trident II' and 630 ranked well in both cuts 3 and 4. After 3 years of testing, only 7 percentage points separate yields of the highest and lowest ranking cultivars.

Table 1. Forage Yields of the Alfalfa Variety Test in 1992, Mound Valley Unit, Southeast Kansas Branch Experiment Station

Source	Variety	Forage Yield 1992 4/24	6/12	7/6	8/31	10/27	Total	3-Yr Total
		- - - - - - - - - - tons/acre @ 12% moisture - - - - - - - - - -						
ICI (Garst)	636	1.60ab[1]	2.40ab	1.40abcd	1.00abc	0.86a	7.26a	16.76a
Dairyland	Magnum III	1.48bc	2.41ab	1.43abc	1.00abc	0.82a	7.15a	16.51a
Cargill	Trident II	1.52bc	2.33ab	1.42abc	1.09ab	0.76a	7.11a	16.48a
Pioneer	5364	1.62ab	2.42ab	1.39abcd	1.00abc	0.82a	7.25a	16.39a
Agripro	Ultra	1.42c	2.52a	1.20d	0.97abc	0.78a	6.90ab	16.37a
Garst	630	1.51bc	2.28ab	1.32a	1.01abc	0.78a	7.12a	16.30a
America's Alfalfa	Apollo Supr.	1.43c	2.42ab	1.34abcd	1.13ab	0.81a	7.14a	16.24a
Pioneer	5472	1.59ab	2.29ab	1.46ab	0.88bc	0.81a	7.04a	16.20a
Agripro	Dart	1.56abc	2.38ab	1.38abcd	1.04ab	0.84a	7.18a	16.16a
W-L Research	WL 317	1.49bc	2.24b	1.39abcd	1.07ab	0.83a	7.03a	16.07a
W-L Research	WL 320	1.53bc	2.24b	1.29bcd	1.02abc	0.84a	6.92ab	15.88a
Pioneer	5432	1.68a	2.32ab	1.37abcd	0.82c	0.69a	6.88ab	15.81a
Great Plains Res.	Cimarron VR	1.51bc	2.32ab	1.30bcd	1.02abc	0.72a	6.88ab	15.79a
DeKalb	DK 135	1.42c	2.34ab	1.31bcd	0.81c	0.68a	6.56b	15.72a
KS AES & USDA	Riley	1.61ab	2.32ab	1.25cd	0.92abc	0.72a	6.83ab	15.62a
	Average	1.53	2.35	1.37	0.99	0.78	7.02	16.15
	LSD(.05)	0.13	NS	0.17	0.18	NS	0.39	NS

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

FORAGE YIELDS OF TALL FESCUE VARIETIES IN SOUTHEASTERN KANSAS

Joseph L. Moyer

Summary

In the sixth harvest year of the test, 'Phyter' yielded more first-cut forage than 'Stef', 'Cajun', 'Johnstone', 'AU Triumph', and 'Kenhy'. For the year, Phyter produced more forage than 'Forager', Cajun, AU Triumph, and Kenhy under hay management. Under a 9-clipping system, Phyter produced more than Stef, Kenhy, Cajun, 'Martin', and Forager. Over the 6 years of the test, Phyter averaged more forage production than Stef, Johnstone, and AU Triumph.

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 apparent for as long as the stand exists.

Experimental Procedure

Plots were seeded on 4 September, 1986 at 20 lb/acre at the Mound Valley Unit, ostensibly with seed free of *Acremonium coenophialum* endophyte. Plots were 30 x 7.5 ft each, in four randomized complete blocks. Application of 160-50-57 lb/acre of N-P_2O_5-K_2O was made on 2 March, 1992, followed by fertilization with 60 N on 20 August, 1992. Plots 15'x 3' were cut on 26 May, 11 August, and 22 December, 1992. A subsample from each plot was collected for determinations of moisture, fiber, crude protein, and *in vitro* digestibility. A 10'x 7.5' subplot of each plot was measured with a disk meter for yield estimation before those harvests, plus an additional six clippings.

Results and Discussion

'Phyter' yielded significantly more in cut 1 than 'Stef', 'Cajun', 'Johnstone', 'AU Triumph', and 'Kenhy' (Table 1). Cool and wet July conditions enabled an above-average second cutting in August, averaging 63% of the yield of cut 1, but yields did not actually differ because Stef plots were infested with grassy weeds. For the year, Phyter produced more forage than 'Forager', Cajun, AU Triumph, and Kenhy under hay management. Six-year average production was significantly higher from Phyter than from Stef, Johnstone, and AU Triumph.

Intensive clipping in 1992 caused few changes in the long-term relative productivity of the cultivars. Phyter produced more under intensive clipping than Stef, Kenhy, Cajun, Martin, and Forager (data not shown).

AU Triumph, Forager, and 'Fawn', headed significantly earlier than seven other cultivars in 1992 (Table 2). Mo-96, Ky 31, Kenhy, Johnstone, and Phyter headed significantly later than six other cultivars.

Forage digestibilities for cut 1 in 1991 and 1992 are also listed in Table 2. There was no significant (P>.10) interaction between year and cultivar, meaning that relative digestibilities of cultivars were similar for the 2 years. Average digestibilities for Kenhy, Johnstone, Stef, Mo-

96, and Phyter were significantly higher than those for six other cultivars. Cultivars with later heading dates tended to have higher first-cut digestibilities than early-maturing lines.

Table 1. Forage Yield of Tall Fescue Varieties for 1992, Mound Valley Unit, Southeast Kansas Branch Experiment Station

Variety	Cut 1 (5/26)	Cut 2 (8/11)	Cut 3 (12/22)	Total	6-Year Average
	- - - - - - - - - - - - - -	tons/acre @ 12% moist.	- - - - - - - - - - - - - -		
Phyter	4.06a[1]	2.36ab	1.74a	8.16a	7.12a
Festorina	3.98ab	2.48ab	1.61ab	8.06ab	6.94ab
Mozark	3.89abc	2.20ab	1.76a	4.08ab	6.81abc
Mo-96	4.01ab	1.98ab	1.51ab	7.50abcd	6.81abc
Martin	3.92ab	2.16ab	1.52ab	7.60abcd	6.80abc
Ky-31	3.73abc	2.42ab	1.64ab	4.03ab	6.76abc
Kenhy	3.28bc	2.28ab	1.47ab	7.04bcd	6.75abc
Forager	3.68abc	1.78b	1.34b	6.80cd	6.64abc
Fawn	3.82abc	2.06ab	1.54ab	7.42abcd	6.56abc
Cajun	3.17c	2.22ab	1.54ab	6.93cd	6.51abc
AU Triumph	3.32bc	2.11ab	1.54ab	6.97cd	6.37bc
Johnstone	3.29bc	2.02b	1.39b	4.28ab	6.19c
Stef	1.85d	2.75a	1.06c	4.09ab	5.60d
Average	3.54	2.22	1.52	7.27	6.60
LSD(.05)	0.63	NS	0.27	0.93	0.58

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

Table 2. Heading Date in 1992 and IVDMD of Cut 1 for Tall Fescue Varieties in 1991 and 1992 at the Mound Valley Unit

Variety	1992 Heading Date[1]	Cut 1 Digestibility (IVDMD) 1991	1992	Average
	- - - - - - - - - - - - % - - - - - - - - - - - -			
Kenhy	125.2ab[2]	54.3a	52.6ab	53.4a
Johnstone	126.2ab	53.5ab	53.2a	53.4a
Stef	120.8bcd	52.3abc	52.7ab	52.5ab
Mo-96	130.5a	51.4bcd	52.8ab	52.1ab
Phyter	124.8ab	51.6bcd	51.9abc	51.8bc
Ky-31	128.5a	52.7abc	49.7cd	51.2bcd
Festorina	123.2abc	50.8cd	50.4bcd	50.6cde
Cajun	116.0cde	50.6cd	49.1d	49.9def
AU Triumph	108.0e	49.9d	49.7cd	49.8ef
Mozark	115.5de	50.6cd	48.9d	49.8ef
Fawn	112.2e	50.5cd	48.2d	49.4ef
Martin	116.0cde	50.5cd	48.0d	49.2ef
Forager	112.2e	49.6d	48.6d	49.1f
Average	120.2	051.4	50.5	50.9
LSD(.05)	6.8	2.1	2.3	1.3

[1]Julian day when heads first appeared. (Day 120=29 April).
[2]Means within a column followed by the same letter are not significantly (P#.05) different, according to Duncan's test.

EFFECT OF GROWTH-REGULATING HERBICIDES ON TALL FESCUE SEEDHEAD SUPPRESSION AND FORAGE YIELD AND QUALITY

Joseph L. Moyer and Kenneth W. Kelley

Summary

This study compared effects of potential herbicides on tall fescue to effects of mefluidide, a well-known growth regulator. Forage yield reduction and some forage quality improvement were seen from metsulfuron (Ally®) and imazethapyr (Pursuit®) similar to effects of mefluidide (Embark®). However, control of seedhead production was greatest from use of mefluidide.

Introduction

Spring forage quality of tall fescue (*Festuca arundinacea* Schreb.) can be improved by using plant growth regulators, including some that have herbicidal activity. Mefluidide and other growth-regulating chemicals increase quality primarily by suppressing development of the seedhead, the plant component with the poorest forage quality.

Metsulfuron is an herbicide that can be used at low rates alone or with 2,4-D to control certain weeds in tall fescue. The chemical has also reportedly caused decreases in seedhead numbers in tall fescue. This study was performed to compare some herbicides that are or could be used in tall fescue with mefluidide, a well-known plant growth regulator, for effects on seedhead density and forage production and quality.

Experimental Procedure

Established 'Fawn' and 'Ky 31' tall fescue in adjacent meadows were fertilized with 90 lb N, 48 lb P_2O_5, and 48 lb K_2O in early February of 1991 and 1992. Chemical treatments were applied on 4 April, 1991 and 31 March, 1992 in 20 gal water/acre with 0.125% (v/v) AG-98® surfactant (Rohm and Haas) to plots in an RCB design with three replications. Treatments included metsulfuron at 0.06, 0.09, and 0.12 oz (a.i.)/acre; 0.12 oz of metsulfuron with 2 oz of 2,4-D; imazethapyr (0.5 and 1 oz/acre); mefluidide (4 oz/acre); two levels of a dicamba-2,4-D mixture (1+2 and 4+16 oz/acre); and a control. Treatments were rated visually for injury (stunting, leaf yellowing, and desiccation) relative to the control on 22 April of each year. Seedhead counts and forage harvests were made on 17 and 15 May, 1991 and 1992, respectively. Forage subsamples were taken at harvest (except 1991 Fawn) for determination of moisture, CP, NDF, and IVDMD.

Results and Discussion

Visible foliar injury in 1991 was greatest from use of imazethapyr at 1 oz/acre, particularly for Fawn (data not shown). In 1992, however, the use of metsulfuron at 0.12 oz/acre resulted in the greatest visible injury. The greatest reduction in seedhead density resulted from use of mefluidide in both years and from imazethapyr at 1 oz/acre in 1992 (Table 1). The use of dicamba and 2,4-D resulted in little visible injury or reduction of seedhead density in 1991 and no effects in 1992.

Spring forage yield of Ky 31 was reduced most by use of mefluidide (Table 2). The use of 1 oz/acre of imazethapyr and the two higher rates (0.06 and 0.12 oz/acre) of metsulfuron also resulted in substantial forage yield reductions of Ky 31. Dicamba + 2,4-D application reduced yield only of Ky 31 in 1991. Use of the highest metsulfuron rate on Fawn in 1992 caused the greatest yield reduction of the test.

Forage CP concentration was highest in Ky 31 treated with mefluidide (Table 3). Use of imazethapyr (both rates) and the 0.12-oz rate of metsulfuron resulted in increased CP of both cultivars.

The use of mefluidide on Ky 31 resulted in the greatest reduction of NDF content of spring forage relative to the control (Table 4). Both rates of imazethapyr and the two higher rates of metsulfuron also resulted in less NDF in Ky 31 forage. Digestibility as measured by % IVDMD was affected by chemical treatments only in 1991 Ky 31 forage (data not shown). The use of mefluidide, imazethapyr at both rates, and the two higher rates of metsulfuron resulted in greater forage IVDMD than in the control.

Metsulfuron and imazethapyr at herbicidal rates were effective growth regulators of tall fescue. Visible foliar injury and forage yield reduction in Ky 31 resulting from use of metsulfuron at 0.09 and 0.12 oz/acre were similar to those caused by use of mefluidide, a labelled plant growth regulator, and imazethapyr at both rates. However, control of seedhead production was greater with mefluidide than the other chemical treatments, except for the 1-oz rate of imazethapyr.

Forage quality was generally slightly improved by mefluidide, imazethapyr, and metsulfuron. Forage crude protein concentration was increased by the use of mefluidide, imazethapyr, and the 0.12-oz rate of metsulfuron. Neutral-detergent fiber content of Ky 31 was reduced by the use of mefluidide, both rates of imazethapyr, and the two higher rates of metsulfuron. The same treatments that reduced NDF content resulted in increased IVDMD in 1991, but not in 1992 forage.

Table 1. Relative Seedhead Density of Tall Fescue Cultivars Treated with Growth-Regulating Chemicals

Chemical	Rate	Seedhead Density			
		1991		1992	
		Ky31	Fawn	Ky31	Fawn
	oz a.i./acre	- - - - - - - - - - - % of Control† - - - - - - - - - - -			
Mefluidide	4.0	7	16	6	7
Imazethapyr	0.5	57	34	35	22
	1.0	34	12	9	12
Metsulfuron	0.06	84	70	31	43
	0.09	61	26	23	23
	0.12	53	38	19	23
Metsulfuron+2,4-D	0.12 + 2	79	55	29	34
Dicamba+2,4-D	1 + 2	73	118	107	113
	4 + 16	78	76	107	110
Control	- - -	100	100	100	100
$LSD_{.05}$		24	43	21	24

†Controls averaged 45.3, 8.4, 21.9, and 22.2 seedheads/ft^2 for Ky 31 and Fawn in 1991 and 1992, respectively.

Table 2. Spring Forage Yield of Tall Fescue Cultivars Treated with Growth-Regulating Chemicals

Chemical	Rate	Forage Yield		
		1991	1992	
		Ky31	Ky31	Fawn
	oz a.i./acre	- - - - - - - % of Control†- - - - - - -		
Mefluidide	4.0	32	38	42
Imazethapyr	0.5	63	48	39
	1.0	44	44	33
Metsulfuron	0.06	69	64	49
	0.09	55	42	35
	0.12	52	40	28
Metsulfuron+2,4-D	0.12 + 2	66	45	27
Dicamba+2,4-D	1 + 2	65	109	103
	4 + 16	63	104	103
Control	- - -	100	100	100
$LSD_{.05}$		24	12	10

†Controls averaged 3.73 and 2.37 tons/acre (12% moisture) for Ky 31 in 1991 and 1992, respectively, and 2.71 tons/acre for Fawn in 1992.

Table 3. Spring Crude Protein Concentration of Tall Fescue Cultivars Treated with Growth-Regulating Chemicals

Chemical	Rate	Forage Crude Protein 1991 Ky31	1992 Ky31	1992 Fawn
	oz a.i./acre	- - - - - - - - - - - %	- - - - - - - - - - -	
Mefluidide	4.0	12.2	12.2	9.9
Imazethapyr	0.5	11.1	11.7	10.6
	1.0	10.3	11.4	11.0
Metsulfuron	0.06	10.2	10.1	10.0
	0.09	8.8	11.5	9.6
	0.12	10.6	11.3	10.5
Metsulfuron+2,4-D	0.12 + 2	10.5	11.2	10.4
Dicamba+2,4-D	1 + 2	8.7	8.2	7.6
	4 + 16	8.7	8.0	7.3
Control	- - -	8.8	7.9	7.4
$LSD_{.05}$		1.4	1.0	1.1

Table 4. Spring Forage Neutral-Detergent Fiber Content (NDF) of Tall Fescue Cultivars Treated with Growth-Regulating Chemicals

Chemical	Rate	NDF 1991 Ky31	1992 Ky31	1992 Fawn
	oz a.i./acre	- - - - - - - - - - %	- - - - - - - - - -	
Mefluidide	4.0	59.0	56.6	56.8
Imazethapyr	0.5	59.8	58.5	57.7
	1.0	60.9	58.8	58.8
Metsulfuron	0.06	67.9	60.1	59.6
	0.09	59.4	58.9	59.0
	0.12	61.1	58.8	57.9
Metsulfuron+2,4-D	0.12 + 2	64.1	58.9	57.4
Dicamba+2,4-D	1 + 2	65.8	61.3	61.8
	4 + 16	65.7	59.8	62.3
Control	- - -	65.9	62.3	58.6
$LSD_{.05}$		4.3	2.0	2.9

USE OF A LEGUME-GRAIN SORGHUM ROTATION IN A CROP-LIVESTOCK SYSTEM

Joseph L. Moyer, Daniel W. Sweeney, and Kenneth P. Coffey

Summary

Grain sorghum was grown for the second year after no clover (winter fallow) or after red clover that was hayed (2.78 tons/acre) or mulched. Production on continuous sorghum and hayed plots was increased by N application. Conversely, no real difference occurred between mulched clover plots, whether N was added or not.

Introduction

Grain sorghum is a productive feedgrain crop that is heat and drought tolerant but requires the input of N and does not maintain soil physical condition. Legume crop rotations are under development that can reduce the reliance of grain sorghum production on added N and help maintain the physical condition of the soil, but the topgrowth could also be used as a livestock supplement. Red clover is suitable as a green manure crop because of its yield potential and substantial N content.

The optimum use of the legume-grain sorghum rotation in a crop-livestock system requires that several trade-offs be assessed. The legume topgrowth can benefit the livestock component by supplementing low-quality roughage. The objectives of this research are to determine the effects of 1) fall-seeded red clover on grain sorghum yield and quality and on selected soil properties, 2) clover removal vs. incorporation of topgrowth on subsequent crop and soil properties, 3) 0 or 100 lb/acre of N, with or without haying on grain sorghum characteristics, and 4) the systems on nutrient content of grain sorghum stover.

Experimental Procedure

Red clover was seeded on designated plots in September, 1990. Hayed plots were cut on 29 May, 1991, and all plots were offset-disked on 12 June. Grain sorghum was grown on all plots in 1991, but yields were low because of droughty conditions. In 1992, plots were tandem-disced once on 27 March and field-cultivated four times from 14 April to 18 June. Nitrogen fertilizer (100 lb/acre as solid urea) was broadcast on appropriate plots on May 18. Pioneer Brand 8699 hybrid grain sorghum was planted (63,000 seeds/acre) on June 19, 1992, and sprayed with 2 qt Lasso/acre. All plots received 0-21-33 (N-P_2O_5-K_2O) applied with the planter.

Plant samples and soil data were collected at the 9-leaf stage (15 July), the boot stage (6 August), and the soft-dough stage (10 September). At harvest on 9 November, whole plants, grain, and stover samples were collected for dry matter production, multinutrient concentration, and forage quality determinations.

Results and Discussion

In 1991, hayed plots produced 2.78 tons/acre (12% moisture) of red clover forage that contained 2.7% N (16.9% crude protein), for a total of 132 lb N/acre.

Grain sorghum yield and test weight for 1992 are shown in Table 1. Plots that received N produced the highest yields, averaging 85.8 bu/acre. Continuous sorghum (no clover) with no added N resulted in the lowest yield of any treatment, 45.0 bu/acre. The addition of N to continuous sorghum and sorghum after hayed red clover resulted in significantly (P<.05) higher grain yield than the corresponding treatment without N. Conversely, the 8.7 bu/acre difference between mulched clover plots with and without N was not significantly (P>.05) different. Test weights were similar, except that continuous sorghum with no N tended (P<.10) to have lower test weight than sorghum from other treatments.

Table 1. Grain Yield and Test Weight of Grain Sorghum Grown in 1992 at 0 and 100 lb N/acre after Different Clover Treatments

Previous Clover Treatment	Nitrogen Application	Grain Yield	Grain Test Wt.
	lb/ac	bu/acre	lb/bu
None	0	45.0	56.3
	100	87.8	57.6
Mulched clover	0	75.1	57.7
	100	83.8	57.8
Hayed clover	0	64.0	57.2
	100	86.0	57.2
LSD(.05)		18.3	NS

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

Daniel W. Sweeney

Summary

In general, double-crop soybean yields were low from 1983 to 1992, with a poorly defined trend for disc-only residue management to result in higher yields. However, wheat (or oat) yields often were lower where the previous double-crop soybeans were planted no-till as compared to burn and disc or discing only. Increased N rates for wheat had minimal effect on wheat or soybean yields.

Introduction

Double-cropping of 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 double-crop 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 double-crop soybeans were grown with no tillage, could increase small grain yields.

Experimental Procedure

Three wheat residue management systems for double-crop 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, fertilized, and planted to wheat. 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 had been 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 1992, except in 1986 and 1987, when oats were planted in the spring because of wet conditions in the fall.

Results and Discussion

In general, yields of double-crop soybeans were low during the 10 crop-years of this study and were nearly always less than 20 bu/a (Table 1). The disc-only treatment tended to give higher yields in years where residue management resulted in significant differences. No tillage tended to result in lower 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 yields in the burn-then-disc and in the disc-only treatments. 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 double-crop soybeans affected the subsequent wheat or oat crops (Table 2). Small grain yields were up to 20 bu/a less where soybeans were double-cropped 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 resulted in an increase in small grain yield only in 1990. However, oat yields in 1987 and wheat yields in 1991 were affected by an interaction between residue management system and N rate. In 1987, increasing N rate lowered oat yields in areas where double-crop 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. In 1991, increasing N rate increased wheat yields only in the disc-only system.

Table 1. Soybean Yield as Influenced by Straw Residue Management and Residual N Rates

	Soybean Yield									
Treatment	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
	bu/a									
Residue mgmt.										
Burn then disc	7	-	15	10	13	1	11	8	5	17
Disc only	4	-	21	12	17	3	10	12	14	16
No-tillage	6	-	0	9	13	6	0	3	5	10
LSD (0.05)	NS	-	2	NS	3	2	6	4	5	2
N Rate (lb/a)										
83	-	-	12	10	13	3	5	7	9	13
129	-	-	13	12	15	4	10	9	8	15
LSD (0.05)	-	-	NS	NS	1	NS	2	NS	NS	NS
Interaction	-	-	NS	NS	*	NS	**	NS	NS	NS

Table 2. Wheat Yield in 1984, 1985, 1988, 1989, 1990, 1991, and 1992 and Oat Yield in 1986 and 1987 as Influenced by Previous Straw Grain Residue Management and N Rates

	Small Grain Yield								
Treatment	1984	1985	1986	1987	1988	1989	1990	1991	1992
	bu/a								
Previous residue mgmt.									
Burn, then disc	63	59	79	51	58	40	18	23	35
Disc only	59	55	85	49	53	45	12	17	38
No-tillage	43	48	64	42	50	33	7	15	26
LSD (0.05)	13	8	6	NS	5	NS	6	3	6
N Rate (lb/a)									
83	-	53	77	47	56	38	10	19	34
129	-	55	75	47	51	40	14	18	32
LSD (0.05)	-	NS	NS	NS	5	NS	3	NS	NS
Interaction	-	NS	NS	*	NS	NS	NS	**	NS

NITROGEN AND PHOSPHORUS RATE AND PLACEMENT EFFECTS ON NO-TILL GRAIN SORGHUM[1]

Daniel W. Sweeney, John L. Havlin[2], Ray E. Lamond[2], and Gary Pierzynski[2]

Summary

Responses to placement, N rate, and P rate were minimal in 1992. Even though background soil P level was low, the apparent high potential for N mineralization may account for the minimal response to fertilization at this site.

Introduction

Economic concerns of producers as well as increased public awareness of environmental issues have emphasized the need for efficient management of N and P fertilizers for crop production. Among management options, proper N and P placement often can greatly influence crop uptake efficiency of the fertilizer. Recent development of a 'point-injection' (spoke wheel) fertilizer applicator has provided an additional fluid fertilizer placement option in reduced-tillage systems. Thus, this study was initiated to determine how grain sorghum is affected by N and P rates and method of fluid fertilizer application.

Experimental Procedure

The experiment was established in spring 1990 on a low P, Parsons silt loam at the Parsons field of the Southeast Kansas Branch Experiment Station. The treatments were randomized as a 4x2x3 factorial in a complete block with three replications. Fertilizer placement methods were broadcast, dribble, knife, and spoke. Dribble, knife, and spoke spacing was 30" and knife and spoke depth was 4". The two N rates were 50 and 100 lb/a and the three P rates were 0, 20, and 40 lb P_2O_5/a. A check (no fertilizer) was included in each replication. Grain sorghum (Pioneer 8500c) was no-till planted at approximately 62,000 seeds/a on June 25, 1992. The grain sorghum was harvested on Dec. 3, 1992. Prior to harvest, total head number was counted in the harvest area. Average kernel weight was determined from duplicate 1000-kernel weights. Whole plant samples were taken to determine dry matter production at the soft dough stage.

Results and Discussion

Method did not significantly affect yield in 1992 (Table 1). However, subsurface applications as either knife or dribble tended to result in higher number of heads/a than with surface applications. Although not significant, this appeared to be offset by lower number of kernels/head with knife and spoke applications. Plant growth at the soft dough stage appeared to be enhanced by knife and spoke application as compared to surface applications, especially dribble.

Yield, yield components, or dry matter production at the soft dough stage were not significantly affected by N or P rates in 1992 (Table 1). However, P fertilization resulted in higher number of heads/a and dry matter production at the soft dough stage than the check.

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

[2] Department of Agronomy, KSU.

As a result, yield tended to be higher with fertilization than without. The lack of effect of N rate on yield or yield components may have been due to the high organic matter content (3.7% in the surface 6") and total N (1470 ppm in the 0-6" zone) in the soil, which may reflect a high potential for mineralizable N.

Table 1. Effect of Fluid Fertilizer Placement, N Rate, and P Rate on Grain Sorghum Yield, Yield Components, and Dry Matter Production at the Soft Dough Stage in 1992

Treatment Means	Yield	Heads/a	Kernel Weight	Kernels /Head	Soft Dough Dry Matter
	bu/a		- mg -		- lb/a -
Method:					
Broadcast	48.8	33300	24.4	1530	5040
Dribble	50.6	33000	24.6	1610	4640
Knife	49.7	36200	24.5	1470	5510
Spoke	50.9	35900	25.1	1450	5570
LSD (0.05)	NS	2700	NS	NS	640
N Rate (lb/a):					
50	48.3	33800	24.9	1490	5130
100	51.7	35400	24.4	1540	5250
LSD (0.05)	NS	NS	NS	NS	NS
P Rate (lb P_2O_5/a):					
0	48.0	33400	24.2	1540	5130
20	53.5	35300	24.8	1580	5120
40	48.5	35100	25.0	1420	5320
LSD (0.05)	NS	NS	NS	NS	NS
Interaction(s)	NS	NS	NS	NS	NS
Check[1]	39.9	28000	24.1	1500	4110
Contrasts:					
Check vs. All	10%	**	NS	NS	10%
Check vs. N-only	NS	*	NS	NS	NS
Check vs. P-treatments	10%	**	NS	NS	*

[1] Not included in the 4x2x3 factorial analyses.

PHOSPHORUS, POTASSIUM, AND CHLORIDE EFFECTS ON ALFALFA AND BIRDSFOOT TREFOIL[1]

Daniel W. Sweeney, Joseph L. Moyer, and David A. Whitney[2]

Summary

Because of frequent rains, total yields for alfalfa and birdfoot trefoil were high in 1992. Yield of both legumes increased with increasing P rate. Yield response to K additions was minimal. Chloride application had little effect on total forage yield.

Introduction

With the attention recently given to sustainable agriculture, interest has been renewed in the use of legumes in a cropping system. Because sustainability of our agricultural resources needs to coincide with profitability, achieving and maintaining adequate soil fertility levels are essential. The importance of initial soil test levels and maintaining those levels has not been clearly shown for alfalfa and birdsfoot trefoil production in southeastern Kansas. Thus, the objective of this study was to determine the effect of soil and fertilizer phosphorus, potassium, and chloride levels on the emergence, stand persistence, yield, and quality of alfalfa and birdsfoot trefoil.

Experimental Procedure

The experiment was established on a Parsons silt loam in spring 1991. Initial soil test values were low in P and K. Since 1983, soil test levels have been established in the whole plots by P and K treatments, with current P levels ranging from below 10 to more than 60 lb/a and K levels from approximately 120 to more than 200 lb/a. The experimental design was a split-plot. The whole plots comprised a factorial arrangement of P and K rates, in addition to selected chloride comparison treatments. Phosphorus rates were 0, 40, and 80 lb P_2O_5/a, and K rates were 0, 125, and 250 lb K_2O/a. Split plots were alfalfa and birdsfoot trefoil. Cuttings were taken from a 3x40' area of each plot.

Results

Frequent early-summer rains in 1992 resulted in high total forage yields of alfalfa and birdsfoot trefoil. Total yield of both legumes increased with increasing P rate; however, the largest increase was with the first 40 lb P_2O_5/a (Figure 1). Increasing the P rate to 80 lb P_2O_5/a resulted in an additional 0.5 ton/a alfalfa yield, whereas increasing P additions to the higher rate had little effect on birdsfoot trefoil. The yield response of both legumes to K was minimal, with little difference between the 125 and 250 lb K_2O/a rates (Figure 2). Alfalfa yield was increased nearly 10% by 125 lb K_2O/a, but birdsfoot trefoil was affected little by any rate of K fertilization.

Individual cuttings show that alfalfa was responsive to P and K, especially to the first 40 lb P_2O_5/a and 125 lb K_2O/a, at each of the 5 cuttings taken in 1992 (Table 1). Applying P at the highest rate further increased alfalfa yield in cuttings 1 and

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

[2] Department of Agronomy, KSU.

5, whereas increasing K fertilization to 250 lb K_2O/a did not increase individual cutting yields above those from 125 lb K_2O/a. Birdsfoot trefoil forage yield was increased in only the first and last cutting by P fertilization (Table 2). Trefoil yield was not affected by K application, except for small increases in the fifth cutting.

Chloride application had little effect on total forage yield (data not shown). Chloride additions as KCl or $CaCl_2$ resulted in small increases in first cutting alfalfa yield but did not affect subsequent cuttings. Individual cuttings of birdsfoot trefoil were not affected by Cl fertilization.

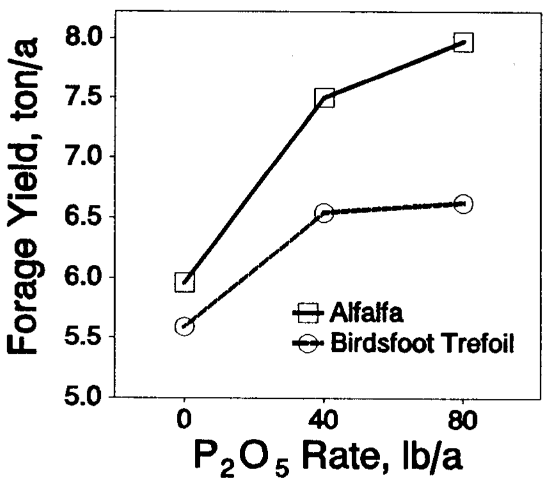

Figure 1. Effect of P Fertilization Rate on Total Forage Yield of Alfalfa and Birdsfoot Trefoil in 1992.

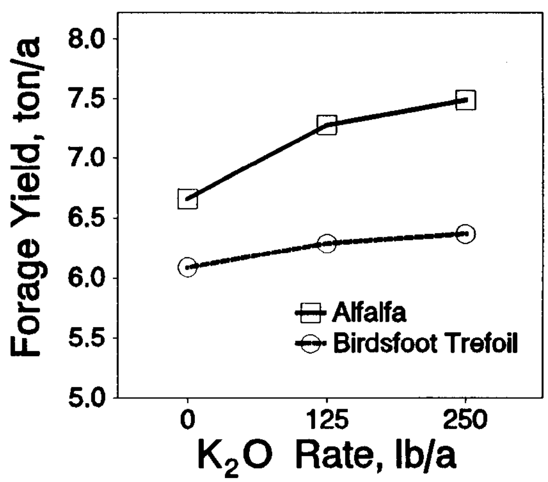

Figure 2. Effect of K Fertilization Rate on Total Forage Yield of Alfalfa and Birdsfoot Trefoil in 1992.

Table 1. Effect of P and K Applications on Yield of Individual Cuttings of Alfalfa in 1992

Treatment	Cutting 1	2	3	4	5
	---------------------- ton/a				------------------------
P_2O_5 Rate (lb/a)					
0	1.04	1.40	1.64	1.26	0.62
40	1.46	1.73	1.90	1.42	0.97
80	1.66	1.75	1.94	1.43	1.19
LSD (0.05)	0.11	0.06	0.14	0.13	0.10
K_2O Rate (lb/a)					
0	1.29	1.58	1.65	1.27	0.87
125	1.44	1.65	1.89	1.38	0.93
250	1.43	1.66	1.95	1.47	0.99
LSD (0.05)	0.11	0.06	0.14	0.13	0.10

Table 2. Effect of P and K Applications on Cutting Yields of Birdsfoot Trefoil in 1992

Treatment	Cutting 1	2	3	4
	--------------- ton/a			------------------
P_2O_5 Rate (lb/a)				
0	1.70	2.30	1.16	0.42
40	2.25	2.33	1.14	0.83
80	2.33	2.30	1.15	0.84
LSD (0.05)	0.19	NS	NS	0.15
K_2O Rate (lb/a)				
0	1.99	2.33	1.17	0.60
125	2.14	2.29	1.16	0.69
250	2.14	2.30	1.13	0.80
LSD (0.05)	NS	NS	NS	0.15

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

Daniel W. Sweeney

Summary

In 1992, the tenth cropping year of a grain sorghum-soybean rotation, tillage systems or residual N fertilization did not affect soybean yields.

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, 1989, and 1991 grain sorghum were a) no N check, 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. Harvests were collected from each subplot for both grain sorghum (odd years) and soybean (even years) crops, even though N fertilization was applied only to grain sorghum.

Results and Discussion

No significant differences related to tillage or residual N fertilization were found for soybean yield in 1992 (data not shown). The test average yield was 38.5 bu/a.

TIMING OF LIMITED-AMOUNT IRRIGATION TO IMPROVE YIELD AND QUALITY OF EARLY-MATURING SOYBEANS

Daniel W. Sweeney, James H. Long, and Mary Beth Kirkham[1]

Summary

Adequate rainfall in 1992 resulted in no differences in yield, seed protein, or oil content as affected by supplemental irrigation.

Introduction

Production of early-maturing soybeans may spread economic risk by crop diversification. Previous research has shown that early-maturing soybeans often can have yields comparable to those of full-season soybeans. However, one potential disadvantage of early-maturing soybeans has been reduced quality. This potential for poor quality may be due to late reproductive growth that generally occurs in July when rainfall is typically low. Irrigation may improve not only early-maturing soybean yield but also quality. Even though large irrigation sources such as aquifers are lacking in southeastern Kansas, supplemental irrigation could be supplied from the substantial number of ponds in the area. Thus, the objective of this study was to determine the effect of timing and quantity of limited-amount irrigation for improving yield and quality of early-maturing soybeans.

Experimental Procedure

The experiment was established in 1991 on a Parsons silt loam soil. It was a split plot arrangement of a randomized complete block design. The main plots comprised a 3x2 factorial arrangement of irrigation timing and amount. The three timings were irrigation at the R4, R5, and R6 soybean growth stages. The two amounts were 1 and 2 inches. Also included was a nonirrigated check plot. The subplots were two Maturity Group I soybean cultivars, Hodgson 78 and Weber 84. Both cultivars were drilled at 200,000 seeds/a on May 13, 1992. Plots were harvested on Sept. 4, 1992.

Results and Discussion

Adequate rainfall during the growing season resulted in no significant differences in yield, grain protein, or oil content as affected by supplemental limited irrigation in 1992 (data not shown). Weber 84 yielded 48.0 bu/a, whereas Hodgson 78 yielded 25.9 bu/a. Protein was slightly higher in Hodgson 78 soybeans (36.0%) than Weber 84 (35.5%); however, the two cultivars did not differ in oil content.

[1] Department of Agronomy, KSU.

LAND APPLICATION OF COMPOSTED MUNICIPAL SOLID WASTE FOR GRAIN SORGHUM PRODUCTION[1]

Daniel W. Sweeney and Gary Pierzynski[2]

Summary

The lowest application rate (4.5 ton/a) of composted municipal solid waste (MSW) did not appear to suppress grain sorghum growth and tended to increase yield. However, MSW compost at 13.5 ton/a appeared to mitigate the benefit of cow manure on grain sorghum dry matter production. Yields also tended to decline with MSW compost applications in excess of 4.5 ton/a.

Introduction

One of the most pressing environmental issues that will face communities in the near future is solid waste disposal. In recent years, news media coverage of landfill problems has become common. With diminishing capacity of existing landfills and the reluctance of the general populace to create new landfills at their own "backdoor", other alternatives to straight landfilling of municipal solid waste (MSW) need to be explored. Incineration may reduce waste volume, but likely raises as many environmental concerns as landfilling. However, composting of MSW may be more environmentally acceptable and should substantially reduce waste volume. Landfill longevity could be further extended by finding alternatives to landfilling the composted MSW. Composted MSW has potential uses in agriculture, horticulture, silviculture, and reclamation. Thus, the objective of this study was to determine the effect of application rate of composted MSW, with or without cow manure and with or without commercial fertilizer, on the growth, composition, and yield of grain sorghum and on selected soil chemical properties.

Experimental Procedure

A field study was established in 1992 on a Zaar silty clay soil at an off-station site in Montgomery County. The experimental design was a split plot arrangement of a randomized complete block with three replications. The whole plots comprised a 4 x 2 factorial arrangement of four rates of MSW compost with or without cow manure. The four rates of MSW compost were none, 4.5, 9, and 13.5 ton/a to be applied each year. These rates were selected to be more in-line with a "utilization-" rather than a "disposal-mentality". The cow manure rates were none or 4.5 ton/a applied yearly. The subplots were with or without commercial fertilizer, 100-60-30 lb N-P_2O_5-K_2O/a. Cool, wet weather in early June delayed applying the compost and planting the grain sorghum until July 1.

Results and Discussion

At the 9-leaf and the soft dough growth stages, the MSW compost interacted with cow manure applications to affect grain sorghum growth (Figure 1). Without cow manure, there was little difference in dry matter production at any of the three growth stages, regardless of the MSW

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[1] With the cooperation of Resource Recovery, Inc.

[2] Department of Agronomy, KSU.

compost rate. In general, cow manure increased grain sorghum growth; however, at soft dough, the highest MSW compost application rate (13.5 ton/a) appeared to suppress the benefit of the cow manure to the same level of dry matter that was produced without cow manure. Either cow manure or commercial fertilizer increased yields by approximately 15 bu/a (data not shown). The effect of MSW compost on yield was less than the effect of either cow manure or fertilizer; however, MSW compost did tend to affect yield (P<.10). The first 4.5 ton/a of MSW compost increased yield by approximately 6 bu/a above no compost; however, further increases in compost rates declined yields to levels equal to or less than yields without compost (Figure 2).

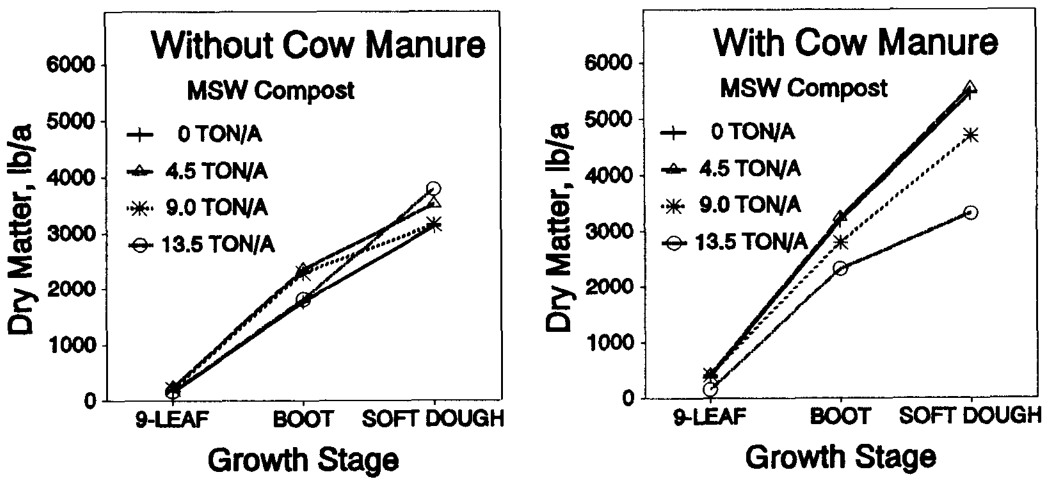

Figure 1. Effect of MSW Compost and Cow Manure on Grain Sorghum Dry Matter Production

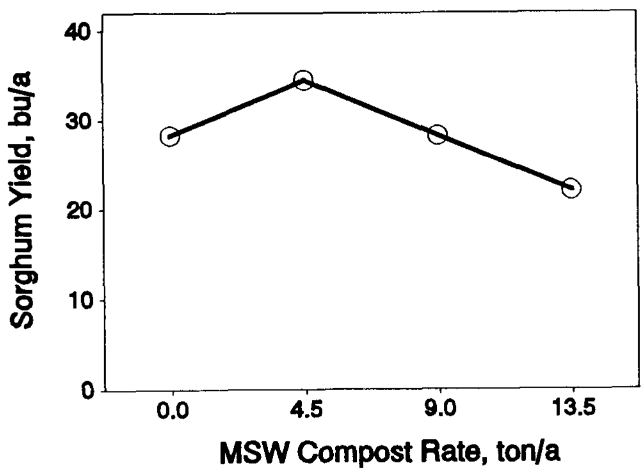

Figure 2. Effect of MSW Compost on Grain Sorghum Yield in 1992.

EFFECTS OF PLANTING DATE AND FOLIAR FUNGICIDE ON WINTER WHEAT YIELD

Kenneth Kelley and Robert Bowden[1]

Summary

Grain yield was significantly affected by planting date, foliar fungicide application, and cultivar selection. In 1992, a late September planting produced the highest grain yield for most cultivars. Extreme cold temperatures in late October severely damaged cultivars that lacked winter-hardiness. In late May, armyworms defoliated all leaves of the entire plot area when wheat was at the soft-dough stage of grain development. Despite the loss of leaves from armyworms, foliar fungicide still significantly increased grain yield of disease-susceptible cultivars.

Introduction

Wheat is often planted over a wide range of planting dates in southeastern Kansas because of the varied cropping rotations. Wheat following early corn, early grain sorghum, or wheat is planted in late September and early October, whereas wheat following soybeans is typically planted from early October through early November. This research seeks to determine how planting date affects grain yield and yield components of selected hard and soft winter wheat cultivars with variable disease resistance.

Experimental Procedure

Six winter wheat cultivars were planted on four different dates at the Parsons Unit. Cultivars were selected for various foliar disease resistances: 1) moderately resistant soft wheat cultivars (Caldwell and Pioneer 2551), 2) susceptible hard wheat cultivars (Chisholm and TAM 107), and 3) resistant hard wheat cultivars (Karl and 2163). Cultivars were seeded at the recommended rate for each planting date (850,000 seeds/a for late Sept., 1,050,000 seeds/a for October plantings, and 1,250,000 seeds/a for early Nov.). Tilt, a systemic foliar fungicide, was applied at 4 oz/a to half of the plot area for each planting date when the wheat was at Feekes' growth stage 8 (flag leaf just visible from the boot). Grain yield and yield components were measured.

Results and Discussion

Grain yield results (Tables 1 and 2) from the early October planting date were affected by the sudden cold temperature that occurred in late October. Cultivars that lacked winter-hardiness (Chisholm and Caldwell) received the most damage. In the latter part of May, armyworms stripped off all leaves of all plots when wheat was near the soft-dough stage of grain development. Although it was not possible to determine the extent of armyworm damage to grain yield, test weights were significantly reduced (Tables 1 and 2) because of the leaf loss. In 1992, most cultivars produced the highest grain yield when planted in late September. However, results in 1990 and 1991 showed that a late September planting normally is too early for southeastern Kansas conditions.

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[1] Extension Plant Pathologist, KSU.

Despite the loss of leaves from armyworms, the Tilt application gave sufficient foliar disease control to significantly increase grain yield of selected cultivars at all planting dates. Leaf diseases (leaf rust and septoria nodorum) were present on wheat leaves a week to 10 days prior to armyworm invasion. All cultivars, with the exception of Karl, had a positive yield response from Tilt. Karl appears to have excellent disease resistance to the current races of leaf rust. Yield component and plant maturity data are shown in Table 3. Number of heads per unit area and kernels per head were not affected by foliar fungicide application; however, Tilt did significantly increase individual seed weight. A 6-week delay in planting delayed plant maturity by only 3 to 5 days for most cultivars.

Table 1. Effects of Planting Date and Foliar Fungicide on Wheat Yield and Test Weight of Selected Cultivars, Parsons Unit 1992

Planting Date / Cultivar	Grain Yield Fungicide No	Grain Yield Fungicide Yes	Grain Yield Avg.	Test Weight Fungicide No	Test Weight Fungicide Yes	Test Weight Avg.
	----------- bu/a ---------			------------- lbs/bu ---------		
Late September (Sept. 25)						
Caldwell (S)	41.9	51.0	46.5	52.3	53.1	52.7
Chisholm	39.9	44.9	42.4	56.4	57.7	57.1
Karl	40.7	41.0	40.8	56.2	56.1	56.2
2163	47.3	50.9	49.1	53.4	54.6	54.0
Pioneer 2551 (S)	47.0	51.4	49.2	52.6	53.3	52.9
TAM 107	44.1	48.2	46.2	54.9	55.6	55.3
Early October (Oct. 9)						
Caldwell (S)	29.4	32.5	30.9	50.7	53.1	51.9
Chisholm	27.4	37.4	32.4	55.2	57.7	56.5
Karl	46.3	46.2	46.3	58.0	58.3	58.1
2163	43.5	52.3	47.9	52.7	55.0	53.8
Pioneer 2551 (S)	36.0	45.0	40.5	50.3	52.6	51.5
TAM 107	39.1	42.5	40.8	54.2	55.1	54.7
Late October (Oct. 23)						
Caldwell (S)	38.9	48.4	43.6	51.9	55.1	53.5
Chisholm	39.8	47.4	43.6	56.4	59.1	57.8
Karl	45.1	46.1	45.6	58.8	58.8	58.8
2163	43.1	47.7	45.4	54.7	55.4	55.1
Pioneer 2551 (S)	39.5	44.1	41.8	51.5	53.5	52.5
TAM 107	37.1	44.1	40.6	54.0	56.0	55.0
Mid-November (Nov. 13)						
Caldwell (S)	34.2	43.5	38.9	51.3	54.9	53.1
Chisholm	31.0	42.0	36.5	56.0	59.1	57.5
Karl	40.0	40.5	40.2	58.6	59.0	58.8
2163	38.8	43.7	41.2	54.1	56.3	55.2
Pioneer 2551 (S)	31.4	40.3	35.9	50.3	52.1	51.2
TAM 107	33.3	40.6	36.9	53.1	55.9	54.5
LSD (0.05):						
Cultivar within same (F) & (DOP)		3.1			0.8	
Cultivar for different (F) & same (DOP)		2.9			0.9	

S = soft wheat cultivar.
Foliar fungicide = Tilt, applied at 4 oz/A at Feekes' GS 8 (early boot stage.)

Table 2. Grain Yield and Test Weight Summarized over Planting Dates and Cultivars, Parsons Unit 1992

Variable	Grain Yield Fungicide No	Grain Yield Fungicide Yes	Grain Yield Avg.	Test Weight Fungicide No	Test Weight Fungicide Yes	Test Weight Avg.
	------------ bu/a	-----------		----------- lbs/bu	-----------	
Cultivar:						
Caldwell (S)	36.1	43.9	40.0	51.6	54.1	52.8
Chisholm	34.5	42.9	38.7	56.0	58.4	57.2
Karl	43.0	43.4	43.2	57.9	58.0	58.0
2163	43.2	48.6	45.9	53.7	55.3	54.5
Pioneer 2551 (S)	38.5	45.2	41.9	51.2	52.9	52.0
TAM 107	38.4	43.9	41.1	54.1	55.7	54.9
Planting Date:						
Late Sept. (Sept. 25)	43.5	47.9	45.7	54.3	55.1	54.7
Early Oct. (Oct. 9)	36.9	42.7	39.8	53.5	55.3	54.4
Late Oct. (Oct. 23)	40.6	46.3	43.4	54.6	56.3	55.4
Mid-Nov. (Nov. 13)	34.8	41.8	38.3	53.9	56.2	55.0
AVG.	39.0	44.7	---	54.1	55.7	---
LSD (0.05):						
Cultivar mean for same (F):		1.5			0.4	
Fung. mean for same (DOP):		0.7			0.6	

Table 3. Effect of Planting Date and Foliar Fungicide on Wheat Yield Components and Maturity of Selected Cultivars, Parsons Unit, 1992

Planting Date Cultivar	1000 Ker. Wt. Fungicide No	 Yes	Hds	K/hd	Maturity
	------- gr -----			#/M^2	
Late September (Sept. 25)					
Caldwell (S)	20.9	24.2	745	41.9	Apr. 23
Chisholm	24.5	28.5	676	37.8	Apr. 21
Karl	25.6	25.8	693	34.3	Apr. 21
2163	24.0	26.3	710	37.8	Apr. 22
Pioneer 2551 (S)	23.9	25.0	605	44.6	Apr. 25
TAM 107	27.6	30.7	711	36.2	Apr. 20
Early October (Oct. 9)					
Caldwell (S)	20.7	22.1	701	43.5	Apr. 24
Chisholm	25.1	30.0	630	31.7	Apr. 22
Karl	27.6	29.8	821	31.9	Apr. 22
2163	23.5	26.6	724	35.5	Apr. 23
Pioneer 2551 (S)	22.2	25.5	590	41.9	Apr. 26
TAM 107	26.1	27.5	694	33.9	Apr. 20
Late October (Oct. 23)					
Caldwell (S)	22.0	25.5	653	40.8	Apr. 26
Chisholm	27.2	31.6	703	31.6	Apr. 22
Karl	29.8	29.9	680	28.4	Apr. 22
2163	26.4	27.2	654	34.3	Apr. 25
Pioneer 2551 (S)	23.8	27.6	610	39.7	Apr. 27
TAM 107	26.5	29.3	702	33.0	Apr. 22
Mid-November (Nov. 13)					
Caldwell (S)	21.0	24.4	647	39.7	Apr. 27
Chisholm	25.3	30.3	623	30.9	Apr. 23
Karl	28.8	29.4	739	26.5	Apr. 24
2163	25.0	28.2	687	33.4	Apr. 26
Pioneer 2551 (S)	20.7	24.5	648	38.3	Apr. 28
TAM 107	25.4	29.0	753	33.0	Apr. 23
LSD (0.05):					
Cultivar mean for same (F) & (DOP):		1.2	46	2.5	
Cultivar mean for different (F) & same (DOP):		1.4			

S = soft wheat cultivar.

WHEAT AND SOYBEAN CROPPING SEQUENCES COMPARED[1]

Kenneth Kelley

Summary

Three different wheat and soybean crop rotations have been compared over a 12-yr period. Full-season soybeans have yielded significantly higher than double-crop during 6 of the years, no yield differences occurred in 5 yrs, and double-crop soybeans yielded higher in 1 yr. Full-season soybean yield was highest where no double-cropping occurred in the previous year. Wheat yield was highest following wheat and lowest following continuous double-crop soybeans.

Introduction

In southeastern Kansas, producers often rotate wheat after soybeans or plant double-crop soybeans following wheat harvest. Management practices of one crop, therefore, may affect the production of the subsequent crop. This research seeks to determine the long-term effects of wheat and soybean cropping rotations on yield and soil properties.

Experimental Procedure

Beginning in 1981, three different wheat and soybean cropping rotations were established at the Parsons Unit: 1) [continuous wheat - double-crop soybean], 2) [wheat - double-crop soybean] - soybean, and 3) full-season soybean following wheat with no double-cropping. Prior to 1988, full-season soybeans were maturity group (MG) V and double-crop, MG III or IV. Beginning in 1988, MG I, III, IV, and V were compared in both full-season and double-crop rotations (Rotation # 2). Group I maturity was planted in early May in 7-inch row spacing, whereas the other full-season maturity groups normally were planted in mid-June in 30-inch row spacing. Double-crop soybeans have been planted in late June or early July after wheat straw was burned and disced. Prior to 1988, wheat was planted after all double-crop and full-season soybeans had matured, regardless of rotation. However, since 1988, wheat has been planted at different times with respect to individual crop rotations.

Results and Discussion

Table 1 shows the yearly soybean yields for the different wheat and soybean rotations for the past 12 years. Full-season soybeans have averaged nearly 7 bu/a more than double-crop soybeans, but the variation in yield from year to year has been significant. Full-season soybeans following summer-fallowed wheat have yielded nearly 3 bu/a higher compared to those following double-crop soybeans. During the years when wet weather conditions delayed full-season planting (1982, 1985, 1989, and 1992) until the same time as double-crop planting, no significant difference occurred in yield among rotations.

Since 1988, soybean maturity has had a significant effect on both double-crop and full-season yields (Tables 2 and 3). MG I has surprisingly produced highest full-season yields in 4 of 5 years; however, seed quality has sometimes

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

been poor. In double-crop systems, MG IV has normally produced the highest yield.

Wheat yield as affected by the different crop rotations is shown in Table 4. Yield differences have been more pronounced since wheat has been planted at different dates according to the particular rotation scheme (Table 5). More data are needed on the effects of soybean maturity and crop rotation on wheat yield; however, in the continuous double-crop rotation, wheat yield has been significantly lower.

Table 1. Effects of Wheat and Soybean Cropping Systems on Soybean Yield, Southeast Ks. Branch Expt. Station, Parsons, KS

Yr	Rot. - 1 Wh - DC Soy	Rot. - 2 Wh - DC Soy FS Soy	Rot. - 2 Wh - DC Soy FS Soy	Rot. - 3 Wh - Wh FS Soy	LSD (0.05)
	bu/a				
1981	18.7	18.0	25.8	25.7	3.7
1982*	23.6	23.0	24.3	24.9	NS
1983	17.9	16.9	15.5	14.5	NS
1984	2.1	2.0	11.1	12.8	2.9
1985*	33.2	31.6	32.6	32.1	NS
1986	19.9	17.5	21.2	23.9	3.8
1987	19.5	19.3	35.4	42.6	2.5
1988	9.1	8.4	22.7	25.1	1.5
1989*	27.6	28.0	28.3	29.8	1.7
1990	22.1	23.9	19.6	22.0	1.2
1991	18.6	15.2	24.9	27.3	0.8
1992*	36.6	35.0	37.1	38.7	2.3
Avg.	20.7	19.9	24.9	26.6	

(*) - Full-season and double-crop soybeans were planted on the same date in 1982, 1985, 1989, and 1992.
DC = Double-crop soybeans; FS = full-season soybeans.
Cultivars planted: Double-crop (MG IV); Full-season (MG V).

Table 2. Comparison of Soybean Maturity Groups in a Full-Season Soybean Crop Rotation, Southeast Ks. Branch Expt. Station, Parsons, KS

Mat. Group	Cultivar	Full-Season Soybean Yield 1988	1989	1990	1991	1992	Avg.
		bu/a					
I	Weber 84	31.8	31.5	22.0	3.9	38.8	25.6
III	Flyer	24.0	30.8	14.5	23.8	36.4	25.9
IV	Stafford	26.9	28.8	16.0	24.0	36.5	26.4
V	Hutcheson	22.7	28.3	19.6	24.9	37.1	26.5
LSD (0.05)		1.5	1.8	1.3	0.8	2.2	

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

Table 3. Comparison of Soybean Maturity Groups in a Double-Crop Soybean Crop Rotation, Southeast Ks. Branch Expt. Station, Parsons, KS

Mat. Group	Cultivar	Double-crop Soybean Yield 1988	1989	1990	1991	1992	Avg.
		bu/a					
I	Weber 84	2.0	28.7	10.9	4.2	29.3	15.0
III	Flyer	2.2	28.9	16.6	14.7	31.6	18.8
IV	Stafford	8.4	28.0	23.9	15.1	35.0	22.1
V	Essex	6.5	22.8	20.7	12.1	32.7	19.0
LSD (0.05)		1.5	1.8	1.3	0.8	2.2	

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

Table 4. Effect of Wheat and Soybean Cropping Rotations on Wheat Yield, Southeast KS Branch Expt. Station, Parsons, KS

Year	Crop Rotation (Rot. 1) (WH - DC Soy)	(Rot. 2) (WH - DC Soy) FS Soy	(Rot. 3) Wheat Wheat FS Soy	(Rot. 4) Wheat Wheat FS Soy	LSD (0.05)
	bu/a				
1982	58.9	55.4	52.1	51.6	4.1
1983	48.4	53.4	51.6	51.9	1.4
1984	51.4	55.1	55.0	54.6	1.6
(1982-84 Avg)	52.9	54.6	52.9	52.7	
1988	49.5	52.6	60.5	61.6	6.2
1989	50.3	64.8	64.3	68.6	6.5
1990	30.4	29.5	33.4	23.7	4.5
1991	39.4	46.1	39.5	60.0	6.6
1992	56.1	57.6	57.2	72.9	3.0
(1988-92 Avg)	45.1	50.1	51.0	57.4	

Wheat was not harvested from 1985 through 1987 because of wet soil conditions.
Spring oats were planted in 1986 and 1987 as a substitute crop for wheat.
Soybean maturity group:
Rotation 1: Group III or early Group IV
Rotation 2, 3, & 4: Group V

Table 5. Effects of Soybean Maturity Group on Wheat Yield, Parsons Unit

Soybean Maturity	Wheat Yield 1989	1990	1991	1992	4-yr Avg.
	------------------------------------ bu/a	------------------------------------			
Group I	71.4	25.1	58.2	69.1	56.0
Group III	68.1	27.5	54.9	67.5	50.2
Group IV	71.9	36.0	48.3	65.7	52.1
Group V	64.8	29.5	46.1	57.6	46.8
LSD (0.05):	5.8	5.1	5.8	2.4	----

Crop rotation: [Wheat - double-crop soy] - full-season soybeans

Planting dates:
1989: Oct. 14, 1988 (MG I, III, & IV)
Oct. 25, 1988 (MG V)
1990: Oct. 16, 1989 (MG I & III)
Oct. 27, 1989 (MG IV & V)
1991: Oct. 5, 1990 (MG I, & III)
Oct. 16, 1990 (MG IV)
1992: Oct. 7, 1991 (MG I,III, & IV)
Oct. 23, 1991 (MG V)

ECONOMIC COMPARISONS OF WHEAT AND SOYBEAN CROPPING SEQUENCES[1]

Patrick T. Berends[2], Robert O. Burton, Jr.[2], 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 above variable costs based on 1992 yields and prices or average yields and prices favored a 1-year sequence of wheat followed by double-crop soybeans. Four soybean maturity groups were considered in the 2-year rotation containing wheat, double-crop soybeans, and full-season soybeans. A comparison of income above variable costs based on 1992 yields and prices or average yields and prices favored Group IV soybeans for double-crop use. This same comparison for full-season soybeans provided mixed results.

Introduction

Farmers producing wheat and soybeans in southeastern Kansas select a cropping sequence that enables them 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 Procedure

Budgeting was used to calculate income above variable costs for each crop in three crop sequences (Table 1). Crop sequences included 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 months of harvest, July for wheat; October for soybean maturity groups III, IV, V, and group I when double- cropped; 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 cost 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 1992 yields and prices for both wheat and soybeans and also based on average yields and prices over several years--1988-92 yields for wheat, 1981-92 yields for soybeans, and 1987-92 prices. The

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

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1987-91 prices were converted to a 1992 price level before averaging.

Results and Discussion

Results of a comparison of income above variable costs based on 1992 yields and prices or average yields and prices favor a 1-year sequence of wheat followed by double-crop soybeans (Table 3). Although both 1992 and average data favor double-cropping, this result will not hold every year. For example, in a previous progress report, budgeting based on 1988 yields and projected prices 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 machinery operations may be performed during harvesting and planting periods.

One strategy for managing labor and machinery constraints during critical seasons is to use early maturing soybeans. From 1988 to 1992, four maturity groups were considered in the 2-year rotation containing wheat, double-crop soybeans, and full-season soybeans (see previous article). 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 30 cents per pound plus a 2 cents per pound shipping charge. Group III, IV, and V soybeans were planted in 30-inch rows with per acre seeding rates of 50 pounds for Groups III and IV and 35 pounds for Group V. Costs of Group III, IV, and V soybean seeds were 15.83 cents per pound, based on a $9.50 price per bushel obtained from a seed distributor in Southeastern Kansas. Thus, budgeted seed costs were $7.92 per acre for Group III and IV soybeans, $5.54 for Group V, and $28.80 per acre for Group I. Early harvest favors full-season Group I soybeans, because soybeans harvested prior to the traditional harvest season typically have a price advantage.

Early maturing soybeans have shown promise in the past few years by taking advantage of southeast Kansas's normally abundant spring rainfall. For full-season soybeans (Table 4), Group V had the highest returns above variable costs in 1992. For double-crop soybeans (Table 5), Group IV had the highest for 1992. However, rainfall was plentiful throughout the growing season in 1992, resulting in good yields and good returns above variable costs for all maturity groups.

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

		Wheat			Double-crop Soybeans Group IV			Full-season Soybeans Group IV		
Item	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.	$3.09	57.60	$177.98	$5.01	35.00	$175.35	$5.01	36.50	$182.87
2. Variable Costs										
Seed	Lbs.	0.12	75.00	9.00	0.16	50.00	7.92	.16	50.00	7.92
Nitrogen	Lbs.	0.22	70.00	15.40	-	-	0.00	-	-	0.00
Phosphate	Lbs.	0.23	50.00	11.50	-	-	0.00	-	-	0.00
Potash	Lbs.	0.13	50.00	6.50	-	-	0.00	-	-	0.00
Herbicides		-	-	0.00	-	-	23.94	-	-	23.94
Labor	Hrs.	8.00	1.25	9.99	8.00	1.35	10.81	8.00	1.68	13.42
Machinery				14.13			15.01			19.04
Interest on ½ of variable cost	Dol.	0.10	33.26	3.33	0.10	28.89	2.88	0.10	32.16	3.22
Total Variable Cost				69.85			60.55			67.54
3. Income above variable costs				108.13			114.80			115.33

[a]Wheat and soybean prices are for the 1992 month of harvest from Kansas Agricultural Statistics, Topeka, Kansas. Input costs other than machinery and soybean seed costs are projections from Fausett, Marvin, Soybean Production in Southeast Kansas and Continuous Cropped Winter Wheat in Southeast Kansas, KSU Farm Management Guides MF-994 and MF-992, revised October 1992. Machinery variable costs (fuel, lubrication, and repairs) and labor requirements are based on information from Fuller, Earl, Bill Lazarus, Lonnie Carrigan and Geoff Green, Minnesota Farm Machinery Economic Cost Estimates for 1992, Minnesota Extension Service, University of Minnesota, AG-FO-2308-C, revised 1991, with adjustments for Southeastern Kansas. Soybean seed costs are from a seed distributor in Southeastern Kansas.

[b]Yields, seed, and fertilizer are 1992 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 Double-crop Soybeans
	- - - Number of Times over the Field - - -				
Burn Wheat Straw			1.00		
Moldboard Plow	0.50				
Chisel Plow				1.00	1.00
Disc	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
	- - - Acres/Truck Load - - -				
Medium Truck[b]	6.67	7.13	11.43	10.34	10.78
	- - - Acres/Hour - - -				
Light Truck	3.50	3.50	3.50	3.50	3.50
	- - - Dollars/Acre - - -				
Machinery Variable Costs[c]	19.26	14.13	15.06	20.42	19.04

[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 each crop in each rotation. Lower yields would increase acres per truckload and decrease costs per acre and vice versa. Thus, truck costs for the same crop in a different sequence will differ because of different yields.

[c]Variable costs include fuel, lubrication, and 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]: 1992 Yields and Output Prices[e]	Incomes above Variable Costs[d]: 1988-1992 Average Wheat and 1981-1992 Average Soybean Yields, 1987-1992 Average Output Prices[f]
	Dollars/Acre	
[W-DCSB]		
W	103.60	80.48
DCSB	122.72	70.52
Annual Average[c]	226.32	151.00
[W-DCSB]-FSSB		
W	108.13	96.82
DCSB	114.80	65.64
FSSB	120.82	84.14
Annual Average[c]	171.88	123.30
W-W-FSSB		
W Year 1	106.92	120.20
W Year 2	148.57	112.10
FSSB	126.42	97.88
Annual Average[c]	127.30	110.06

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

[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 1992 wheat and soybean prices for the month of harvest is Kansas Agricultural Statistics, Topeka, KS.

[f] Source of average 1987-92 prices for the month of harvest is Kansas Agricultural Statistics. Prices were updated to a 1992 price level using the personal consumption expenditure (PCE) portion of the implicit GNP price deflator before averaging.

Table 4. Incomes above Variable Costs for Soybean Maturity Groups: Full-Season Soybeans in a 2-Year Rotation, Parsons, Kansas[a]

		1992 Soybean Price[b]		6-yr. Avg. Soybean Price[b]	
Variety	Maturity Group	1992 Yield[c]	6-yr. Avg. Yield[c]	1992 Yield[c]	6-yr. Avg. Yield[c]
Weber 84	I	114.49	45.72	172.88	84.25
Flyer	III	114.83	62.22	158.83	93.53
Stafford	IV	114.33	64.73	159.45	96.64
Hutcheson	V	120.83	57.70	165.68	87.32

[a]Rotation is [wheat-doublecrop soybeans] - full-season soybeans.

[b]Prices are for the 1992 month of harvest, August for group I and October for groups III, IV, and V. Prices for 1987-91 were updated to a 1992 price level to calculate a 6-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 of this report.

Table 5. Incomes above Variable Costs for Soybean Maturity Groups: Double-crop Soybeans in a 2-Year Rotation, Parsons, Kansas[a]

		1992 Soybean Price[b]		6-yr. Avg. Soybean Price[b]	
Variety	Maturity Group	1992 Yield[c]	6-yr. Avg. Yield[c]	1992 Yield[c]	6-yr. Avg. Yield[c]
Weber 84	I	67.94	-3.70	103.36	14.43
Flyer	III	97.76	33.63	135.96	56.36
Stafford	IV	114.80	50.17	157.11	76.88
Hutcheson	V	105.77	37.13	145.30	60.10

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

[b]Prices are for the 1992 month of harvest, October for groups I, III, IV, and V. Prices for 1987-91 were updated to a 1992 price level to calculate a 6-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 of this report.

EFFECTS OF CROPPING SYSTEMS ON SOYBEAN YIELDS[1]

Kenneth Kelley

Summary

Four different soybean crop rotations have been compared at the Columbus Unit since 1979 in the presence and absence of soybean cyst nematode. In the absence of SCN, continuous soybeans have yielded nearly 10% less than soybeans grown in a 2-yr rotation following double-crop soybeans, grain sorghum, or fallowed wheat. However, in the presence of SCN, soybean yield has declined nearly 25% in the monoculture soybean system.

Introduction

Soybean is a major crop for farmers in southeastern Kansas. Typically, soybeans are grown in several cropping sequences with wheat, grain sorghum, and corn or in a double-cropping rotation with wheat. However, soybeans may follow soybeans, if a producer elects to enter the federal farm program and does not have a large enough wheat and feed-grain base to permit adequate crop rotation of available crop acreage. With the recent infection of soybean cyst nematode (SCN) into extreme southeastern Kansas, more information is needed to determine how crop rotations can be used to manage around the nematode problem.

Experimental Procedure

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

Some modifications have been added to the original plot design. Starting in 1988, lespedeza has been seeded in the wheat as a summer legume crop in rotation No. 2. Also, beginning in 1991, a susceptible and a resistant SCN cultivar were compared within each of the four cropping systems. During alternate years, a susceptible cultivar is planted in full-season and double-crop rotations.

Results and Discussion

Soybean yields from the initial study (no SCN) are shown in Table 1. Continuous soybeans have yielded 10% less than soybeans grown in a 2-yr rotation. However, in the continuous soybeans, yield has not been depressed as much as anticipated, considering that soybeans have been grown continuously on that site for the past 14 years.

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

Soybean yields from the adjacent study that was started in 1984 are shown in Table 2. At this site, SCN were detected in 1989, and yield was reduced nearly 25% in the continuous soybean rotation. However, when a resistant SCN cultivar was grown, yield was reduced slightly less than 10%. In 1992, double-crop soybeans yielded significantly higher than continuous full-season soybeans on the SCN infected area. However, more data are needed to determine the effect of double-cropping soybeans every 2 years on SCN-infected soil.

Table 1. Effects of Long-Term Cropping Systems on Soybean Yield in the Absence of Soybean Cyst Nematode, Southeast Ks. Branch Expt. Station, Columbus Unit

Crop	Full-Season Soybean Following				
Yr	Wh - DC Soy	Grain Sorg.	Wh - Lesp	Soy	LSD
	bu/a				
1980	12.6	13.3	12.8	10.3	1.0
1982	28.0	30.4	31.9	27.2	3.0
1984	11.8	10.8	12.0	12.1	NS
1986	21.9	23.6	23.9	21.8	1.8
1988	31.3	30.1	32.8	25.2	3.0
1990	22.4	23.4	24.9	22.4	NS
1992 Avg.	43.2	43.2	43.9	37.0	
(Stafford)	44.1	42.8	43.8	35.6	3.8
(KS 5292)	42.2	43.5	44.0	38.4	4.6
7-yr Avg.	24.5	25.0	26.0	22.2	

(*) - Lespedeza was grown in the summer fallow period beginning in 1988.
Beginning in 1992, two soybean cultivars were evaluated within each cropping rotation: (Staffford, nematode susceptible and KS 5292, nematode resistant).

Table 2. Effects of Long-term Crop Rotations on Soybean Yield in the Presence of Soybean Cyst Nematode, Columbus Unit

Crop Rotation	1985	1987	1989	1991 N:Sus	1991 N:Res	4-yr avg. (N:Sus)
	bu/a					
Soybeans following Wheat - doublecrop soy	31.9	30.7	27.0	33.4	32.3	30.8
Soybeans following Grain Sorghum	30.9	31.5	27.5	39.1	35.8	32.3
Soybeans following Wheat - lespedeza (*)	29.5	33.2	33.4	39.4	38.3	33.9
Soybeans following Soybeans	27.9	28.2	20.7	30.6	33.2	26.9
LSD: (0.05)	3.2	3.8	4.5	7.1	3.2	----

(*) Lespedeza was included in the rotation starting in 1988.
Nematodes were found in the continuous soybean rotation beginning in 1989.
(N:Sus) = nematode susceptible and (N:Res) = nematode resistant.

COMPARISONS OF TILLAGE METHODS FOR DOUBLE-CROP SOYBEANS AND SUBSEQUENT CROP EFFECTS

Kenneth Kelley

Summary

Comparisons among four tillage methods (plow, burn, disc, and chisel) for double-crop soybeans have shown that no specific tillage method is superior for all years. When adequate soil moisture was available during the growing season, plowing under the stubble has been slightly superior only to burning the stubble. However, when drought conditions prevailed during the summer, soybean yield was higher from the disc tillage method. After 10 years of data (five complete 2-yr cropping cycles), none of the double-crop tillage methods have significantly affected the yield of subsequent crops (soybeans and wheat) in the rotation.

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 and labor 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 double-crop 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 at the Columbus Unit. Tillage methods are: 1) plow under stubble, 2) burn stubble and then disc, 3) disc stubble, and 4) chisel - disc stubble. 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 soybeans] - followed by full-season soybeans. All plots are chiseled in the spring following double-crop soybeans. Fertilizer is applied only to the wheat crop.

Results and Discussion

Double-crop soybean yields for the 10-yr period are shown in Table 1. When averaged over years, highest yield has occurred where the wheat stubble was plowed under, with no difference in yield between burning the stubble compared to discing. However, double-crop yields have fluctated considerably over the period. With normal or above rainfall during the summer growing period, plowing the residue under has been more beneficial to double-crop soybean growth. However, when droughty conditions prevailed, higher yield was produced with the disc tillage method, which leaves more residue on the soil surface.

The subsequent effects of double-crop tillage methods on full-season soybean and wheat yields are shown in Table 2. After five complete cycles of the 2-yr crop rotation, the previous double-crop tillage method has not significantly affected soybean or wheat yields.

Table 1. Long-term Effects of Double-crop Tillage Methods on Soybean Yield, Southeast Ks. Branch Expt. Station, Columbus Unit

Crop	Doublecrop Tillage Method					LSD
	Plow	Burn-Disc	Disc	Chisel-Disc	No-till	
	bu/a					
1982	26.1	25.8	26.6	---	26.3	NS
1983	25.2	24.2	23.2	---	20.5	3.6
1985	32.9	32.1	30.3	---	24.7	4.9
1986	20.2	14.7	15.2	15.3	---	1.3
1987	18.7	9.8	12.8	14.4	---	2.8
1988	14.6	10.5	19.2	14.3	---	3.0
1989	27.9	23.3	22.6	22.1	---	1.2
1990	20.8	18.3	15.8	16.3	---	2.0
1991	15.5	14.9	19.4	14.1	---	1.9
1992	31.7	31.6	19.5	25.3	---	2.4
10-yr avg.	23.3	20.5	20.5	---	---	

No yield data in 1984 because of poor stands and summer drought.
Five cropping cycles have been completed in a 2-yr rotation of wheat - double-crop soy followed by full-season soybeans.

Table 2. Long-Term Effects of Double-Crop Tillage Methods on Subsequent Full-Season Soybean and Wheat Yield, Southeast Ks. Branch Expt. Station, Columbus Unit

Double-crop Tillage (*)	Full-Season Soybean Yield 1992	Full-Season Soybean Yield 10-yr Avg	Wheat Yield 1992	Wheat Yield 10-yr Avg
	bu/a			
Plow	35.8	26.4	65.6	51.7
Burn - Disc	34.7	25.9	62.2	49.8
Disc	34.4	25.7	65.7	51.6
Chisel-Disc	34.5	26.3	65.3	51.3
LSD (0.05)	NS	---	NS	NS

(*) All double-crop tillage treatments are chiseled in the spring prior to planting full-season soybeans, so the tillage method represents only the double-crop tillage effect from the previous year. After full-season soybean harvest, all plots are disced prior to planting wheat.
Five cropping cycles of a 2-yr rotation of wheat - doublecrop soybeans followed by full-season soybeans have been completed.

PERFORMANCE EVALUATION OF GRAIN SORGHUM HYBRIDS

Kenneth Kelley and Kraig Roozeboom[1]

Summary

Fifty-five grain sorghum hybrids were evaluated for agronomic performance. Average grain yield was 150 bu/a, ranging from 116 to 186 bu/a.

Introduction

Grain sorghum is an important feed crop in southeastern Kansas, especially on the shallow, upland soils. Performance tests provide farmers, extension workers, and private research and sales personnel with unbiased agronomic information on many hybrids marketed in Kansas.

Experimental Procedure

Fifty-five grain sorghum hybrids were evaluated in 1992 at the Parsons Unit. Hybirds were planted on May 5, 1992 and thinned to a desired population of 35,000 plants/a. Fertilizer applied included 115 lb N/a, 60 lb P_20_5/a, and 60 lb K_20/a. Furadan was applied in-furrow at planting for greenbug control. Ramrod/atrazine herbicide was applied preemergence for weed control. Hybrids were harvested with a modified Gleaner plot combine on October 1.

Results and Discussion

Excellent conditions during the growing season provided for outstanding yields. Test yields averaged 150 bu/a, with a range of 116 to 186 bu/a. Complete test results are compiled in the 1992 Kansas Performance Tests with Grain Sorghum Hybrids, Report of Progress 674, which is available in local county extension offices.

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SOYBEAN HERBICIDE RESEARCH

Kenneth Kelley

Summary

Various soybean herbicide treatments and application methods were compared for weed control in conventional and no-till conditions. In 1992, wet soil conditions delayed planting until late June; however, abundant rainfall after planting was ideal for both preemergent and postemergent herbicide applications. Early preplant applications were somewhat less effective in weed control because of the delay between herbicide application and planting.

Introduction

Soybeans occupy approximately 40% of the crop acreage in southeastern Kansas. Herbicide research studies are conducted to compare herbicide performance and application methods for the control of annual broadleaf and grassy weeds in soybeans. Because of the interest in conservation tillage practices, several studies evaluated herbicide performance in no-till conditions.

Experimental Procedure

Soybean herbicide trials were conducted at the Columbus Unit in 1992. Soybeans were grown in 30-inch row spacing. All treatments were applied with a tractor-mounted, compressed air sprayer, with a spray volume of 20 GPA. Plot size was 4 rows wide by 30' in length, with three replications. The center two rows of each plot were harvested for yield. Preplant treatments were incorporated with a field cultivator, equipped with a three-bar tine mulcher. Weed ratings were taken at 4 weeks after herbicide treatment.

Results and Discussion

No-till

No-till herbicide results are shown in Tables 1, 2, and 3. Soybeans were planted no-till into standing grain sorghum stubble. Early preplant applications gave variable results at the two sites. Where weed pressure was primarily small-seeded broadleaf and grassy weeds (Tables 1 and 2), early preplant (6 wks ahead of planting) and preplant (4 wks ahead of planting) applications gave good to excellent weed control. However, at the second site (Table 3), cocklebur was the primary broadleaf weed competitor. Early preplant applications gave poor weed control, and preplant treatments provided fair to good control. Because of abundant rainfall after planting, preemergent and postemergent applications generally gave good to excellent control of broadleaf and grassy weeds. Soybean yields were excellent and averaged over 30 bu/a. However, at one site, excess rainfall after planting resulted in moderate soybean crop injury and subsequent yield reduction where Canopy was applied preemerge. Pinnacle, applied postmerge in a tank-mix with Classic, also appeared to stunt soybean growth in 1992. More data are needed on no-till soybean weed control under various climatic conditions.

Conventional Tillage

Herbicide results with conventional tillage are shown in Tables 4, 5, 6, and 7. Results where broadleaf weeds (velvetleaf and cocklebur) were the primary competitors are shown in Table 5. Canopy tank-mixes, applied preplant or preemerge, gave good soil-applied weed control. Pursuit and Scepter, applied preplant or preemerge, provided only fair to good control of broadleaf weeds, but soybean yield was not significantly affected. In 1992, with abundant rainfall during the growing season, weed pressure did not reduce soybean yields to the extent that it would have in a drier year. All postemerge treatments gave excellent weed control. Weeds were less than 6" in height and actively growing at the time of herbicide application. The tank-mix combination of Classic + Pinnacle gave moderate soybean injury.

Table 6 shows results where cocklebur was the primary weed competitor. Scepter provided slightly better cocklebur control than Canopy when applied preplant or preemerge. Postemerge treatments were compared at reduced and conventional rates, with all treatments receiving one cultivation. Soybean yields were not affected by herbicide treatment or application method, even though a second flush of cockleburs emerged after the initial reduced-rate treatments were applied. Previous weed research has shown that when weeds emerge after soybeans have grown for 4 to 6 weeks, soybean yield normally is not affected.

Table 7 shows the comparison of postemerge herbicides at reduced and conventional rates, with and without cultivation. Primary weed competition was smooth pigweed and cocklebur. Broadleaf weed control was good to excellent with reduced herbicide rates (1/2x) applied 10 days after planting and followed by one cultivation compared to the conventional rate applied 21 days after planting. Applying a second 1/2x rate 12 days after the initial reduced rate generally improved weed control, but soybean yield was not increased. Two years of research data indicate that reduced rates (1/2x) of postemerge broadleaf herbicides can give acceptable weed control when they are applied 10 to 14 days after planting and weeds are actively growing. When weeds are drought stressed and herbicides are applied 3 to 4 weeks after planting, conventional rates should be used.

Table 1. Comparison of Soybean Herbicides and Application Methods Planted No-till, Southeast Ks. Branch Experiment Station, Columbus Unit, 1992

	Herbicide Treatment[1]	Product Rate	Soybean Yield	BL	GR	WA
			bu/a	%	%	%
1)	Roundup + Prowl + Canopy (EPP)	1 pt + 1.5 pt + 6 oz	37.6	96	99	97
	Roundup + NIS (AP)	1 pt + .25%				
2)	Roundup + Squadron (EPP)	1 pt + 3 pt	36.6	87	96	88
	Roundup + NIS (AP)	1 pt + .25%				
3)	Roundup + Prowl + Canopy (PP)	1 qt + 1.5 pt + 6 oz	36.0	94	93	87
4)	Roundup + Squadron (PP)	1 qt + 3 pt	38.8	90	95	90
5)	Roundup + Prowl (EPP)	1 pt + 1 qt	30.9	87	95	73
	Roundup + Canopy + NIS (AP)	1 pt + 6 oz + .25%				
6)	Squadron + Sun-it + 28%N (EPP)	3 pt + 1.5 pt + 1 qt	37.2	87	97	83
	Roundup + NIS (AP)	1 pt + .25%				
7)	Prowl + Canopy + Sun-it + 28%N	1.5 pt + 6 oz + 1.5 pt + 1 qt	34.2	95	98	93
	Roundup + NIS (AP)	1 pt + .25%				
8)	Roundup + 2,4-D,ester (PP)	1 qt + .5 pt	33.2	88	94	83
	Pursuit + Sun-it + 28%N (Post)	4 oz + 1.5 pt + 1 qt				
9)	Prowl + 2,4-D, ester (EPP)	1 qt + .5 pt	34.0	85	90	53
	Roundup + Canopy + NIS (AP)	1 qt + 6 oz + .25%				
10)	Control (No herbicide)	----	5.5	0	0	0
	LSD: (0.05)		2.7	8	6	8

1- EPP = early preplant (5/8), PP = preplant (5/29), AP = at planting (6/26), Post = postemerge (7/15)
BL = broadleaf (smooth pigweed and common cocklebur), GR = grass (crabgrass and fall panicum),
WA = winter annuals. NIS = nonionic surfactant.

Table 2. Comparison of Soybean Herbicides and Application Methods Planted No-till, Southeast Ks. Branch Experiment Station, Columbus Unit, 1992

	Herbicide Treatment[1]	Product Rate	Soybean Yield	BL	GR	WA
			bu/a	%	%	%
1)	Roundup (PP)	1 qt	29.6	88	97	87
	Lasso + Canopy + NIS (AP)	1.5 qt + 6 oz + .25%				
2)	Roundup (PP)	1 qt	29.9	92	96	93
	Dual + Canopy + NIS (AP)	1.5 pt + 6 oz + .25%				
3)	Roundup (PP)	1 qt	36.8	90	98	85
	Lasso + Scepter + NIS (AP)	1.5 qt + .66 pt + .25%				
4)	Roundup (PP)	1 qt	37.7	90	98	88
	Dual + Scepter + NIS	1.5 pt + .66 pt + .25%				
5)	Roundup + Lasso + Canopy (PP)	1 pt + 1.5 qt + 6 oz	38.6	92	87	82
6)	Roundup + Lasso + Scepter (PP)	1 pt + 1.5 qt + .66 pt	31.9	67	70	63
7)	Roundup + Lasso (PP)	1 qt + 2 qt	31.3	89	94	88
	Canopy + NIS (PRE)	6 oz + .25%				
8)	Roundup + Dual (PP)	1 qt + 1 qt	31.5	92	98	90
	Canopy + NIS (PRE)	6 oz + .25%				
9)	Roundup + Prowl (PP)	1 qt + 1 qt	33.8	92	97	93
	Canopy + NIS (PRE)	6 oz + .25%				
10)	Control (No herbicide)	----	8.0	0	0	0
	LSD: (0.05)		2.4	6	7	9

1- PP = preplant (5/29), AP = at planting (6/26), PRE = preemerge (6/26)
BL = broadleaf (smooth pigweed and common cocklebur), GR = grass (crabgrass and fall panicum), WA = winter annuals. NIS = nonionic surfactant.

Table 3. Comparison of Soybean Herbicides and Time of Application with No-Tillage, Columbus Unit, 1992

	Herbicide Treatment[1]	Product Rate	Soybean Yield	Bl	GR
			bu/a	%	%
1)	Squadron + Sun-it + 28%N (EPP)	3 pt + 1.5 pt + 1 qt	19.9	33	43
	Roundup + NIS (AP)	1 pt + .25%			
2)	Roundup + Squadron (EPP) +	1 pt + 3 pt	19.7	35	47
	Sun-it + 28%N	1.5 pt + 1 qt			
3)	Roundup + Squadron (PP) +	1 qt + 3 pt	34.7	73	77
	Sun-it + 28%N	1.5 pt + 1 qt			
4)	Roundup + Dual + Canopy (PP)	1 qt + 1.5 pt + 6 oz	36.0	77	70
5)	Roundup + Prowl (PP)	1 qt + 1 qt	36.8	83	87
	Pursuit + Cobra + NIS + 28%N (P)	4 oz + 6 oz +.25% + 1 qt			
6)	Roundup + Lasso (PP)	1 qt + 2 qt	24.5	78	63
	Classic + Pinnacle + NIS + 28%N (P)	.25 oz + .25 oz + .25% + 1 qt			
7)	Roundup + Dual (PP)	1 qt + 1 qt	33.4	68	75
	Basagran + Blazer + NIS + 28%N (P)	.75 pt + .75 pt + .25% + 1 qt			
8)	Canopy + Sun-it + 28%N (PP)	6 oz + 1.5 pt + 1 qt	35.3	93	37
	Roundup + Lasso (PRE)	1 qt + 2 qt			
9)	Roundup + 2,4-D, ester (PP)	1 qt + .5 pt	35.7	88	80
	Canopy + Sun-it + 28%N (PRE)	6 oz + 1.5 pt + 1 qt			
10)	Roundup + 2,4-D, ester (PP)	1 qt + .5 pt	34.3	96	90
	Lasso + Canopy + Sun-it + 28%N (PRE)	1.5 qt + 6 oz + 1.5 pt + 1 qt			
11)	Roundup + 2,4-D, ester (PP)	1 qt + .5 pt	39.6	86	87
	Lasso + Lorox(+) + Sun-it + 28%N (PRE)	1.5 qt + 14 oz + 1.5 pt + 1 qt			
12)	Control (No herbicide)	----	1.9	0	0
	LSD: (0.05)		2.8	7	8

1- EPP = early preplant (5/8), PP = preplant (5/29), PRE = preemerge (6/29), P = postemerge (7/15).
BL = broadleaf (smooth pigweed and common cocklebur), GR = grass (crabgrass and fall panicum).

Table 4. Comparison of Soybean Herbicides and Time of Application with Conventional Tillage, Columbus Unit, 1992

Herbicide Treatment[1]	Product Rate	Soybean Yield	BL	GR
		bu/a	%	%
1) Squadron (EPP)	3 pt	34.7	57	73
2) Squadron (PP)	3 pt	40.9	63	70
3) Dual + Canopy (PP)	1.5 pt + 6 oz	38.9	83	87
4) Prowl (PP)	1 qt	46.1	94	98
Pursuit + Cobra + NIS + 28%N (P)	4 oz + 6 oz + .25% + 1 qt			
5) Lasso (PP)	2 qt	39.2	90	90
Classic + Pinnacle + NIS + 28%N (P)	.25 oz + .25 oz + .25% + 1 qt			
6) Dual (PP)	1 qt	43.2	77	93
Basagran + Blazer + NIS + 28%N (P)	.75 pt + .75 pt + .25% + 1 qt			
7) Canopy (PP)	6 oz	42.5	85	92
Lasso (PRE)	2 qt			
8) Canopy (PRE)	6 oz	39.9	90	90
9) Lasso + Canopy (PRE)	1.5 qt + 6 oz	44.3	93	92
10) Lasso + Lorox(+) (PRE)	1.5 qt + 14 oz	44.6	90	90
11) Control (No herbicide)	---	27.8	20	53
LSD: (0.05)		2.8	7	8

1- EPP= early preplant (5/8), PP = preplant (5/29), PRE = preemerge (6/29), P = postemerge (7/15).
BL = broadleaf (smooth pigweed and common cocklebur), GR = grass (crabgrass and fall panicum).

Table 5. Comparison of Soybean Herbicides for Weed Control with Conventional Tillage, Columbus Unit, 1992

	Herbicide Treatment	Product Rate	Application Time	Soybean Yield	BL	GR
				bu/a	%	%
1)	Treflan + Canopy	1.5 pt + 6 oz	PPI	40.6	97	73
2)	Pursuit (+)	2.5 pt	PPI	39.4	58	90
3)	Squadron + Command	3 pt + 4 oz	PPI	39.8	73	60
4)	Salute + Scepter	2.25 pt + .33 pt	PPI	35.6	60	80
5)	Freedom + Scepter + Command	2.5 qt + .33 pt + 4 oz	Shal. PPI	40.6	73	80
6)	Lasso + Canopy	1.5 qt + 6 oz	Shal. PPI	40.4	93	87
7)	Lasso + Pursuit	1.5 qt + 4 oz	Shal. PPI	40.7	80	95
8)	Turbo + Scepter	1 qt + .33 pt	PRE	40.3	75	93
9)	Lasso + Canopy	1.5 qt + 6 oz	PRE	39.4	88	93
10)	Dual + Pursuit	1.5 pt + 4 oz	PRE	40.5	77	92
11)	Commence + Basagran	1 qt + 1 pt	PPI + Post	41.1	97	77
12)	Prowl + Pursuit	1.5 pt + 4 oz	PPI + Post	40.2	97	98
13)	Treflan + Basagran + Cobra	1.5 pt + 1 pt + .5 pt	PPI + Post	42.4	96	87
14)	Treflan + Classic + Pinnacle	1.5 pt + .25 oz + .25 oz	PPI + Post	33.9	93	70
15)	Cultivation Only	----	----	39.6	73	63
16)	Control (No herbicide)	----	----	18.2	0	0
	LSD: (0.05)			3.0	10	10

Shal PPI = shallow preplant incorporated (6/24),
PRE = preemerge (6/24), Post = postemergent (7/15).
BL = broadleaf (velvetleaf, smooth pigweed, and common cocklebur), GR = grass (crabgrass).
Nonionic surfactant (0.25% v/v) and 28 % N (1 qt/a) added to postemergent treatments.

Table 6. Comparison of Soybean Herbicides and Time and Method of Application on Soybean Yield and Cocklebur Control, Columbus Unit, 1992

	Herbicide Treatment	Product Rate	Application Time	Soybean Yield	COC
				bu/a	%
1)	Prowl + Canopy	1.5 pt + 6 oz	E-PPI	41.8	82
2)	Prowl + Scepter	1.5 pt + .66 pt	E-PPI	42.6	93
3)	Lasso + Canopy	1.5 qt + 6 oz	Shal. PPI	40.6	92
4)	Lasso + Scepter	1.5 qt + .66 pt	Shal. PPI	41.0	99
5)	Dual + Canopy	1.5 pt + 6 oz	PRE	42.1	87
6)	Dual + Scepter	1.5 pt + .66 pt	PRE	41.3	93
7)	Treflan + Basagran	1.5 pt + .5 pt	PPI + EP	41.3	75
8)	Treflan + Basagran	1.5 pt + 1 pt	PPI + Post	42.3	90
9)	Treflan + Basagran + Cobra	1.5 pt + .5 pt + .33 pt	PPI + EP	40.4	85
10)	Treflan + Basagran + Cobra	1.5 pt + 1 pt + .66 pt	PPI + Post	41.2	94
11)	Treflan + Classic	1.5 pt + .25 oz	PPI + EP	40.5	85
12)	Treflan + Classic	1.5 pt + .5 oz	PPI + Post	41.9	100
13)	Prowl + Pursuit	1.5 pt + 2 oz	PPI + EP	41.7	94
14)	Prowl + Pursuit	1.5 pt + 4 oz	PPI + Post	42.7	100
15)	Prowl + Scepter	1.5 pt + .166 pt	PPI + EP	42.4	94
16)	Prowl + Scepter	1.5 pt + .33 pt	PPI + Post	42.0	99
17)	Control (No herbicide)	----	----	18.7	0
18)	Cultivation only	----	----	32.9	60
19)	Hand weeded	----	----	43.0	99
	LSD: (0.05)			3.1	8

All herbicide treatments cultivated 28 days after planting.
EPPI = early preplant incorporated (5/27), Shal. PPI = shallow preplant incorporated (6/24),
EP = early postemerge (7/9), Post = postemerge (7/15).
Nonionic surfactant (0.25% v/v) added to all postemerge treatments.

Table 7. Comparison of Postemergent Soybean Herbicides and Time and Rate of Application on Soybean Yield, and Weed Control, Columbus Unit, 1992

	Herbicide Treatment	Product Rate	Application Time	Soybean Yield No Cult.	Soybean Yield Cult.	Weed Control No Cult.	Weed Control Cult.
			days	------ bu/a----		----- % ------	
1)	Basagran + Blazer	1 pt + 1 pt	Full-21	39.3	40.4	88	100
2)	Basagran + Blazer	.5 pt + .5 pt	Reduced-10	38.2	40.9	65	88
3)	Basagran + Blazer	.5 pt + .5 pt	Split-10+21	39.8	41.3	92	100
4)	Classic + Pinnacle	.25 oz + .25 oz	Full-21	38.5	38.2	100	100
5)	Classic + Pinnacle	.125 oz + .125 oz	Reduced-10	38.8	40.6	78	95
6)	Classic + Pinnacle	.125 oz + .125 oz	Split-10+21	37.9	38.4	100	100
7)	Scepter + Cobra	.33 pt + 6 oz	Full-21	40.7	41.6	100	100
8)	Scepter + Cobra	.166 pt + 3 oz	Reduced-10	39.6	41.0	73	96
9)	Scepter + Cobra	.166 pt + 3 oz	Split-10+21	39.5	40.8	100	100
10)	Pursuit	4 oz	Full-21	40.7	41.8	100	100
11)	Pursuit	2 oz	Reduced-10	40.1	39.1	87	100
12)	Pursuit	2 oz	Split-10+21	40.7	41.5	100	100
13)	Weed Free	---	---	41.4	43.5	100	100
14)	Control	---	---	31.8	39.9	0	60
	LSD: (0.05)			1.3	1.3	2	2

Herbicide date: full (7/22), reduced (7/9), split (7/9 and 7/22)
BL = broadleaf (smooth pigweed and common cocklebur). Cultivation date: (7/29)
Split-10+21 application received product rate at both 10 and 21 days after planting.
Postemerge grass herbicide (Fusilade 2000) applied to all plot for grass control.
Nonionic surfactant (0.25% v/v) and 28% N (1 qt/a) added to all postemerge treatments.

SHORT-SEASON CORN COMPARED TO GRAIN SORGHUM

James H. Long and Gary L. Kilgore[1]

Summary

Short-season corn has done as well as grain sorghum at two locations in Southeastern Kansas. The early planted crop spreads the work load and allows early harvest so that wheat can be planted in a timely fashion after the corn. Total receipts from short-season corn compare to those from grain sorghum. Higher variable costs of equipment needs and seed for corn should be considered.

Introduction

Short-season corn, those hybrids of 105 or less days relative maturity, can be a viable alternative crop for use in rotations that are planted back to wheat in the fall or where corn is needed for animal consumption. However, there is little information on how it compares to other summer-planted crops such as grain sorghum. This study was started to compare short-season corn to grain sorghum as a summer-planted crop. Comparisons were also made between cash returns per acre for corn and grain sorghum.

Experimental Procedure

Two corn hybrids, DK 535 and Pioneer 3737, were planted in early April. Grain sorghum, Oro G Xtra, was planted at two times to coincide as closely as possible to early May and early June target dates. Information in Table 1 indicates important dates for field operations. The soil was a Parsons silt loam. Both crops received 100 lb/a of N and 50 lb/a of P_2O_5 and K_2O fertilizer applied before planting. Lasso and atrazine herbicides were applied for weed control after planting. Both crops were monitored for blooming dates and maturity. Crops were harvested with a plot combine when grain was determined to be field ready. Yields were adjusted to a dry weight at 15% moisture for corn and 14 % moisture for grain sorghum and reported on a bushel basis appropriate for each crop. Test weight and grain moisture were measured with a Dickey-John analyzer.

Results and Discussion

Short-season corn generally performed as well as grain sorghum. The short-season corn outperformed the grain sorghum at Parsons in 1991 and yielded nearly the same as grain sorghum at Columbus (Figure 1). In the wet year of 1992, grain yields of both corn and grain sorghum were very good, with neither holding a distinct advantage. Cash returns for the crop, before costs, indicate that the short- season corn also compared favorably to the grain sorghum (Figure 2). However, variable costs for corn were greater than for grain sorghum, mainly because of higher costs for equipment and seed.

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[1]Southeast Kansas Area Extension Agronomist, Chanute.

Table 1. Dates of Operations for Corn and Grain Sorghum

Crop	Parsons		Columbus	
	Plant	Harvest	Plant	Harvest
	1991			
Corn	4/3	8/8	4/5	8/21
Grain Sorghum				
Early	5/9	8/20	5/14	9/9
Late	6/3	10/3	5/30	9/20
	1992			
Corn	3/30	9/15	4/3	9/16
Grain Sorghum				
Early	5/6	10/5	5/6	10/6
Late	6/19	10/21	6/25	11/9

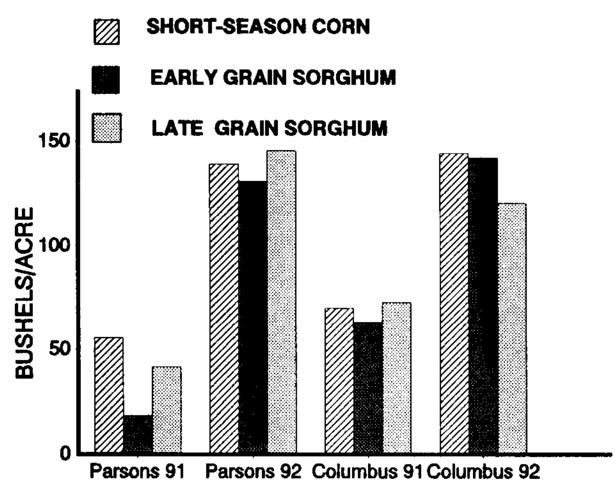

Figure 1. Grain Yield of Short-Season Corn and Grain Sorghum.

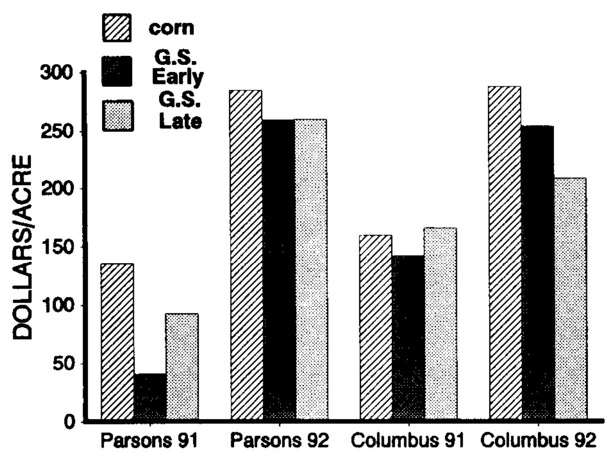

Figure 2. Short-Season Corn Compared to Grain Sorghum In S. E. Kansas. Returns on Grain Sales.

SOYBEAN VARIETY TRIAL FOR CYST NEMATODE RESISTANCE

James H. Long, William T. Schapaugh[1], Ted Wary[2] and Timothy Todd[3]

Summary

Soybean varieties with resistance to cyst nematodes had as much as twice the grain yield of varieties without such resistance at Columbus, Kansas in both 1991 and 1992. Severe drought occurred in 1991 whereas 1992 was a wet year. Several varieties in both Maturity Groups IV and V had very good yield potential and adequate soybean cyst nematode resistance. These could be used in suitable rotations to combat the pest.

Introduction

The appearance of soybean cyst nematode in Southeastern Kansas has complicated the production of soybeans by requiring a definite plan to combat the pest. Part of this planning is to use varieties that are resistant to the nematode. This requires identifying those varieties that are resistant and are also adapted to this region of the state. To achieve this for cyst nematode resistance an ongoing trial was established in an area of the state known to have damaging populations of the pest.

Experimental Procedure

Twenty varieties of soybeans, some rated as resistant to cyst nematode, were planted on June 17, 1991 and June 25, 1992 at the Soybean Cyst Nematode Research Area located on the Martin Farms in Columbus, Kansas. This is a dedicated area for the study of the soybean cyst nematode in southeastern Kansas. Seed were planted at 8 per row foot in 30-inch rows. Fertilizer application included 100 lb/a of 6-24-24 before planting in 1992. Maturities were rated in September and October, and plots were harvested with a plot combine on October 9, 1991 and November 11, 1992. Test weight and seed moisture were measured with a Dickey-John analyzer, and grain yields were adjusted to 13% moisture.

Results and Discussion

Varieties with resistance to soybean cyst nematode yielded 40% more grain than those that were not resistant in both 1991 and 1992 (Table 1). Resistant varieties such as 'Manokin' yielded nearly 29 bu/a over a 2 year period, whereas susceptible varieties such as 'Essex' have averaged only 15 bu/a during 1991 and 1992. Soybean maturity grouping may have also played a role in grain yield. The mid maturity group V 'Hutcheson' average 16.5 bu/a during that same period whereas the earlier maturing, late Group IV 'Stafford' yielded only 13.8 bu/a over the same period (Table 1). In 1992, Hutcheson yielded 21.4 bu/a whereas an early Group IV variety, 'Flyer', yielded 16 bu/a.

Growing conditions in 1991 were poor with extended drought all summer. Yields reflected the hot dry conditions ranging from 7.5 bu/a to 20

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[1]Soybean Geneticist, Department of Agronomy, KSU.

[2]Cherokee County Agricultural Extension Agent, Columbus.

[3]Nematologist, Department of Plant Pathology, KSU.

bu/a. Growing conditions were very good in 1992, with above average rainfall for the summer and cooler than normal temperatures.

A dry period in late July and early August hurt the cyst-susceptible soybean varieties due to a lack of root development. Test yields ranged from 16 bu/a to 39.5 bu/a.

Table 1. Grain Yield and Agronomic Traits of Cyst Nematode Resistant and Susceptible Soybean Varieties at the Martin Farm - Columbus, 1992

			Race Resistance[1]		Grain Yield			1992 Agronomic Characteristics		
Brand	Variety	MG[2]	1	3	1991	1992	2 yr	Mat.[3]	Ht.	Lodge[4]
					---------bu/a----------				-in-	
Asgrow	A4715	IV	S	R	--	32.4	--	38	29.7	1.5
Public	Flyer	IV	S	S	--	16.0	--	33	23.7	1.3
Public	Avery	IV/V	S	R	19.8	33.5	26.6	43	39.3	3.2
Public	Delsoy 4900	IV	R	R	17.3	35.7	26.5	50	38.1	3.2
Public	Manokin	IV/V	R	R	19.9	37.7	28.8	49	33.4	3.8
Public	Stafford	IV	S	S	9.6	18.0	13.8	47	25.1	1.2
Asgrow	XP5112	V	--	R	--	39.5	--	51	30.9	1.2
Asgrow	5403	V	--	R	--	37.3	--	54	31.6	2.6
Asgrow	5979	V	--	R	--	30.1	--	58	35.8	2.3
Pioneer	9521	V	--	R	15.7	38.0	26.8	52	35.0	3.5
Pioneer	9531	V	S	R	15.2	35.9	25.6	51	36.8	2.5
Pioneer	9551	V	--	R	--	34.2	--	55	33.1	2.2
Public	Bay	V	S	S	14.0	18.6	16.5	57	32.5	2.0
Public	Essex	V	S	S	7.5	22.4	15.0	52	25.6	1.0
Public	Forrest	V	R	R	20.0	34.5	27.3	57	37.2	3.4
Public	Hartwig	V	R	R	--	37.9	--	56	30.9	3.6
Public	Hutcheson	V	S	S	11.6	21.4	16.5	55	27.4	1.3
Public	KS 5292	V	S	R	14.3	38.1	26.2	53	33.8	2.8
Public	K81-27-278-22	V	--	--	--	34.8	--	52	31.8	1.7
Public	Rhodes	V	S	R	19.9	36.7	28.3	57	41.3	2.9
	Average				14.2	31.6	--	51	32.6	2.4
	L.S.D. (0.05)				2.9	5.5	--	2	3.8	.7

[1] Resistance to either race 1 or race 3 of the soybean cyst nematode.
[2] MG is the maturity grouping.
[3] Maturity is days after August 31; day 50 = October 20.
[4] Lodging on a scale of 1-5 with 1 being no lodging and 5 all plants down.

DOUBLE-CROP SOYBEAN VARIETY PERFORMANCE TRIAL

James H. Long and Gary L. Kilgore[1]

Summary

Twenty six double-crop soybean varieties were planted following winter wheat in Parsons, Kansas and evaluated for yield and other agronomic characteristics throughout the summer of 1992. Grain yields were very good, and variety differences were seen under these excellent growing conditions. Yields ranged from near 27 bu/a to 41 bu/a. The short-season MG (maturity group) III and IV varieties matured much earlier than the long-season varieties in MG V and were harvested earlier. Generally, the longer the MG the higher the pod set, although there were notable exceptions. 'Avery' matured in mid-October but set it's first pods much higher than other varieties maturing at the same time.

Introduction

Double-cropped soybean is an opportunistic crop grown after winter wheat over a wide area of southeast Kansas. Because this crop is vulnerable to weather-related stress, such as drought and early frosts, it is important that the varieties not only have high yield potential under these conditions but also have the plant structure to allow them to set pods high enough to allow harvest. They also should mature before a threat of frost.

Experimental Procedure

Twenty six soybean varieties were evaluated in a double-crop variety trial following winter wheat harvest at Parsons, Kansas on a Parsons silt loam soil. Wheat was harvested on June 18, 1992. The wheat stubble was burned and the soil field cultivated twice prior to planting. Squadron was applied at 3.0 pt/a before the field cultivations. Soybeans were then planted on June 29, 1992 at seven seed per foot of row. The soybeans were harvested October 23 and November 17, 1992. The latter date was for the MG V soybeans that matured after mid-October.

Results and Discussion

Yields ranged from 27.4 bu/a to 41.2 bu/a. Ohlde 4386, Golden Harvest H-1483, Pioneer 9521, KS5292, Stine 4390, Pioneer 9442, and Pioneer 9391 were in the top yield group. Careful consideration should be given to maturity and the height to the first pod. The height to the first pod ranged from 2.3 in to 7.3 in. The public variety 'Avery' had the first pods 7.3 in. from the ground. Most varieties matured before October 15; however, approximately 25% of those tested matured laterthan October 20 and ran the risk of being hit by frost.

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[1]Southeast Kansas Area Extension Agronomist, Chanute.

Table 1. Yield of Double-Crop Variety Trial Soybeans at Parsons, Kansas, 1992

Brand	Variety	MG	Yield	Agronomic Characteristics Ht.	Ht. to 1st pod	Test Wt.	Mat. Date
			-bu/a-	---------in--------		lb/bu	Oct.
Delange	DS-390	III	34.5	26.0	3.0	57.4	6.8
Delange	DS-455	IV	32.4	27.5	3.5	57.3	12.8
Dekalb	CX 415	IV	33.5	27.5	3.8	57.3	7.8
Dekalb	CX 458	IV	34.1	24.3	3.5	57.3	14.5
Golden Harvest	H-1483	IV	39.8	32.3	4.0	57.4	14.5
Golden Harvest	H-1407	IV	34.8	24.8	2.3	56.4	5.3
Northrup-King	S44-77	IV	35.6	27.0	3.5	56.2	8.0
NC+	3A81	III	30.4	25.5	3.5	55.9	5.0
NC+	5H61	V	33.2	29.0	7.0	58.1	25.8
Ohlde	5660	V	34.6	30.0	6.5	56.9	25.5
Ohlde	5850	V	33.9	36.0	8.8	59.3	28.0
Ohlde	4386	IV	41.2	31.3	4.0	57.6	14.0
Pioneer	9442	IV	37.0	23.5	3.8	56.7	5.3
Pioneer	9521	V	38.6	31.0	7.0	58.7	23.3
Pioneer	9391	III	37.4	28.0	3.8	56.7	5.3
Dynagro	3340	III	27.4	23.0	3.0	56.4	3.5
Dynagro	UAP-X-75	--	33.5	25.0	2.3	56.6	7.0
Dynagro	3371	III	32.2	21.5	2.5	56.6	3.8
Jacques	467	IV	35.7	25.3	3.3	57.8	14.3
Jacques	396	III	36.8	27.0	3.3	56.6	5.5
Stine	4390	IV	37.5	19.5	3.3	59.1	15.3
Terra	TS 402	IV	33.5	23.5	2.3	56.5	5.0
Terra	Cycle	III	33.0	24.5	3.0	57.2	2.8
Public	Flyer	III	32.5	22.3	3.0	57.0	6.3
Public	Avery	IV	33.5	34.5	7.3	57.6	16.5
Public	KS5292	V	38.3	28.3	7.0	57.3	25.8
(L.S.D. 0.05)			5.1	2.4	.8	.7	1.5

VARIETY RESISTANCE AND ROTATIONS FOR SOYBEAN CYST NEMATODE

James H. Long and Timothy Todd[1]

Summary

The keys to reducing the effect of soybean cyst nematode are the management techniques of using resistant soybean varieties and rotation of crops to minimize its impact. Results from the cyst nematode management studies at the Martin Farms Research Area in Columbus indicate that the effect of using resistant varieties is much greater than previously thought. Rotation also reduces the impact of the cyst nematode. However, results from only 2 years show that holding a field out of susceptible soybean varieties for 1 year is not sufficient time to overcome the problem.

Introduction

The soybean cyst nematode is a serious problem in the eastern U.S. It is persistent in the soil and will continually rob soybean yield if good management practices are not used each year. Many cropping strategies including resistant varieties have been used to overcome this pest, yet it has now spread to Kansas.

Each region of the U.S. has had to develop locally adapted soybean varieties and cropping rotations suited for that area's agricultural soils and climate. Southeast Kansas is a region with shallow clay-pan soils that are drought prone and a climate that permits growth of long maturity crops such as MG (maturity group) V soybeans. Because of the need to develop cropping strategies and evaluate varietal resistance under southeast Kansas conditions, a study was started in 1991 at the Martin Farms Cyst Nematode Research Area near Columbus, Kansas.

Experimental Procedure

Five rotations ranging from 0 to 3 years out of susceptible soybeans and with no soybeans were started in 1991. The rotations include:

1. Continuous susceptible soybeans.
2. Grain sorghum followed by susceptible soybeans (1 year out).
3. Grain sorghum followed by a small grain that is followed by susceptible soybeans (2 years out).
4. Grain sorghum followed by resistant soybeans followed by grain sorghum then susceptible soybeans (3 years out).
5. Grain sorghum followed by a small grain that is double-cropped to resistant soybeans followed by grain sorghum then a small grain double-cropped to susceptible soybeans (3 years out).
6. Grain sorghum followed by a small grain (no soybeans).

The susceptible soybean variety was 'Bay' and the resistant variety was 'Pioneer 9531', both early MG V soybeans. Two sister studies with the same rotations were run. One was on heavily infested soils at the Martin Farms Cyst Nematode Research Area, and the second was at the Southeast Branch Experiment Station -

[1]Nematologist, Department of Plant Pathology, KSU.

Columbus Field, an area that has no detectable levels of the cyst nematode.

Results and Discussion

After only 2 years, striking differences can be seen in 1992 (Figure 1). The continuous susceptible 'Bay' soybeans at Martin Farms yielded only a third as much as the resistant variety, 'Pioneer 9531', that is being grown in rotation, and only 50% as much as the 'Bay' variety that is being grown in rotation. After 2 years, these rotations have been held out of soybeans only one year. That is contrasted with the Columbus field, where a smaller difference in yield was seen when no rotation was used. The large difference in grain yields is mirrored by equally large differences in egg and cyst counts for each rotation at the Martin Farms Area (Table 1). The continuous 'Bay' variety ended 1992 with 50 times the eggs/100 cm^3 of the 'Pioneer 9531' in rotation.

While it is still to early to draw conclusions about individual rotations in the study, large general rotation effects of increased grain yield and reduced cyst nematode counts and large additive effects of using a resistant variety can be seen.

Table 1. Effect of Rotation and Soybean Variety on the Numbers of the Soybean Cyst Nematode Following the 1992 Crop Year - Martin Farms Rotation Study

Treatment	Eggs	cysts
	-------no/100 cm^3-------	
Continuous-Bay	109,600	452
One year out-Bay	58,524	198
One year out-P-9531	2,195	12
L.S.D. (0.05)	29,490	108

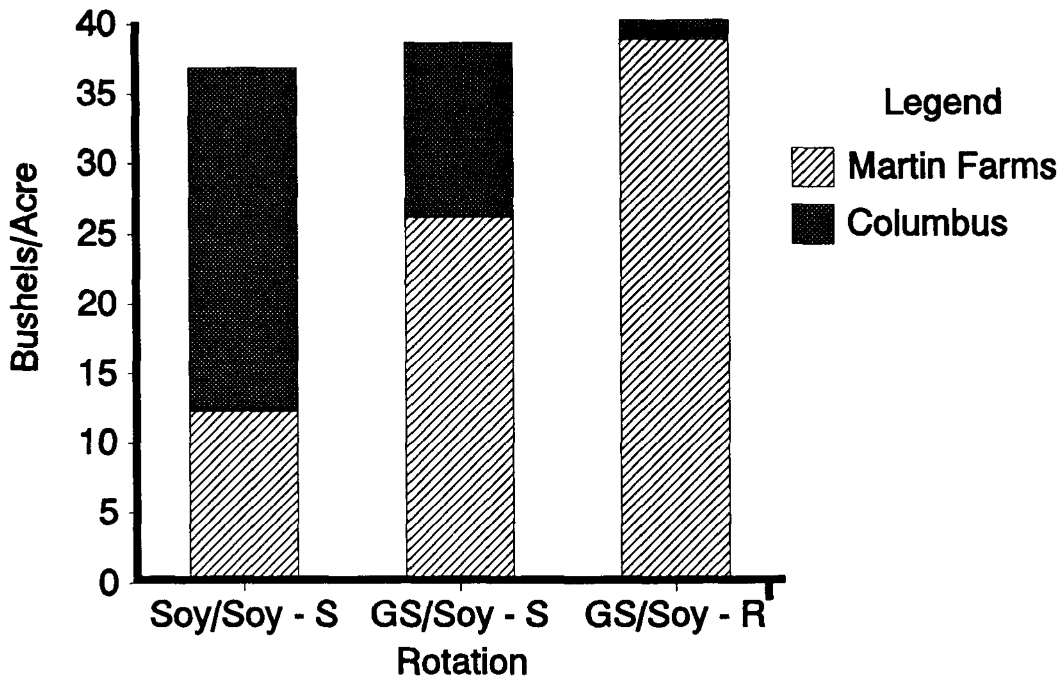


Figure 1. Effect of Rotation and Variety Resistance on Soybean Yield when Grown on Infested and Uninfested Soils.

ANNUAL WEATHER SUMMARY FOR PARSONS - 1992

Mary Knapp[1]

1992 DATA

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Avg. Max	47.0	54.0	60.2	66.8	73.1	78.9	86.7	80.9	78.9	71.2	50.0	44.8	66.0
Avg. Min	28.1	36.1	37.5	44.3	53.7	61.2	68.5	61.7	56.6	43.8	36.5	27.3	46.3
Avg. Mean	37.5	45.1	48.8	55.6	63.4	70.1	77.6	71.3	67.7	57.5	43.3	36.0	56.1
Precip	0.75	1.85	1.58	3.86	3.23	4.74	13.39	1.76	5.94	1.36	6.8	5.57	50.83
Snow	0	0	0	0	0	0	0	0	0	0	5	2	7
Heat DD*	852	579	502	305	121	24	0	12	67	246	653	898	4256
Cool DD*	0	1	0	21	71	173	391	206	149	12	0	0	1023
Rain Days	7	6	8	8	11	10	9	9	10	6	14	9	107
Min < 10	0	0	0	0	0	0	0	0	0	0	0	0	0
Max >= 90	0	0	0	0	0	2	7	1	0	0	0	0	10
Min =< 32	22	11	10	3	0	0	0	0	0	0	10	24	80

NORMAL (1951-1980 Average)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Avg. 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
Avg. 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
Avg. 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	4.8	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

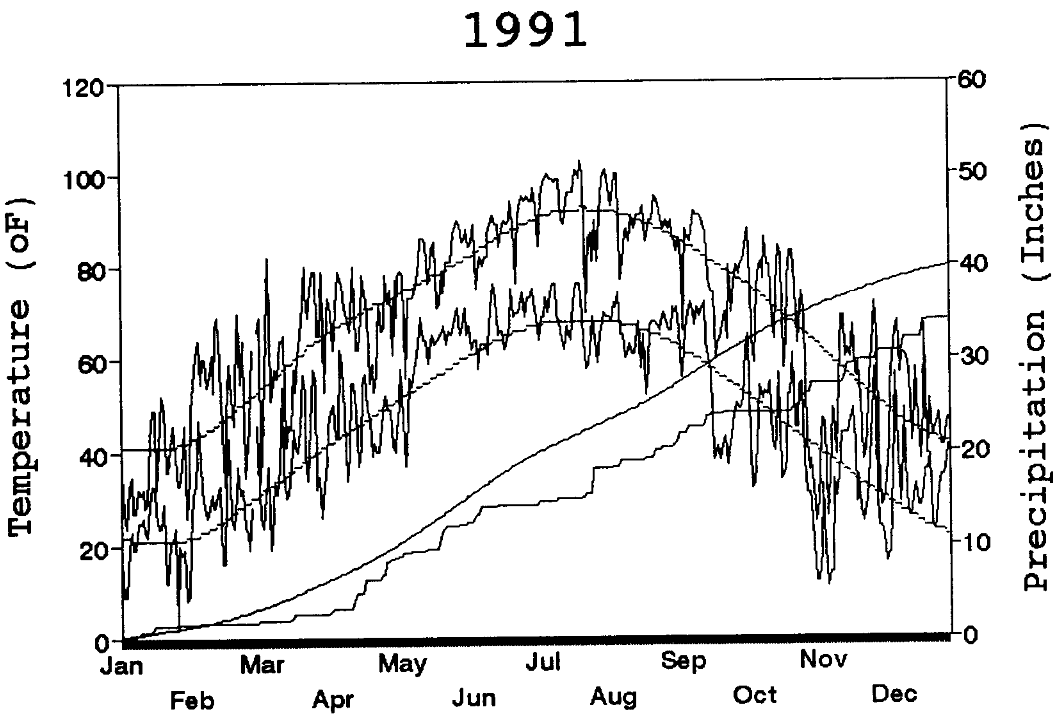
DEPARTURE FROM NORMAL

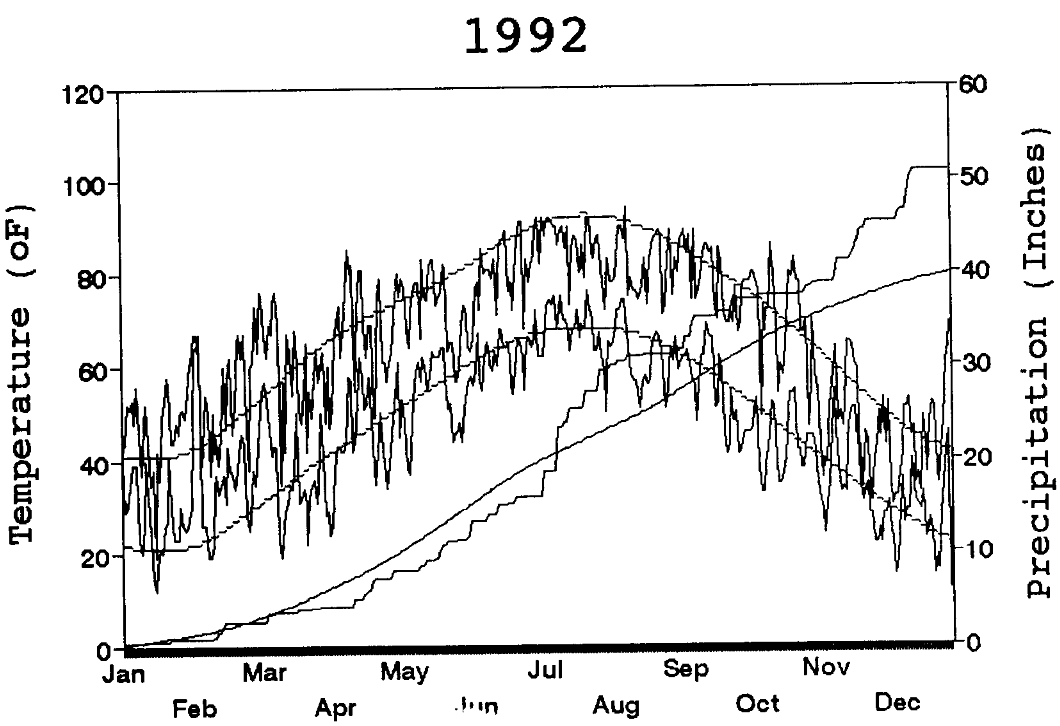
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Avg. Max	4.2	4.7	1.6	-4.0	-5.7	-8.3	-6.4	-11.3	-5.1	-2.4	-7.9	-2.5	-3.6
Avg. Min	5.5	8.5	2.0	-2.9	-2.8	-3.7	-1.0	-5.9	-3.7	-5.2	-0.3	-0.5	-0.8
Avg. Mean	4.8	6.6	1.7	-3.5	-4.3	-6.0	-3.7	-8.6	-4.4	-3.8	-4.1	-1.6	-2.3
Precip	-0.47	0.51	-1.40	0.14	-1.95	-0.06	9.74	-1.67	1.41	-2.11	4.26	3.92	12.32
Snow	-2	-3	-2	0	0	0	0	0	0	0	3	2	-2
Heat DD*	-150	-163	-63	96	62	18	0	12	43	73	125	49	100
Cool DD*	0	1	-10	-8	-72	-167	-115	-256	-89	-46	0	0	-761

* Daily values were computed from mean temperatures. Each degree that a day's mean temperature is below (or above) 65E F is counted as one heating (or cooling) degree day.

[1]Assistant Specialist, Weather Data Library, KSU.

WEATHER SUMMARY FOR PARSONS





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