SOUTHEAST FARM PROGRESS REPORT 1996

This thirty-sixth annual report of the research program at the Southeast South Dakota Research Farm has special significance for those engaged in agriculture and the agriculturally related businesses in the ten county area of Southeast South Dakota. The results shown are not necessarily complete or conclusive. Interpretations given are tentative because additional data resulting from continuation of these experiments may result in conclusions different from those based on any one year.

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Brookings, SD 57007

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INTRODUCTION--- Robert K. Berg

Welcome to our 36th Annual Progress Report. This publication summarizes many of the research and demonstration projects conducted here during 1996. It represents thousands of hours of hard work and cooperation between our staff and various agricultural disciplines at South Dakota State University. I would like to take this opportunity to recognize Ruth Stevens, our Secretary from Centerville, for earning her 15-year Career Service Award this fall. Her dedication and many talents contribute greatly to the success of Southeast Research Farm and the South Dakota Agricultural Experiment Station and we truly appreciate her outstanding service. In addition, we are also grateful for valuable contributions made by Bryan Stevens and Matt Jurgensen, who worked for us this summer.

Temperatures and precipitation for 1996 are presented on page 1. Long-term comparisons for this year are based on 43-yr, instead of 30-yr, averages to reflect an extra decade of climatic data. For comparison, the 30-yr annual averages are 4 and 2°F warmer for maximum and minimum air temperatures, respectively and precipitation was 1 inch wetter than the 43-yr annual averages.

Our annual precipitation was 29 inches (3 inches above normal). Of this, 75% or 21.5 inches (2 inches above normal) arrived during the growing season (April - September). We accumulated a total of 2739 growing degree units (86% of normal) from April through October. The coldest day this year was -26°F on February 2 and 3 and the hottest temperature recorded was 94°F on June 29. The last freeze this spring occurred on April 30 (24°F) and the first fall freeze on October 3 (29°F) providing 163 frost free days (32°F basis). We measured a total of 27.75 inches of snow in 1996 with 12.75 inches from January through June and 15 inches since July.

Our climate was mild and somewhat dry during most of the year. Only February, June and early fall had warmer than average monthly air temperatures (+2 to 4°F). Other months were 1 to 4° F below normal until it really cooled down in late fall (5 to 10° F below normal). February through April were relatively favorable for early spring plantings of small grain, alfalfa, and corn even though temperatures stayed cool. May was quite wet making it a challenge to plant soybean and much of the remaining corn. Cumulative precipitation was 2 to 3.5 inches less than normal throughout most of the growing season. Rainfall distribution was normal from June through August until September rains brought us up to normal for the year to date. Winter arrived in mid

November with ice, snow, strong winds, and dangerous wind chills making it impossible to finish harvesting a few corn fields in the surrounding area.

Soil moisture levels were good going into the growing season because of surplus precipitation in 1995. A mild summer coupled with a relatively long mild fall resulted in excellent production of all crops even though grasshoppers and European corn borer pressures were moderate to heavy again this year. Abundant precipitation in September and November have replenished soil moisture reserves for next year. Cattle prices remained very low again, however, market prices recovered for swine and crop prices set record or near record highs.

Our livestock research evaluated ways to utilize co-products of ethanol production in beef and swine rations suitable for commercial feedlot and confinement operations. Pork production using early-weaning management strategies for single source vs. commingle genetics (preliminary study) and disease evaluation was also investigated. Crop research was started to examine the effectiveness of several Bt corn hybrids and other types of new crop genetic and weed control strategies. Several additional counties in Southeast South Dakota were identified with soybean cyst nematode and its impact in 1996 is reported. A year ago we began using precision farming technology and these efforts were continued and are expanding with assistance from the SD Corn and Soybean Associations. Soil fertility research was initiated to evaluate nitrogen management for CRP fields and new types of liquid starter fertilizers. Several experiments designed to investigate row spacings, plant populations, planting dates, develop new varieties, evaluate crop performance, disease, and tillage systems are also discussed.

Our pesiticide and fertilizer storage facilities were upgraded this year. A larger used combine with a yield and moisture monitor was purchased. We also tested variable rate planting equipment and are attempting to upgrade some computer equipment.

Please feel free to stop by and visit whenever you can. Let us know if we can be of assistance in any way. We can be reached by mail or telephone at:

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Table 1. Air temperatures at the Southeast Research Farm - 1996

Month	1996 Average Air Temps.(°F)[a]		43-year Average Air Temps. (°F)		Departure from 43-year Average	
	Maximum	Minimum	Maximum	Minimum	Maximum	Minimum
January	22.3	2.3	24.9	4.6	-2.6	-2.3
February	35.0	11.7	30.7	10.4	+4.3	+1.3
March	38.7	13.6	41.8	21.6	-3.1	-8.0
April	56.5	28.4	57.7	33.4	- 1.2	-5.0
May	65.0	46.0	69.4	45.3	-4.4	+0.7
June	80.7	59.4	78.5	54.9	+2.2	+4.5
July	80.2	57.6	82.6	59.0	-2.4	-1.4
August	80.0	58.3	81.1	56.6	-1.1	+1.7
September	69.5	49.3	72.0	46.5	-2.5	+2.8
October	63.7	35.4	61.2	36.0	+2.5	-0.6
November	33.2	17.4	42.6	22.5	-9.4	-5.1
December	19.8	3.6	29.0	10.9	-9.2	-7.3

[a]Computed from daily observations

Table 2. Precipitation at the Southeast Research Farm - 1996

Month	Precipitation 1996 (inches)	43-year Average (inches)	Departure from Avg. (inches)
January	0.53	0.47	+0.06
February	0.01	0.88	-0.87
March	0.78	1.55	-0.77
April	0.49	2.50	-2.01
May	4.95	3.49	+1.46
June	3.89	4.14	-0.25
July	3.87	3.42	+0.45
August	2.93	3.00	-0.07
September	5.36	2.68	+2.68
October	1.42	1.73	-0.31
November	3.88	1.20	+2.68
December	0.69	0.66	+0.03
Totals	28.80	25.72	+3.08

TILLAGE & CROP ROTATIONS FOR SOUTHEAST SOUTH DAKOTA

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Southeast Farm 9601

INTRODUCTION

This research project has evaluated the feasibility of seven cropping systems in southeastern South Dakota since 1991. Our primary goal is to compare the production and economics of no-till and conventional tillage systems using multiple crop rotations. Ridge-till, in a two-crop rotation, is also evaluated. During the project's first 5 years tillage systems were established and one or more cycles completed for each crop rotation. Alfalfa was initially managed as an annual and later a biennial crop. Reduced inputs in a conventionally tilled four-crop rotation were also evaluated by restricting the use of fertilizers and herbicides in system 6. Extremely wet weather made it impossible to plant any crop in 1993 and greatly delayed planting of alfalfa, corn, and wheat in 1995. Results from these previous years are summarized in our 31st, 32nd, 34th, and 35th Annual Research Progress Reports. This information can help producers select or modify cropping strategies based on long term systems-based research.

Table 1. Tillage and crop rotation systems. Southeast Research Farm; Beresford, SD; 1996.

System	Tillage	Crop Rotation
1	No-Till (NT)	Corn-Soybean (C-S)
7	Ridge-Till (RT)	Corn Soybean (C-S)
2	Conventional (CT)	Corn-Soybean (C-S)
3	No-Till (NT)	Corn-Soybean-Wheat (C-S-W)
4	Conventional (CT)	Corn-Soybean-Wheat (C-S-W)
5	No-Till (NT)	Corn-Soybean-Wheat-Oat/Alf (C-S-W+OA)
6	Conventional (CT)	Corn-Soybean-Wheat-Oat/Alf (C-S-W+OA)

METHODS

Our research strategy was slightly modified in 1996. Fertilizers and herbicides are now being used in system 6 so it can be managed as a more traditional conventional tillage system and we intend to keep alfalfa stands established longer. These modifications should allow a more thorough investigation of the interaction between the factors of tillage methods and crop rotations. Doug Franklin, an SDSU Agricultural Economist, is also using data collected from this project to summarize the long-term trends of these systems more extensively***.***

Table 1 outlines the seven cropping systems used in this study. No-till (NT) systems are raised without tillage or cultivation. Primary tillage for the conventional (CT) system consists of chiseling corn stalks and small grain stubble after harvest and either field cultivating or disking soybean residue in the spring as needed to incorporate fertilizer and herbicide during seedbed preparation. Row crops are planted on ridges in the ridge-till (RT) system using row cleaners to displace corn residue, herbicide is banded over the row at planting, and weeds between rows are controlled by cultivation. The two-crop systems (C-S) are corn-soybean rotations. Three-crop systems (C-S-W) have corn then soybean followed by spring wheat. Four-crop systems (C-S-W+OA) consist of the three-crop rotation plus alfalfa managed as a long-term forage crop that was established this year with an oat nurse crop.

Field operations were performed using commercial-sized farm equipment as outlined in Table 2. Spring wheat, oat, alfalfa, and most soybean were drilled at 7.5-inch row widths. Corn and RT soybean were established at 30-inch row widths using an Accuplantä hydraulic variable rate controller (Rawson Control Systems, Inc.; Oelwein, IA) mounted on a six-row planter. DeKalb 127 alfalfa was drilled at 15 lb/ac with 'Jerry' oat at 1.5 bu/ac as a nurse crop. 'Sharp' spring wheat was drilled at 1,400,000 seeds/ac. DeKalb 560 corn was planted at 27,000 seeds/ac. 'Sturdy' soybean was drilled at 210,000 seeds/ac in NT and CT systems with RT planted at 175,000 seeds/ac.

Table 3 summarizes planting dates as well as fertilizer and herbicide applications for 1996. Liquid fertilizer was broadcast before planting as 10-34-0 and 28-0-0 for yield goals of 180 bu/ac corn, 50 bu/ac soybean and wheat, and 5 ton/ac alfalfa based on fall soil samples collected from every plot in 1995 (SDSU Soil Testing Laboratory; Brookings, SD). Corn was later sidedressed by injecting 28-0-0 between alternate rows and broadcast sprayed for first-generation European corn borer (ECB) with liquid Pounce at 6 oz/ac.

Table 2. Field operations for tillage and crop rotation systems. Southeast Research Farm; Beresford, SD; 1996.

Tillage System	1996 Crop Rotation	Before Planting	After Planting	After Harvest
NT	Corn	spray	spray	
	Soybean	spray	walk	
RT	Corn		spray, cultivate (2x)	
	Soybean		cultivate (2x), bean buggy, walk	
CT	Corn	disk, spray, field cultivate (2x)	cultivate	fall chisel
	Soybean	fall chisel corn stalks, disk, spray, field cultivate (2x)	walk	
NT	Corn	spray	spray	
	Soybean	spray	walk	
	Wheat		spray	spray (2x)
CT	Corn	disk, spray, field cultivate (2x)	cultivate	fall chisel
	Soybean	fall chisel corn talks, disk, spray, field cultivate(2x)	walk	
	Wheat	field cultivate (2x)	spray	spray (2X), fall chisel
NT	Corn	spray	spray	
	Soybean	spray	walk	
	Wheat		spray	spray (2x)
	Oat+Alfalfa		spray, mow, harvest	
CT	Corn	disk, spray, field cultivate (2x)	cultivate	fall chisel
	Soybean	fall chisel corn stalks, disk, spray, field cultivate (2x)	walk	
	Wheat	field cultivate (2x)	spray	spray (1x), fall chisel
	Oat+Alfalfa	field cultivate (2x)	spray, mow, harvest	

All plots were fertilized, planted, harvested, and soil sampled; Corn stalks were chopped after harvest.

Table 3. Herbicide and fertilizer rates for tillage & rotation system study. Southeast Research Farm; Beresford, SD; 1996

Tillage & Rotation	Crop	Planting Date	$N\text{-}P_2O_5\text{-}K_2O$[1] (lb/ac)	Herbicide (material/ac)[2]
NT C-S	C	April 26	167-64-0	1.6 lb Bladex + 0.5 lb Atrazine, PP; 1.5 lb Bladex, POST
	S	May 8	13-45-0	4 oz Pursuit + 2 pt Prowl, PP
RT C-S	C	April 26	165-90-0	2.5 pt Dual II, Banded PRE; 1 pt Buctril, POST
	S	May 9	13-45-0	2.5 pt Dual II, Banded, PRE
CT C-S	C	April 26	136-45-0	2.5 pt Dual II + 0.9 lb Atrazine, PPI
	S	May 8	13-45-0	1.5 pt Treflan + 4 oz Pursuit, PPI
NT C-S-W	C	April 26	198-45-0	1.6 lb Bladex + 0.5 lb Atrazine, PP ; 1.5 pt Roundup, PRE; 1.5 lb Bladex, POST
	S	May 8	13-45-0	4 oz Pursuit + 2 pt Prowl, PP
	W	April 19	113-37-0	1 pt Bronate, POST; 1 pt Roundup + 1 pt 2,4-D, AH1; 2 pt Roundup, AH2
CT C-S-W	C	April 26	151-45-0	2.5 pt Dual II + 0.9 lb Atrazine, PPI
	S	May 8	13-45-0	1.5 pt Treflan + 4 oz Pursuit, PPI
	W	April 18	82-37-0	1 pt Bronate, POST; 1 pt Roundup + 1 pt 2,4-D, AH1; 2 pt Roundup, AH2
NT C-S-W+OA	C	April 26	110-60-0	1.6 lb Bladex + 0.5 lb Atrazine, PP; 1.5 pt Roundup, PRE; 1.5 lb Bladex, POST
	S	May 8	13-45-0	4 oz Pursuit + 2 pt Prowl, PP
	W	April 19	88-37-0	1 pt Bronate, POST; 1 pt Roundup + 1 pt 2,4-D, AH1; 2 pt Roundup, AH2
	OA	April 19	17-56-0	4 oz Pursuit, POST
CT C-S-W+OA	C	April 26	80-60-0	2.5 pt Dual II + 0.9 lb Atrazine, PPI
	S	May 8	15-52-0	1.5 pt. Treflan + 4 oz. Pursuit, PPI
	W	April 18	73-37-0	1 pt Bronate, POST; 1 pt Roundup + 1 pt 2,4-D, AH1; 2 pt Roundup, AH2
	OA	April 18	17-56-0	4 oz Pursuit, POST

[1] Liquid fertilizer applied as 10-34-0 and 28-0-0.
[2] PP = Preplant, PPI = Preplant Incorporated, PRE = Preemerge, POST = Post emerge, AH = After Harvest (1=Aug 15, 2=Oct 15)

Percentage of the 1995 crop residue that overwintered was measured for each plot before and after planting. Stand counts (except alfalfa) and plant height (wheat and soybean) were recorded before harvest. Production was measured at harvest by weighing the entire crop for each plot. Wheat and soybean grain was weighed in a weigh wagon with moisture content and test weight recorded and samples were submitted for protein and oil analyses. Corn yield and moisture were determined using a combine yield monitor with a differential global positioning system (DGPS). Alfalfa was sprayed for mid-season weed control, mowed 3 weeks later to keep the remaining oat from shading young alfalfa seedlings, then hayed in late August. Spring wheat straw and alfalfa hay were weighed and stored as large round bales.

Cropping systems are planted in the same location every year with crops rotated as needed. The proper combination of tillage and crop rotation systems require twenty treatments. Each treatment is replicated four times in a randomized block experimental design and the size of each plot is 0.4 ac (60 ft x 300 ft). Comparisons among systems for measured agronomic responses are based on treatment averages by using Least Significant Differences (LSD) at the 90% probability level. Coefficient of Variation (CV) is a measure of the variability associated with a particular response and should generally be less than 15% to be considered reliable.

Economic analyses by crop are based on the actual inputs and yield for each system. Crop revenues are determined using local cash prices with all commodities marketed at harvest. Variable and fixed costs including depreciation are compared on a per acre, per bushel (or ton), and whole farm basis (Maximum Economic Yield Analysis Software; Potash and Phosphate Institute; Atlanta, GA; Version 2.0). Income and production costs for grain and straw were both included for spring wheat. This was accomplished in the spreadsheet by adding extra bushels of grain to the yield that would equal the value of the straw produced by each system (adjusted yield). Equipment inventory and costs commonly used for each type of tillage system suitable for a 640-ac cash grain farm are shown in Table 4.

Table 4. Tillage and crop rotation system, equipment inventories. Southeast Research Farm; Beresford, SD; 1996.

	Tillage System		
Equipment	No-Till	Ridge-Till	Conventional
120-HP Tractor	45,000	45,000	45,000
70-HP Tractor	17,000	17,000	17,000
No-Till Drill 15 ft	20,000		
30" Planter 6-Row	10,000		10,000
Sprayer 45 ft	2,500	2,500	2,500
Fertilizer Applicator 6-row	2,500		
Ridge-Till Planter 6-row		14,000	
Ridge-Till Cultivator 6-row		12,000	
Chisel 13 ft			2,000
Tandem Disk 18 ft			9,000
Field Cultivator 19 ft			8,500
Drill 15 ft			6,000
Cultivator 6-row			4,500
Total Equipment Cost	$97,000	$90,500	$104,500

RESULTS AND DISCUSSION

Agronomic

Soil test results from last fall (1995) were similar among all seven cropping systems in terms of pH (6.3), organic matter (3.9%), available phosphorus (14 lb P/ac) and potassium (806 lb K/ac), and soluble salts (0.5 mmho/cm). Residual soil nitrogen levels, however, tended to be higher for four-crop rotations (50-60 lb NO_3-N/ac) than the two- or three-crop systems (30-40 lb NO_3-N/ac). Early spring planting conditions were drier than normal this year which was relatively favorable for establishing alfalfa, small grain, and corn through April. Very wet weather in May made planting soybean more challenging. Cool temperatures throughout the growing season delayed crop emergence and growth, however, crop yields were above average when harvested and yield goals for wheat, soybean, and corn were achieved except in the ridge-till system.

Crop residue levels are shown in Tables 5 through 8. Only no-till and ridge-till systems had the 30% recommended minimum levels of 1995 crop residue cover after planting to protect against soil erosion for this year’s corn and wheat. All systems, however, maintained enough corn residue for establishing soybean. Residue cover was very low where alfalfa was established primarily because these fields were packed after planting to obtain a firm seedbed.

Final corn populations were relatively consistent among the cropping systems (Table 5). Corn yield ranged from 157 to 195 bu/ac and was lowest in the ridge-till system. Grain yield increased an average of 7 to 10 bu/ac as the number of crops in the system increased (173 vs. 183 vs. 190 bu/ac) and was more pronounced in the NT vs. CT systems. Grain moisture at harvest averaged 20 to 22%. The three-crop rotations dried down slower than the other rotations .

Table 5.Effects of tillage and crop rotation systems on corn production. Southeast Research Farm; Beresford, SD; 1996.

Tillage	Rotation	Past Crop	Stand Count	Grain Yield[1]	Moisture Content	Crop Residue	
						4-16-96	6-7-96
			plts/ac	bu/ac	%	%	%
NT	C-S	Soybean	21,500	169	20.9	82	65
RT	C-S	Soybean	22,000	157	20.3	72	47
CT	C-S	Soybean	23,500	178	19.9	71	24
NT	C-S-W	Wheat	22,300	188	22.3	89	63
CT	C-S-W	Wheat	21,600	179	21.7	33	11
NT	C-S-W+0A	Alfalfa	25,100	195	21.5	86	57
CT	C-S-W+OA	Alfalfa	23,300	185	21.2	25	07
Avg			22,800	178	21.1	65	39
$LSD_{0.10}$			NS[2]	11	1.3	10	09
CV (%)			11.4	5.0	4.9	13	19

[1] Grain yield at 15% moisture and 56 lb/bu test weight, harvested Oct 11 & 22, 1996
[2] NS = not significant

Table 6. Effect of tillage and crop rotation systems on soybean production. Southeast Research Farm; Beresford, SD; 1996.

Tillage	Rotation	Past Crop	Plant Height	Stand Count	Grain Yield	Moisture Content	Crop Residue	
							4-16-96	6-7-96
			inch	plts/ac	bu/ac	%	%	%
NT	C-S	Corn	40	156,000	52	10.7	75	72
RT	C-S	Corn	33	152,000	41	10.5	76	48
CT	C-S	Corn	37	170,000	53	10.6	37	37
NT	C-S-W	Corn	34	156,000	47	10.7	90	71
CT	C-S-W	Corn	34	174,000	52	10.7	41	31
NT	C-S-W+OA	Corn	38	161,000	53	11.1	80	64
CT	C-S-W+OA	Corn	39	178,000	54	10.7	85	34
Avg			34	164,000	50	10.7	62	51
$LSD_{0.10}$			NS[2]	NS	3	0.3	9	11
CV (%)			18	14.76	5	2.4	12	18

[1] Grain yield at 13% moisture and 60 lb/bu test weight, harvested Oct 3, 1996
[2] NS=not significant

Soybean populations were slightly better with conventional tillage but there were no major population advantages among any of these seven systems (Table 6). Moisture content was 10.5 to 11% and test weight averaged nearly 58 lb/bu at harvest. Yield ranged from 41 to 54 bu/ac and was relatively stable at 52 to 54 bu/ac among most of the systems where soybean was drilled, except the NT three-crop rotation which yielded 10% less (47 bu/ac). The biggest difference, was a 20% yield reduction obtained with ridge-tilled soybean. The reduced RT yield may be at least partially explained by the combination of a lower seeding rate, wider row spacing, and plant height.

Spring wheat yielded very well this year. No-till systems produced more tillers and yielded better than the CT systems especially in the four-crop rotation (Table 7). This probably indicates a lower level of residual productivity from not using fertilizer in this system until this year. Many systems raised 50 bu/ac in grain. Test weights were heavy at 61 lb/bu and was uniform among these treatments.

Forage information during the establishment year is given in Table 8. Excellent stands produced between 3 and 4 tons of forage this season. There was just under 2 ton/ac of primarily oat forage produced when these systems were mowed in late June. Approximately 1.5 to 2.0 ton/ac of alfalfa regrew by the time they were hayed in late August. Even though there were a few more weeds in the CT system this is not expected to have a major impact on future production.

Table 7. Effects of tillage and crop rotation systems on wheat production. Southeast Research Farm; Beresford, SD; 1996.

Tillage	Rotation	Past Crop	Plant Height	Stand Count	Grain Yield[1]	Straw Yield	Moisture Content	Crop Residue 4-11-96	Crop Residue 6-4-96
			inch	tillers/ft^2	bu/ac	ton/ac	%	------%	------
NT	C-S-W	Soybean	38	63	49	0.9	11.5	70	64
CT	C-S-W	Soybean	39	57	48	1.0	10.3	57	23
NT	C-S-W+OA	Soybean	39	69	52	1.1	12.3	74	60
CT	C-S-W+OA	Soybean	39	48	49	1.0	10.3	67	19
Avg			39.0	59	50	1.0	11.1	67	41
$LSD_{0.10}$			1.0	10	2	0.2	NS[2]	NS	16
CV (%)			2.0	13	3	14.6	13.1	19	29

[1] Grain yield at 13% moisture and 60 lb/bu test weight, harvested Aug 2 & 9, 1996
[2] NS = not significant

Table 8. Effects of tillage and crop rotation systems on first-year alfalfa hay production. Southeast Research Farm; Beresford, SD; 1996.

		Past	--------- 1st cut			---------	2nd cut		Crop Residue	
Tillage	Rotation	Crop	Oat	Alfalfa	Weeds	Total	Alfalfa	Total[1]	4-11-96	6-7-96
			--------------		ton /ac			--------------	----- %	-----
NT	C-S-W+OA	Oat+ Alfalfa	1.4	0.5	0.01	1.9	2.0	3.9	79	23
CT	C-S-W+OA	Oat+ Alfalfa	1.6	0.2	0.09	1.8	1.5	3.3	23	10
Avg			1.5	0.3	0.05	1.9	1.7	3.6	51	16
Pr > F[2]							0.02			
CV%							9.1			

[1] Harvested: June 25 (mow) and August 24 (windrow), 1996.
[2] Pr > F = Probability of treatment differences not being significantly different

Economics

Economic analyses for these systems are derived from 1996 costs using the actual rates of inputs, local commodity prices at harvest, and crop yields from each system. Corn, soybean, and wheat were raised profitably in every cropping systems this year, but alfalfa failed to breakeven when a single cutting was marketed the year it was established. Fixed expenses for land and machinery were $80 to 85/ac and depreciation was $10 to 15/ac with relatively minor adjustments compared to the variable costs in each cropping system. The no-till systems also consistently had the lowest labor requirements needed for field operations.

Gross receipts from corn marketed at harvest exceeded $400/ac (Table 9) except in the ridge-till system ($382). Total expenses (variable, fixed, and depreciation costs) were between $310 and 360/ac. Variable costs ($1.15-1.45/bu) accounted for approximately two-thirds of the total corn expenses. Fixed cash expenses were nearly 25%, and depreciation costs about 5% of the total expenses needed to produce corn. Market prices needed to recover all corn expenses in these systems ranged from $1.68 to 2.06/bu. Net income varied from $59 to 144/ac which was 15 to 30% of the gross receipts per acre. Four-crop rotations provided the highest net income on a per-acre basis ($140/ac). At $38,000, the conventionally tilled corn-soybean rotation, however, generated the greatest net income to the operator because of its larger corn acreage. Even though it required the most labor (160 hr) and did not have the highest corn yield, the CT C-S rotation generated twice as much net income to the operator as the ridge-till system.

Gross receipts from soybean (Table 10) exceeded $300/ac for every cropping system, except ridge-till ($279/ac). Total expenses were nearly $190/ac for no-till and conventional tillage systems but almost $20/ac less for ridge-till soybean ($167/ac). The amount of money spent on all soybean variable expenses ($1.68-1.89/bu) was nearly comparable to the amount needed for fixed cash expenses in a given system. These two types of expenses generally were each about 45% of the total soybean expenses with the remaining 10% going to depreciation. Market prices needed to recover all soybean expenses ranged from $3.48 to 4.07/bu and most were close to $3.50/bu. Nearly 40 to 50% of the gross soybean receipts per acre were realized as net income which ranged from $112 to 176/ac this year. All systems produced at least $160/ac in net income from soybean except the two lowest yielding systems (RT and NT C-S-W). The NT and CT C-S rotations provided by far the most net income to the operator which in several cases provided almost twice as much net income as the four-crop rotations. There was very little difference in net income to the operator between the soybean no-till and conventional till systems within a rotation for the two- and four-crop rotations.

Income and costs of production for both grain and straw were taken into account this year for spring wheat (Table 11). Gross receipts for wheat ranged from $260 to 290/ac, with most systems grossing about $265/ac. Total expenses were typically less than $225/ac (55% variable costs, 40% fixed cash expenses, and 5% depreciation). Breakeven prices needed to recover all wheat expenses were about $3.80/bu for the three-crop rotations resulting in net incomes of $40/ac (15% of gross receipts) and $3.46/bu in the four-crop rotations with at least $60/ac (23% of gross receipts) for net income. On a per-acre basis the four-crop rotations appear more efficient in generating net income, but the amount available to the operator from wheat averaged about $9,000 regardless of the type of tillage or rotation in these four systems.

A single cutting of first-year alfalfa in late August did not cover establishment costs this year (Table 12). Gross receipts were approximately $100/ac. This was enough to cover fixed cash and depreciation costs but not variable costs. Total expenses to produce alfalfa were around $225/ac (60% variable, 35% fixed cash, 5% depreciation). Market hay prices at the farm of $110 to 150/ton were needed to allow recovery of all alfalfa expenses incurred this year. As a result, the four-crop rotation lost $104 to 138/ac for a loss to the operator of $15,000 to 22,000 for these systems with first-year alfalfa. Either hay prices or yield would need to increase by a factor of two or more in order to breakeven.

The lower productivity in the four-crop CT rotation suggests that prudent management will be needed to build or maintain this as a viable cropping system after restricting inputs coupled with extra tillage during the past 5 years. Selling oat hay this year and prorating seed costs over the projected life of the stand are additional strategies that may help improve the profitability of these two rotations. Excellent stands were achieved this year for both systems so the prospect is good that they will become profitable in future years.

Gross receipts, averaged by crop for these systems were $300 to 400/ac this year on a whole-farm basis (Table 13). This is approximately $390/ac for NT and CT C-S rotations, $350/ac for C-S-W rotations, $300/ac for the C-S-W+OA rotations, and $330/ac for ridge-till. Average total expenses were $250/ac for two- and three-crop NT and CT systems and $15 to 20/ac less for four-crop rotations (60% variable, 35% fixed cash, and 5% depreciation). Total crop receipts for a 640-ac farm this year ranged from $190,000 to 254,000 and in the NT and CT C-S rotations generated close to one quarter of a million dollars. Every cropping system generated a positive net income that was nearly 20 to 35% of its average gross receipts. The CT systems were $10/ac (C-S-W) and $20/ac (C-S) better than their respective NT systems within a rotation, except for the NT (C-S-W+OA) system which had $10/ac more net income than CT system. Net income also tended to decline as the number of crops in a rotation increased (C-S, $85,000; C-S-W, $60,000; C-S-W+OA, $40,000). Net income to the operator was greater from soybean ($28,000-55,000) than from corn ($19,000-38,000) for each system especially for three-crop rotations where soybean net income was twice the amount earned from corn.

SUMMARY

Crop production was excellent this year with most commodities achieving their yield goals. Relatively strong market prices at harvest together with good yields allowed every cropping system to be profitable considering all crops on a whole-farm basis. In this study soybean provided farm operators with the most net income for a given system followed closely by corn and then wheat. First-year alfalfa did not recover its expenses during this establishment year, but we obtained good stands that should help it become profitable for future years.

Four-crop rotations were consistently the most economically efficient rotations for providing net income on a per-acre basis for corn, soybean, and wheat. Two-crop (C-S) rotations, however, generated more net income to the farm operator per system for a given crop and on a whole-farm basis. Conventionally tilled cropping systems performed comparable to or better than no-till systems within a rotation in many instances this year.

Table 9. Economic Analysis, Corn Rotations ($2.43/bu). Southeast Research Farm; Beresford, SD; 1996.

GENERAL FIELD INFO.	NT C-S	RT C-S	CT C-S	NT C-S-W	CT C-S-W	NT C-S-W+0A	CT C-S-W+OA
System	1	7	2	3	4	5	6
Acres	320	320	320	213.3	213.3	160	160
Yield (bu/ac)	169	157	178	188	179	195	185
PER ACRE AMOUNTS							
Receipts	411	382	433	457	435	474	450
Variable Expenses							
Field Operations	46.74	47.13	50.90	48.81	50.78	49.36	47.08
Seed	29.87	29.87	29.87	29.87	29.87	29.87	29.87
Fertilizer	70.95	76.43	54.45	73.01	59.09	50.94	41.66
Pesticides*	24.65	22.78	27.58	33.38	27.58	32.51	27.58
Drying Expenses	49.01	40.82	42.72	67.68	60.86	62.40	57.35
Operating Interest	10.55	10.79	9.97	11.34	10.25	9.96	8.95
Total Variable Costs	231.76	227.80	215.48	264.08	238.42	235.04	212.49
Fixed Cash Expenses							
Land Costs	70.00	70.00	70.00	70.00	70.00	70.00	70.00
Other fixed cash expenses	12.04	12.48	14.48	11.81	14.02	11.41	13.33
Total Fixed Cash Expenses	82.04	82.48	84.48	81.81	84.02	81.41	83.33
Cash Income	96.88	71.23	132.58	110.95	112.53	157.40	153.70
Fixed Non-Cash Expenses	13.64	12.73	14.70	13.64	14.70	13.64	14.70
Net Income	83.24	58.51	117.88	97.31	97.83	143.76	139.04
Avg/bushel costs							
Variable expenses	1.37	1.45	1.21	1.40	1.33	1.21	1.15
Fixed Cash Expenses	0.49	0.53	0.47	0.44	0.47	0.42	0.45
Fixed Non-cash Expenses	0.08	0.08	0.08	0.07	0.08	0.07	0.08
Total Costs	1.94	2.06	1.77	1.91	1.88	1.69	1.68
OPERATOR SUMMARY							
Total Receipts	131,414	122,083	138,413	97,444	92,779	75,816	71,928
Total Variable Expenses	74,162	72,895	68,954	56,328	50,855	37,606	33,998
Total Fixed Cash Expenses	26,252	26,393	27,034	17,450	17,922	13,026	13,333
Total Cash Income	31,000	22,795	42,424	23,666	24,002	25,184	24,597
Fixed Non-Cash Expenses	4,365	4,073	4,703	2,910	3,135	2,183	2,351
Net Income @ Yield	26,635	18,723	37,722	20,756	20,867	23,002	22,246
Seasonal Labor Hours	92.8	124.8	160.0	72.5	104.5	54.4	78.4
Labor hours/ac	0.29	0.39	0.50	0.34	0.49	0.34	0.49

*Includes insecticide at $7.56/ac for 1st generation ECB and herbicide.

Table 10. Economic Analysis, Soybean Rotations ($6.80/bu). Southeast Research Farm; Beresford, SD; 1996.

GENERAL FIELD INFO.	NT C-S	RT C-S	CT C-S	NT C-S-W	CT C-S-W	NT C-S-W+OA	CT C-S-W+0A
System	1	7	2	3	4	5	6
Acres	320	320	320	213.3	213.3	160	160
Yield (bu/ac)	52	41	53	47	52	53	54
PER ACRE AMOUNTS							
Receipts	354	279	360	320	354	360	367
Variable Expenses							
Field Operations	28.70	29.13	30.70	28.28	30.62	28.71	30.84
Seed	14.22	11.85	14.22	14.22	14.22	14.22	14.22
Fertilizer	17.33	17.33	17.33	17.33	17.33	17.33	20.21
Herbicides	23.77	9.33	23.37	23.77	23.37	23.77	23.37
Drying Expenses	0	0	0	0	0	0	0
Operating Interest	5.15	4.14	5.24	5.12	5.24	5.15	5.43
Total Variable Costs	89.16	71.67	90.86	88.72	90.77	89.17	94.07
Fixed Cash Expenses							
Land Costs	70.00	70.00	70.00	70.00	70.00	70.00	70.00
Other fixed cash expenses	12.04	12.48	14.48	11.81	14.02	11.41	13.33
Total Fixed Cash Expenses	82.04	82.48	84.48	81.81	84.02	81.41	83.33
Cash Income	182.40	124.66	185.06	149.08	178.80	189.82	189.80
Fixed Non-Cash Expenses	13.64	12.73	14.70	13.64	14.70	13.64	14.70
Net Income	168.76	111.93	170.36	135.43	164.11	176.18	175.10
Avg/bushel costs							
Variable expenses	1.71	1.75	1.71	1.89	1.75	1.68	1.74
Fixed Cash Expenses	1.58	2.01	1.59	1.74	1.62	1.54	1.54
Fixed non-cash Expenses	0.26	0.31	0.28	0.29	0.28	0.26	0.27
Total Costs	3.55	4.07	3.59	3.92	3.64	3.48	3.56
OPERATOR SUMMARY							
Total Receipts	113,152	89,216	115,328	68,171	75,423	57,664	58,752
Total Variable Expenses	28,531	22,933	29,075	18,923	19,362	14,267	15,051
Total Fixed Cash Expenses	26,252	26,393	27,034	17,450	17,922	13,026	13,333
Total Cash Income	58,369	39,890	59,219	31,798	38,139	30,371	30,368
Fixed Non-Cash Expenses	4,365	4,073	4,703	2,910	3,135	2,183	2,351
Net Income @ Yield	54,004	35,818	54,517	28,888	35,004	28,188	28,016
Seasonal Labor Hours	144.0	176.0	192.0	96.0	128.0	72.0	96.0
Labor (hours/ac)	0.45	0.55	0.60	0.45	0.60	0.45	0.60

Table 11. Economic Analysis, Spring Wheat (Grain $4.48/bu + Straw $50/ton) Rotations. Southeast Research Farm; Beresford, SD; 1996.

GENERAL FIELD INFO.	NT C-S-W	CT C-S-W	NT C-S-W+OA	CT C-S-W+OA
System	3	4	5	6
Acres	213.4	213.4	160	160
Adjusted Yield	59	59	64	60
PER ACRE AMOUNTS				
Receipts	263	265	289	269
Variable Expenses				
Field Operations	39.08	43.84	44.21	43.45
Seed	14.85	14.85	14.85	14.85
Fertilizer	45.07	35.78	37.64	33.00
Herbicides	24.03	24.03	24.03	12.39
Drying Expenses	0	0	0	0
Operating Interest	7.54	7.26	7.39	6.35
Total Variable Costs	130.56	125.76	128.13	110.04
Fixed Cash Expenses				
Land Costs	70.01	70.01	70.01	70.00
Other fixed cash expenses	11.80	14.02	11.41	13.33
Total Fixed Cash Expenses	81.81	84.02	81.41	83.33
Cash Income	50.83	55.12	79.42	75.88
Fixed Non-Cash Expenses	13.64	14.70	13.64	14.70
Net Income	37.19	40.42	65.78	61.18
Avg / bushel costs				
Variable expenses	2.22	2.13	1.99	1.83
Fixed Cash Expenses	1.39	1.42	1.26	1.39
Fixed Non-cash Expenses	0.23	0.25	0.21	0.24
Total Costs	3.85	3.80	3.46	3.46
OPERATOR SUMMARY				
Total Receipts	56,151	56,514	46,234	43,080
Total Variable Expenses	27,854	26,830	20,500	17,607
Total Fixed Cash Expenses	17,453	17,925	13,026	13,333
Total Cash Income	10,844	11,759	12,708	12,140
Fixed Non-Cash Expenses	2,910	3,135	2,183	2,351
Net Income @ Yield	7,934	8,623	10,525	9,789
Seasonal Labor Hours	53.3	89.6	40.0	59.2
Labor (hour/ac)	0.25	0.42	0.25	0.37

Table 12. Economic Analysis, Oat and Alfalfa Hay Rotations ($60/ton). Southeast Research Farm; Beresford, SD; 1996.

GENERAL FIELD INFO.	NT C-S-W+OA	CT C-S-W+OA
System	5	6
Acres	160	160
Yield (ton/ac)	2.0	1.5
PER ACRE AMOUNTS		
Receipts	120	90
Variable Expenses		
Field Operations	19.40	20.40
Seed	62.49	62.49
Fertilizer	21.66	21.66
Herbicides	17.97	17.97
Drying Expenses	0	0
Operating Interest	7.44	7.50
Total Variable Costs	128.96	130.02
Fixed Cash Expenses		
Land Costs	70.00	70.00
Other fixed cash expenses	11.41	13.33
Total Fixed Cash Expenses	81.41	83.33
Cash Income	(90.37)	(123.36)
Fixed Non-Cash Expenses	13.64	14.70
Net Income	(104.01)	(138.01)
Avg/ton costs		
Variable expenses	64.48	86.68
Fixed Cash Expenses	40.71	55.55
Fixed Non-cash Expenses	6.82	9.80
Total Costs	112.01	152.03
OPERATOR SUMMARY		
Total Receipts	19,200	14,400
Total Variable Expenses	20,634	20,804
Total Fixed Cash Expenses	13,026	13,333
Total Cash Income	(14,460)	(19,737)
Fixed Non-Cash Expenses	2,183	2,351
Net Income @ Yield	(14,733)	(22,088)
Seasonal Labor Hours	30.4	44.8
Labors (hours/ac)	0.19	0.28

Table 13. Economic summary of all rotation systems (640 ac). Southeast Research Farm; Beresford, SD; 1996.

GENERAL FIELD INFO.	NT	RT	CT	NT	CT	NT	CT
Crop Rotation	C-S	C-S	C-S	C-S-W	C-S-W	C-S-W+OA	C-S-W+OA
System	1	7	2	3	4	5	6
PER ACRE AMOUNTS							
Avg. Receipts	382	330	396	347	351	311	294
Avg. Variable Expenses							
Field Operations	37.72	38.13	40.80	38.72	41.75	35.42	35.44
Seed	22.04	20.86	22.04	19.64	19.64	30.36	30.36
Fertilizer	44.14	46.87	35.89	45.13	37.40	31.90	29.13
Herbicide	24.21	16.00	25.47	27.06	24.99	24.57	20.33
Drying Expenses	24.50	20.41	21.36	22.56	20.29	15.60	14.34
Operating Interest	7.85	7.46	7.61	8.00	7.58	7.49	7.06
Total Variable Costs	160.46	149.73	153.17	161.12	151.65	145.33	136.66
Fixed Cash Expenses							
Land Costs	70.00	70.00	70.00	70.00	70.00	70.00	70.00
Other Fixed Cash Expenses	12.04	12.48	14.48	11.81	14.02	11.41	13.33
Total Fixed Cash Expenses	82.04	82.48	84.48	81.81	84.02	81.41	83.33
Cash Income	139.64	97.95	152.82	103.62	115.48	84.07	74.01
Fixed Non-Cash Expenses	13.64	12.73	14.70	13.64	14.70	13.64	14.70
Net Income	126.00	85.22	144.12	89.97	100.78	70.43	59.32
OPERATOR SUMMARY							
Total Receipts	244,566	211,299	253,741	221,766	224,716	198,914	188,160
Total Variable Expenses	102,694	95,828	98,029	103,105	97,047	93,008	87,460
Total Fixed Cash Expenses	52,503	52,786	54,068	52,353	53,769	52,103	53,332
Total Cash Income	89,369	62,685	101,644	66,308	73,900	53,803	47,368
Fixed Non-Cash Expenses	8,730	8,145	9,405	8,730	9,405	8,730	9,405
Net Income @ Yield	80,639	54,540	92,239	57,578	64,495	45,073	37,963
Seasonal labor Hours	236.8	300.8	352.0	221.8	322.1	196.8	278.4
Labor (hours/ac)	0.37	0.47	0.55	0.35	0.50	0.31	0.44

DATE OF PLANTING CORN

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Southeast Farm 9602

SUMMARY:

Two hybrids were each planted on five dates this spring to continue monitoring long-term effects of planting date on production of early and late maturing corn hybrids in southeastern South Dakota. Planting dates this year began April 11 and ended May 29. The best planting dates were late April for the full season (112 day RM) hybrid and mid May for the short season (103 day RM hybrid. Penalties for planting in late spring instead of at the optimum date were $50+/ac for short season and $100+/ac for full season hybrids. The most intense first generation ECB pressure coincided with the optimum planting dates for these hybrids.

METHODS:

The goal of this research is to begin planting in mid April and continue at approximately 10-day intervals through late May. Dates actually planted this year were April 11, April 22, May 3, May 16, and May 29. These plots were sampled as needed for first generation European corn borer(ECB). Data was not collected for this study last year (1995) because excessively wet weather prevented planting until the fourth planting date. Stand counts were taken to monitorcorn populations and grain yield moisture, and test weight were measured at harvest. The late season hybrid we evaluated a 112-day RM as the late season hybrid this year, instead of 116-118-day RM as in previous years. Table 1 outlines additional management factors for the study in 1996.

Table 1. Management practices for date of planting corn study. Southeast Research Farm; Beresford, SD; 1996.

Previous Crop	Soybean
Tillage	Ridge-Till
Planting rate	27,000 seed/acre
Hybrids	Pioneer 3615 (103 day RM)
	Pioneer 3357 (112 day RM)
Fertilizer	30 lb P_2O_5/ac + 175 lb N/ac as 10-34-0 (popup)
	and 28-0-0 sidedress
Herbicide	Dual II + Atrazine + Roundup PRE & EPP
Harvest	October 22

RESULTS AND DISCUSSION:

Soil moisture conditions were dry enough to plant in early April so we started planting four days early even though soil temperatures were still quite cool. As a result our planting dates were 2 to 4 days earlier than usual in April and early May. Table 2 outlines the crop production obtained with these hybrids for 1996.

The full-season hybrid produced 205 bu/ac when planted in April then lost about 5 to 10 bu/ac in yield if planted in early or mid May (195 bu/ac). It outyielded Pioneer 3615 by 30 bu/ac when planted in April and early May and still had a moderate yield advantage of more than 10 bu/ac for the mid May planting date. The short-season hybrid yielded about 170 bu/ac when planted in April and early May, then increased to 183 bu/ac for its optimal planting date in mid May, before the yields of both hybrids crashed if planted in late May.

Table 2. Effect of planting date and relative maturity on corn production; Southeast Research Farm; Beresford, SD; 1996.

Hybrid (RM)	Planting Date	Stand Count	Grain Yield[1]	Moisture Content	Test Weight	Economic Return[2]
		plant/ac	bu/ac	%	lb/bu	$/ac
P-3615	Apr 11	25,900	168	15.5	57.8	293
(103)	Apr 22	26,000	174	15.7	57.8	305
	May 03	25,100	169	15.9	56.8	292
	May 16	21,900	183	16.5	56.3	324
	May 29	29,900	162	20.1	55.1	259
P-3357	Apr 11	24,500	203	20.5	57.4	344
(112)	Apr 22	26,500	208	20.2	57.9	357
	May 03	25,100	197	21.1	56.8	327
	May 16	19,900	196	22.2	55.9	316
	May 29	27,600	168	25.6	54.3	238
	Avg	25,200	183	19.3	56.6	306
	LSD $_{0.10}$	2,300	9	0.9	0.6	24
	CV %	7.23	4.07	3.75	0.87	6.42

[1] Grain yield at 15% moisture content and 56 lb/bu test weight.
[2] Based on $2.41 bu less moisture dock ($0.05/point), seed, fertilizer & herbicide costs.

The 103 day hybrid dried down better as expected. It was consistently 4 to 5% drier at each planting date than the 112 day hybrid which dried down slowly this fall. Test weights were good this year with most planting dates averaging between 56 and 58 lb/bu.

The short-season hybrid had a net economic return of nearly $300/ac when planted through early May. Both hybrids returned about $320/ac at the mid-May planting date, then lost approximately $70/ac if planting was delayed another two weeks ($250/ac). The penalties for planting late in the spring compared to the optimal date amounted to $65/ac for the short season hybrid (May 16) and $120/ac for the full season hybrid (April 22).

Results for this study are influenced by plant population dynamics, especially for the mid and late May dates. The corn population was 25,000 plant/ac in the April and early May planting dates. Stands for the fourth date, however, are 10 to 20% lower (20,000-22,000 plant/ac) and the last date had populations of 28,000 and 30,000 plant/ac. As a result the economic results for the mid-May planting may actually be underestimated compared to the earlier planting dates. The lower yields observed with the May 29 date could indicate overcrowding, a short growing season, or both.

Table 3. Effects of planting date and relative maturity on first generation European corn borer infestation. Southeast Research Farm; Beresford, SD; 1996.

Hybrid (RM)	Planting Date	Shot Holes	Whorl Density	ECB Index[1]
		%	larvae/whorl	
P3615	Apr 11	27	1.0	0.31
(103 day)	Apr 22	30	1.8	0.47
	May 03	40	1.6	0.72
	May 16	40	0.6	0.26
	May 29	36	0.8	0.34
P3357	Apr 11	52	0.9	0.49
(112 day)	Apr 22	64	1.2	0.74
	May 03	45	0.9	0.32
	May 16	42	1.4	0.57
	May 29	32	0.9	0.34
Avg		41	1.1	0.46
LSD $_{0.10\ n=4}$		24	0.8	0.38
CV %		48	56	68

[1] According to SDCES Extension Extra Bulletin 8125 (June 1996)

The presence of European corn borer (ECB) was severe in many areas of South Dakota including at Southeast Research Farm this year. This field was mildly to moderately infested with first generation ECB. Pioneer 3357 seemed to be slightly more susceptible to ECB than Pioneer 3615 (Table 3) In full season hybrids 1/2 to 2/3 (45-64%) of the whorls had shot holes when planted in April through early May, then tapered to 1/3 with the late May planting. It also contained an average of one larva/plant when scouted on July 8 regardless of the date planted. Pioneer 3615 only had 1/4 to 1/3 of the whorls infested on any planting date. It had at least 1.5 to 2 larvae/whorl when planted in late April or early May, then decreased to nearly 0.5 larva/whorl for the later planting dates. This particular field was not sprayed, but treatment would have been justified based on a crop value of $450/ac and control costs of $12/ac for Pioneer 3357 planted on April 22 and Pioneer 3615 planted May 3.

Table 4. Ten year average (1986-1996)[1] grain yields for date of planting corn study. Southeast Research Farm; Beresford, SD; 1996.

Hybrid	- - - - - - - - - - - Avg. Planting Date - - - - - - - - - -				
Maturity	Apr 17	Apr 27	May 7	May 17	May 27
RM	- - - - - - - - - - - - - - bu/ac @ 15% -				
103 day	129	131	129	128	113
112-118 day	141	142	139	129	103

[1] No data for 1995.

The short season hybrid (Pioneer 3615) did not significantly outyield the full season hybrid (Pioneer 3357) when planted in late May as has been frequently observed in previous years and in the long term trend (Table 4). Assuming this did not occur because of overcrowding (with the high plant populations for that planting date), this might have occurred because we changed the relative maturity (RM) of the full season hybrid to 112 day RM. In previous years, RM was 116 to 118 day for the full season hybrids tested. The high yields observed this year increased long term averages in Table 4 by 4 to 5 bu/ac for the short season hybrids and by 7 to 8 bu/ac for full season hybrids. Otherwise the long term trend was not drastically affected.

Full season corn planted before the middle of May normally has a good probability of yielding as good as or better than early hybrids planted at the same time. Their yields are similar when planted the middle of May. After that yield reductions continue for both maturities but the advantage usually shifts more in favor of the shorter season hybrid which often expresses better yield potential with less growing season. While yield is very important it should never be the only factor to consider. Many characteristics, including a hybrid’s ability to dry down or withstand pests and other stresses, coupled with good sound management and marketing also greatly affect profitability. The benefits from utilizing more growing season by planting corn during middle to late April and continuing through the planting season with quality seed of more than one maturity to increase the time when pollination is occurring should not be overlooked as an important management tool.

GPS CORN POPULATION STUDY

R. Berg, D. DuBois, B. Jurgensen,
R. Stevens, and G. Williamson

Southeast Farm 9603

INTRODUCTION

Many agronomists encourage planting relatively high corn populations. Western cornbelt farmers are often reluctant to increase populations because overcrowding can reduce yield, especially during drier years. Research began here in 1995 to determine the optimum plant populations for sustainable dryland corn production using research results based on an entire field using GPS technology. This report provides a preliminary overview of the general trends observed in 1996 rather than a detailed analyses of spatial relationships. Additional research designed to help identify the best combination of row spacing and corn populations using medium sized test plots is presented on page 32 (Southeast Farm 9606).

METHODS

Five seeding rates were planted in 0.5 mile long (0.85 ac) strip plots in a 19-ac corn field. An Accuplantä (Rawson Control Systems, Inc.; Oelwein, IA) hydraulic variable rate controller on our planter delivered a uniform seeding rate per strip of either 17,680; 21,840; 26,000; 30,160; or 34,320 total seed/ac using three replications for each rate. The field was treated for first-generation European corn borer and grain yield and moisture for the entire field were measured in the fall using a combine yield monitor with differential global positioning system (DGPS) capability. Data was collected at two seconds/cycle using each strip as a single load. Net economic return reflects crop income based on local market price at harvest after subtracting several variable costs including grain moisture dockage ($0.05/point, field moisture basis). Additional management information is summarized in Table 1.

Table 1. Management practices for GPS corn seeding rate evaluation. Southeast Research Farm; Beresford, SD; 1996.

Previous Crop	Soybean
Tillage System	No-Till
Hybrid	Pioneer 3489
Planting Date	May 8
Fertilizer	30 lb P_2O_5 + 160 lb N/ac as 10-34-0 (with seed) and 28-0-0 (sidedress)
Herbicide	Dual II banded, at planting Banvel + Atrazine, early POST
Harvest Date	October 16

RESULTS AND DISCUSSION

Seeding rates provided a range of populations from 17,000 to 27,000 plant/ac and are approximately 97% of the amounts of pure live seed (PLS) planted except for the highest rate. The 33,000 PLS/ac rate was achieved during calibration, but approached the upper limit for our equipment. As a result it only produced a field population of 25,500 plant/ac.

Table 2. Seeding rate effect on corn production for precision farming. Southeast Research Farm; Beresford, SD; 1996.

Seeding Rate[1]	Stand Count	Grain Yield[2]	Moisture Content	Economic Return[3]	Relative Yield
PLS/ac	plant/ac	bu/ac	%	$/ac	bu/1000 plants
16,800	16,800	170	20.2	295	10.1
20,750	19,500	188	20.4	331	9.7
24,700	24,200	201	20.5	357	8.4
28,650	27,200	205	20.6	365	7.6
32,600	25,500	189	20.5	320	7.8
Avg.	22,600	190	20.4	333	8.7
LSD 0.10 n=3	1,900	13	NS[4]	28	1.1
CV (%)	5.67	4.39	0.93	5.52	8.34

[1] Pure live seed basis
[2] Grain at 15% moisture and 56 lb/bu test weight.
[3] Based on $2.45/bu less drying, seed, fertilizer, and herbicide costs.
[4] NS = not significant

Corn production averaged 190 bu/ac for this field and ranged from 170 to 205 bu/ac. Populations of 24,000 and 27,000 plant/ac yielded more than 200 bu/ac and had a net economic return of about $360/ac. This amounts to a 15 to 30 bu/ac yield advantage and gave $30 to 65/ac more income than the lower populations.

Livestock manure applied the previous year helped provide enough fertility to produce at least a 210 bu/ac corn crop. These two populations also made the most efficient use of the available nutrients because their yields averaged 97% of this field’s yield potential. The lower populations were more efficient in terms of relative yield per plant. Populations less than 20,000 plant/ac produced 10 bu/1000 plants (0.56 lb/ear) compared to 8 bu/1000 plants (0.45 lb/ear) for the higher populations (assuming one ear per plant). The higher populations efficiently used sunlight, nutrients, and space to produce more grain per acre without jeopardizing income. Lower populations raised 20% more grain per plant, but were less profitable.

SUMMARY

Corn production using at least 24,000 plant/ac is easily justified with the type of climate, soils, and management this year. Even populations of 27,000 and 28,000 plant/ac have been sustainable in terms of yield and profitability when soil moisture was abundant the past two years. Dryer growing seasons and higher populations need to be evaluated to better understand the constraints associated with dryland corn production in the western cornbelt.

DATE OF PLANTING SOYBEAN

R. Berg, D. DuBois, B. Jurgensen,
R. Stevens, and G. Williamson

Southeast Farm 9604

SUMMARY:

This study evaluates the performance of early and mid season soybean varieties as influenced by a range of planting dates from early May through mid June. Our goal is to intentionally begin planting soybean earlier than normal each year then continue with optimum and later than usual seedings at approximately 10-day intervals. Soybean yields this season ranged from 46 to 58 bu/ac. Yields were best when these varieties were planted in May, then decreased by 5 bu/ac when planted in early June, and decreased another 5 bu/ac (10%) when planted in mid June.

METHODS:

The same two varieties tested in 1995 were evaluated again in 1996. This year's planting dates were May 6, May 16, May 22, June 04, and June 12. Stand count, plant height, grain yield, moisture content, and test weight, were measured for each plot. Laboratory analyses are pending for grain protein and oil contents. Economic return was calculated using a market price of $6.80/bu at harvest then deducting variable costs for seed, herbicide, and fertilizer. The first three planting dates were harvested on October 1 and the last two dates on October 4. Table 1 reports additional management information related to this study.

Table 1. Management practices for date of planting soybean study. Southeast Research Farm, Beresford, SD; 1996.

Previous Crop	Corn
Tillage	Ridge-Till
Varieties	‘Granite’ (Group I), ‘Sturdy’ (Group II)
Seeding rate	184,000 seed/ac
Fertilizer	37 lb P_2O_5 as 10-34-0
Weed Control	Pursuit PRE & EPP
Harvest Dates	October 1 & 4

RESULTS AND DISCUSSION:

Good stands were established for both varieties this season although ‘Sturdy’ seemed to have weaker emergence than ‘Granite’. At most planting dates ‘Granite’ had as much as 15,000 to 40,000 more plant/ac than ‘Sturdy’. ‘Sturdy’ compensated very well in this study because grain yields were essentially the same for both varieties. These soybean varieties produced 55 to 58 bu/ac when planted in May, then dropped to 51 bu/ac (10%) if planted in early June, and another 5 bu (10%) to 45 bu/ac if planted in mid June.

Table 2. Effect of planting date on soybean production. Southeast Research Farm; Beresford, SD; 1996.

Variety	Planting Date	Stand Count	Plant Height	Grain Yield[1]	Moisture Content	Test Weight	Economic Return[2]
		plants/ac	inch	bu/ac	%	lb/bu	$/ac
'Granite'	May 06	169,000	38	57	10.7	56.4	341
	May 16	172,000	40	56	10.7.	56.0	342
	May 27	163,000	41	55	10.9	56.3	337
	Jun 04	146,010	40	51	10.7	56.5	306
	Jun 12	168,000	38	46	11.7	56.0	273
'Sturdy'	May 06	145,000	41	58	10.5	56.5	356
	May 16	151,000	39	57	10.8	56.5	353
	May 27	124,000	43	57	11.2	56.6	351
	Jun 04	116,000	42	51	11.0	56.3	312
	Jun 12	142,000	40	47	12.9	55.8	279
	Avg	150,000	40	53	11.1	56.3	325
	$LSD_{0.10}$	15,000	3.2	3	0.4	NS	22
	CV (%)	8.18	4.8	5	3.0	0.8	5

[1] Grain yield at 13% moisture content and 60 lb/bu test weight.
[2] Based on $6.80/bu less seed, herbicide and fertilizer costs.

These varieties were to nearly 40 inches tall, had 56 lb/bu test weights, and were harvested at 11% grain moisture, (except the last planting date was 1 to 2% wetter). Market prices were strong at harvest giving economic returns of $273 to 355/ac after allowing for a portion of the variable costs. This closely followed the same pattern as crop yield except that ‘Granite’ had from $6 to 15/ac less net return than ‘Sturdy’ With the climate, market, and management conditions of this study, producers could lose $30 to 40/ac each week if soybean planting was not completed **by May.**

Table 3. Eleven-year average yields (1986-1996) for date of planting soybean study. Southeast Research Farm; Beresford, SD; 1996.

Variety	Average Planting Date				
	May 5	May 15	May 25	June 4	June 14
	-----------------Bu/ac @ 13%----------------				
Early (Group I & II)	44	43	43	41	36
Mid (Group II)	43	41	40	37	34

The above average yields this year did not alter the long-term trends, but did increase the 11-yr average by 1 bu/ac for the early group and by 1 to 2 bu/ac for the midgroup (Table 3). There is nearly 1 to 4 bu/ac yield advance for raising early maturity (Group I & II) which usually yield well when planted in May or early June, whereas, yield with the Group II soybean varieties do well planted in May then drop off when planted in early June and even more for mid June plantings.

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CULTIVATION EFFECTS ON NO-TILL CORN AND SOYBEAN

R. Berg, D. DuBois, B. Jurgensen,
R. Stevens, and G. Williamson

Southeast Farm 9605

SUMMARY: This study examines whether cultivating influences crop performance in a no-till corn-soybean rotation. Our goal is to measure how the frequency of cultivating between the rows affects crops other than controlling weeds. So far no-till crop responses to cultivating have been neutral or erratic each year, however subtle yield responses have been observed for both crops. In 1996, cultivating between rows increased no-till corn yield by at least 10 bu/ac and increased income $20/ac or more. These field operations had no positive measurable effect on no-till soybean production.

METHODS: Zero, one, two, and three cultivations during the growing season are compared in a no-till corn-soybean rotation using herbicide for weed control. The cultivation treatments have been applied to the same replicated strip plots or both crops each year in this field since 1992. Economic benefits as the return to income for grain marketed at harvest with corn at $2.49/bu and soybean at $6.80/bu after subtracting variable costs for field operations, seed, herbicide, and fertilizer. Additional management practices associated with this research are summarized in Table 1.

Table 1. Management practices: No-till cultivation. Southeast Research Farm; Beresford, SD; 1996.

	Corn	Soybean
Tillage	Modified No-till	Modified No-till
Past Crop	Soybean	Corn
Hybrid/Variety	Curry 2167	'Sturdy'
Planting Date	April 26	May 9
Seeding Rate	27,000 seed/ac	175,000 seed/ac
Herbicide	Dual II +Atrazine + Roundup (PRE)	Dual II (banded at planting) Sencor + Roundup (PRE)
Fertilizer	60 lb P_2O_5/ac+ 140 lb N/ac as 10-34-0 & 28-0-0	None
Harvest Date	October 11	October 4

RESULTS AND DISCUSSION: The soybean crop in this field averaged approximately 127,000 plant/ac (Table 2). It was at least 40 inches tall, yielded 50 bu/ac with grain at

10% and test weight at harvest of nearly 58 lb/bu. Cultivating did not affect soybean production this year. In fact it actually reduced soybean income $10 to 20/ac.

Table 2. Effect of cultivation on no-till soybean production. Southeast Research Farm; Beresford, SD; 1996.

Cultivations	Stand Count	Plant Height	Grain Yield	Moisture Content	Test Weight	Economic Return
	plant/ac	inch	bu/ac	%	lb/bu	$/ac
0	129,600	42	50	10.4	57.9	276
1	129,000	41	50	10.3	57.6	266
2	123,500	42	49	10.4	57.5	259
3	126,500	40	50	10.4	57.6	254
Avg	127,200	41	50	10.4	57.7	264
LSD 0.10	NS	NS	NS	NS	NS	17
CV %	9.09	5.1	3.8	1.2	0.5	4.9

[1] Grain yield at 13% moisture and 60 lb/bu test weight
[2] Based on $6.80/bu less variable costs for field operation, seed, and herbicide
[3] NS = not significant

The corn crop had 23,000 plant/ac and yielded 185 bu/ac at 20% moisture averaged across the field (Table 3). Cultivating corn did influence grain yield, drydown, and economic return this year. Yield was at least 10 bu/ac greater and tended to dry down a little better when corn was cultivated more than once. This also increased the income from no-till corn by $20/ac.

Table 3. Effect of cultivation on no-till corn production. Southeast Research Farm. Beresford, SD; 1996.

Cultivations	Stand Count	Grain Yield[1]	Moisture Content	Economic Return[2]
	plant/ac	bu/ac	%	$/ac
0	21,500	174	21.7	254
1	23,100	183	21.1	273
2	23,400	194	20.5	296
3	23,800	187	20.5	275
Avg	23,000	185	21.0	275
LSD 0.10	NS[3]	11	0.9	26
CV %	9.11	4.52	2.9	7.30

[1] Grain yield at 15% moisture and 56 lb/bu test weight.
[2] Based on $2.49/bu less variable costs for field operations, seed, fertilizer, and herbicide.
[3] NS = not significant

Cultivating has increased no-till soybean yield by 2 to 4 bu/ac 2 of 5 years. No-till corn yield was reduced by 6 bu/ac (2 of 3 treatments) in 1993 and was increased by 3 bu/ac (1 of 3 treatments) (1x cultivation) in 1995, both very wet years. This is the first year that cultivating has had a positive influence on corn production. No-till corn yield was reduced by 2 to 4 bu/ac in 2 of 5 years.

CORN ROW SPACING & POPULATION STUDY

R. Berg, D. DuBois, B. Rops,
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Southeast Farm 9606

INTRODUCTION

The feasibility of narrow-rows and high-seeding rates for corn production continue to elicit much debate. Research information is needed in these areas to help producers make important seeding rate and equipment purchase decisions. This study evaluates several corn populations planted at various row widths. Our goal is to determine if certain combinations of these two factors result in more sustainable dryland corn production in the western cornbelt.

Other companion research studies were also conducted this year. One study characterized corn populations in a 19-acre field with strip plots harvested with a yield monitor and global positioning system (page 23, Southeast Farm 9603). Other studies looked at corn row spacing and hybrid performance at several locations in South Dakota (page 35; Plant Science 9607).

METHODS:

Corn was planted in 20-, 30-, and 36-inch rows at rates of 20,000, 25,000 and 30,000 pure live seed (PLS)/ac within each row spacing using a unit planter in a conventionally tilled corn-soybean rotation. These nine treatment combinations have been tested annually from 1992 to 1996. Stand count, grain yield, moisture content, and test weight were measured this year. Relative yield was calculated as the ratio between grain yield harvested and plant population. The economic return of these treatments was also computed for corn marketed at harvest at $2.41/bu after subtracting several variable costs including seed, fertilizer, herbicide, and moisture dockage ($0.05/point above 15% moisture, field moisture basis). Climate and other management factors relevant to this study are outlined in Table 1.

Table 1. Management practices for corn row spacing and population study. Southeast Research Farm; Beresford, SD; 1996.

Previous Crop	Soybean
Tillage	Spring Field Cultivate
Hybrid	Pioneer 3489
Fertilizer	145 lb N/ac + 50 lbP_2O_5/ac as 10-34-0 & 28-0-0
Herbicide	Lasso + Bladex + Atrazine; PPI
Planting Date	April 23
Harvest Date	October 21

RESULTS AND DISCUSSION:

Growing conditions this season were cooler than normal with good soil moisture conditions and precipitation. The intended stands were achieved with a relatively good population distribution among the row spacings this year. In general, this field had an average population of 25,000 plant/ac that yielded 173 bu/ac with 19% grain moisture and 56.6 lb/bu test weight at harvest (Table 2). Net returns after paying for several types of variable costs were $288/ac and nearly 7 bu of grain was harvested for every 1000 plants. This amounts to nearly 0.40 lb of shelled ear corn per ear assuming one ear per plant.

The 30-inch rows produced more grain and had a high level of income. The populations planted in wide rows were usually either similar to or slightly less productive than those in 30-inch rows. There was little or no evidence that establishing corn in very narrow 20-inch rows would enhance crop production or be a cost effective endeavor with the growing conditions we experienced this year.

Table 2. Row spacing and seeding rate effects on corn production. Southeast Research Farm; Beresford, SD; 1996.

Row Spacing	Seeding Rate[1]	Stand Count	Grain Yield[2]	Grain Moisture	Test Weight	EconomicReturn[3]	Relative Yield
inch	PLS/ac	plant/ac	bu/ac	%	lb/bu	$/ac	bu/1000 plants
20	20,000	19,400	155	19.5	57.0	251	8.0
	25,000	23,800	159	19.5	56.9	257	6.7
	30,000	27,100	175	19.9	57.4	285	6.5
30	20,000	20,400	173	19.0	56.3	295	8.5
	25,000	26,000	188	18.9	56.0	326	7.2
	30,000	34,400	183	18.9	56.5	309	5.3
36	20,000	18,400	168	19.3	56.9	282	9.2
	25,000	28,000	183	19.2	56.4	313	6.5
	30,000	31,000	171	19.2	56.0	278	5.5
Avg		25,400	173	19.3	56.6	288	7.1
LSD 0.10 n=4		1,600	8	0.6	0.6	18	0.50
CV%		5.11	3.82	2.5	0.9	5.16	5.70

[1] Pure live seed basis
[2] Grain yield at 15% moisture and 56 lb/bu test weight.
[3] Based on $2.41/bu less variable costs for moisture dockage, seed, herbicide, and fertilizer.

Plant populations ranged from 18,000 to 34,000 plant/ac and had a spread of at least 30 bu/ac in grain yield from 155 to 188 bu/ac. High corn populations were generally quite productive in this field. Populations of approximately 25,000 to 34,000 plant/ac outyielded populations of 20,000 plant/ac by as much as 15 bu/ac and commonly earned $30/ac more net income. The only indication of reduced corn yield possibly caused by over-crowding was with 31,000 plant/ac in wide rows. Ear size, computed from relative yield ranged from 0.30 to 0.52 lb/ear. Populations of at least 25,000 plant/ac provided among the most sustainable corn production, especially when established in rows 30 inches wide with a plentiful supply of soil moisture this year.

15" vs 30" ROW SPACING EFFECT ON CORN HYBRID YIELD

Dr. Zeno Wicks III and Craig Converse

Plant Science 9607

INTRODUCTION: There has been an increasing interest in narrow row spacing (less than 30 inches) over the last few years. The purpose of this experiment is to evaluate 15 inch narrow rows compared to conventional 30 inch rows in South Dakota. Very little research has been done in South Dakota to determine the effectiveness of planting corn in narrower rows. Research done in the surrounding states has shown that the larger more consistent yield responses have seemed to occur in the northern cornbelt. Most studies have shown anywhere from 0-10% yield increase by narrowing corn rows down to 15 inches. This is the first year of a three year study for my graduate research project.

METHODS: Five Pioneer hybrids were chosen to represent different genetic backgrounds and maturity. The study was set up as a Randomized Complete Block Design, replicated three times. Six 15 and 30 inch rows were planted in 27.5 foot rows and were thinned to a population of 25,344 plants/acre. A six row John Deere flex planter was used to plant the 15 inch rows due to the ability of the planter units to be narrowed to 15 inches. The 30 inch rows were planted with a two row John Deere Max Emerge planter because of the time involved to move the planter units and adjust the planting population.

The center four rows were harvested in the 15 inch plots and the center two rows were harvested in the 30 inch plots to represent the same amount of acres and the same number of plants. The plots were harvested with a Gleaner combine that has a 30 inch head and equipped with an electronic weigh bucket and moisture tester. There was some difficulty in harvesting the narrow row 15 inch plots with the 30 inch head, the ears not picked up by the combine head were hand harvested and placed into the combine after each plot. Climate and other management factors are outlined in Table 1.

RESULTS AND DISCUSSION: Table 2 shows the results of this experiment. The 30 inch rows yielded an average of 10.18 bu/ac better then the 15 inch rows over the entire five hybrids. The yield component has been corrected for the slight differences in the number of plants harvested. All 30 inch rows yielded better than the 15 inch rows in all five hybrids. There was no significant difference in the moisture of the grain or in the amount of ears dropped between the 15 or 30 inch rows. The 15 inch rows did have a 3% increase in the amount of stalks broken compared to the 30 inch rows.

Table 1. Management practices and climatic summary for narrow row spacing study. Southeast Research Farm; Beresford SD; 1996.

Previous Crop	Soybean
Tillage	Spring field cultivate April 24 & May 7
Planting Date	May 10
Thinned	July 11
Harvested	October 27
Herbicide PPI May 7	Eradicane 5.5 pt/ac + bladex 90 DF 1.33 lb/ac + Atrazine 0.5 lb/ac
Herbicide Post June 10	Basagran 2 pt/ac
Herbicide Post June 20	Accent 0.67 oz/ac
Fertilizer	Fertilized by hand
Soil Test Fall 1995	OM 3.1%; $N0_3$-N 0-6 inch = 7.2 ppm, 6-12 inch 3.2 ppm; 0-24 inch - 30 lb/ac; P 0-6 inch 28 ppm (H); K = 582 ppm (VH); pH = 6.3; Texture= Fine
Climate: Precipitation	24.23 inches Jan-Oct; 21.49 April-Sept
Growing Degree Units	2739 April-Oct; 2506 April-Sept
Frost Free Days 32° F	April 30 - Oct 3 - 156 days
28° F	April 30 - Oct 10 = 163 day

Table 2. 1996 Harvest Information. Southeast Research Farm; Beresford SD; 1996

Hybrid	Row Spacing	Moisture	Broken Stalks	Ears Dropped	Yield
	inch	%	%	%	bu/ac
P3559	15	16.8	17	8	113.35
P3559	30	17.2	13	6	125.14
P3563	15	17.0	19	2	128.23
P3563	30	17.5	14	0	146.98
P3730	15	15.8	05	4	123.13
P3730	30	15.9	09	3	128.51
P3733	15	16.6	16	5	122.35
P3733	30	16.5	10	7	130.16
P3751	15	15.7	14	6	118.78
P3751	30	15.6	09	9	125.94
Overall	15	16.38	14	5	121.17
Average	30	16.54	11	5	131.35

The reason for the decrease in yield due to narrowing the rows from 30 to 15 inches is unknown. This same test was conducted at Dakota Lakes Research Farm, Northeast Research Farm and at the Brookings Research Farm. At Dakota Lakes and Brookings the 15 inch rows yielded better overall than the 30 inch rows. At the Northeast farm, there was no significant difference in yield between the two row spacings. It appears that the yield increases are quite variable from one environment to another, more information will be collected over the next two years to determine if climate and other factors have an effect on the performance of producing corn in 15 inch rows.

LONG TERM RESIDUAL PHOSPHORUS STUDY

Ron Gelderman and Jim Gerwing

Plant Science 9608

INTRODUCTION:

This study was reestablished in 1994 on the site of a P study that was begun in 1964. The low soil test P treatment of this experiment has not received fertilizer phosphorus for over 30 years.

The objectives of this study are:

1. To determine optimum P soil test level under residual P management and under management where P is added each year.

2. To determine maintenance levels of P as affected by initial P soil test levels.

3. To compare the influence of annual P placements (broadcast vs band) upon crop yields.

METHODS:

Four soil test levels (Table 1) were established by broadcasting phosphorus fertilizer in the spring of 1993 and were chiseled for incorporation. Soybeans were planted in 1993 and the stubble moldboard plowed in the fall. Two medium (M) soil test levels were established to compare placement effects for annually applied phosphorus rates.

Annual broadcast rates (0, 20, 40, and 60 lb/ac P_20_5) were applied and chiseled in the spring of 1994. The site was planted to DeKalb 554 at 25,600 plants/acre on 10 May 1994. Identical annual P rates were applied at planting with a fertilizer opener that placed the fertilizer 2 inches below and 2 inches to the side of the seed band. The phosphorus fertilizer used for all treatments was 0-46-0. Five pounds of zinc/ac (as zinc sulfate) was applied with all annual treatments (including the zero rate). Ninety pounds of N was applied over the site.

For 1995, soybeans (Marcus) were planted no-till (30" rows) at about 180,000 plants/ac on 19 May 1995. Annual band phosphate for soybean was placed as for corn in 1994. Broadcast phosphate rates were hand applied on the soil surface after planting. All phosphorus fertilizer was 0-46-0. No zinc was applied in 1995.

For 1996, corn (DK 512) was planted at 26,600 plants/ac on 9 May 1996. Band and broadcast treatments were applied as in 1995. Plot size is 15' x 45'. Nitrogen was knifed on all plots as 28% material at 120 lb N/ac on 19 June 1996. Weed control consisted of Dual II and atrazine applied preplant. A burndown treatment of Roundup was applied just prior to planting. Three of the center rows were harvested for grain with a plot combine on 24 October 1996.

Soil samples were taken on all zero annual rate treatments for all soil test levels (Table 1). In addition, soil samples were taken on all broadcast annual rate treatments (Table 2). Samples were taken in 3 inch increments to a 9 inch depth. A grain sample was not taken for P analysis to determine phosphorus removal in 1996.

RESULTS AND DISCUSSION

The soil P tests from the fall of 1994 and 1995 (table 1) reflect the soil test levels that were established by application of phosphorus in 1993. The results indicate that soil tests have declined slightly since the fall of 1994. The 1995 crop of soybeans removed about 30 lb P_2O_5/ac at the higher soil test levels (table 1). Soil tests appear to be stable at the 20 and 40 lb P_2O_5/ac annual broadcast rates (table 2). The highest rate (60 lb/ac) appears to be building soil tests. This would appear consistent with P removal rates that averaged approximately 40 lbs P_2O_5/ac. Phosphorus removed by the grain appears to be slightly higher with higher annual rates on this low-medium soil test level (table 2).

Yields for the study are found in table 3 and are presented in graphical form in figures 1 and 2. Rate of banded phosphate influenced corn yields differently depending on soil test level (table 3 and figure 1). At a very low soil test, corn yield was raised 40 bu/ac by banding phosphorus - maximizing with the 60 lb/ac rate. At the intermediate test levels, yields increased about 9-15 bu/ac, whereas at the high soil test yields increase approximately 10 bu/ac over the check. Apparently, with high corn yields, high soil tests alone could not supply enough phosphate to the plant. Added fertilizer P was also needed to maximize yields.

Placement of phosphorus significantly (0.11) influenced corn yields to rates of phosphorus. Broadcasting P increased yield approximately 10 bu/a over band placement over all rates of P (figure 2). These results are quite surprising considering the broadcast P was applied directly to the surface after planting. Apparently, rootsare absorbing P at the soil surface. Perhaps at this soil test level and these yield levels, banded P was too localized for roots to meet total plant P needs. Placement influence in a dryer year will be interesting to note.

Two year grain P removals for each treatment are shown in figure 3.

Table 1. Phosphorus soil tests [1] and phosphorus removed by grain for 1994 and 1995 of long-term P.

Soil Test Level	- - - - Bray P - - - -		- - - - Olsen P - - - -		P_2O_5 Removed by grain	
	1995	1995	1994	1995	1994	1995
	- - - - - - - - - - - - -ppm- - - - - - - - - - - - -				- - - - - - lb/ac- - - - - -	
1	5	5	3	3	31	20
2	8	7	5	4	46	27
3	13	11	8	7	50	31
4	25	20	15	13	54	33

[1] Sampled in fall of 1994 and 1995 from checks (0-6") of each soil test level.

Table 2. Phosphorus soil tests[1] and phosphorus removed by grain from broadcast rates of long-term P study, SE Farm.

P_2O_5 Rate	- - - - Bray P- - - -		- - - - -Olsen P- - - -		P_2O_5 Removal by grain	
lb/ac	1994	1995	1994	1995	1994	1995
	- - - - - - - - - - - - -ppm- - - - - - - - - - - - - - -				- - - - -lb/ac- - - - -	
0	11	9	6	5	48	31
20	11	11	6	8	51	32
40	14	14	7	8	50	33
60	16	18	8	12	50	35

[1] Sampled in fall of 1994 and 1995 from broadcast treatments (0-6").

Table 3. Corn yields as influenced by soil test level, annual P rates and placement, long-term P study, 1996.

Soil Test Category[1]	- - - - Annual P_2O_5 rates - lb/ac- - - - 0	20	40	60	mean
	----Yield, bu/ac----				
VL (band)	126	155	159	166	152
L (band)	160	166	163	169	164
L (bct.)	170	174	183	179	177
M (band)	158	173	166	173	167
H (band)	173	176	178	183	178
mean	157	169	170	174	---

[1]VL, L, M and H (Olsen P) = very low (3ppm), low (4 ppm), medium (7 ppm), and high (13 ppm), respectively.
Pr >F: soil test level = 0.0007; annural rate = 0.0022; soil test *rate = 0.0093. Placement = 0.11.

NITROGEN FOR CR0P ACRES

Ron Gelderman and Jim Gerwing

Plant Science 9609

INTRODUCTION: In the next four years (1997-2000) over 1.5 million acres of CRP could come back into crop production in South Dakota. Much of these acres are grass or grass/legume and typically are low in plant available nitrate-N; however, if tilled, much of the organic residue will eventually break down into plant available nutrients.

The objective of this study is to evaluate the influence of tillage and added N on yields and soil nitrate levels after a grass sod.

METHODS: The experiment site had been in a warm season grass (big bluestem) for over 20 years. The final stand contained cool season bluegrass as well as bluestem. The grass was chiseled in the fall of 1995 and chiseled and disked in the spring of 1996 before planting.

The experiment was established with two tillage systems (tilled and no-till) and 6 rates of N (0, 30, 60, 90, 120, 150 lbs N/ac)in a split plot design. The tillage treatments will be established in the fall of 1996. The treatments were replicated four times. Corn (Pioneer 3556) was planted at 27,000 plants/ac on May 7, 1996. Nitrogen was hand broadcast as ammonium nitrate just after corn emergence. Weed control consisted of Dual which was applied in a band with the planter and Buctril and Accent applied post emergence. A considerable number of big bluestem plants emerged later in the season from the tilled sod; however, it was felt that yield reduction was minimal from this grass.

Soil samples from the zero N plots were taken at planting and 6-leaf stage. The zero and 150 lb N rate plots were sampled at silk stage and all plots were sampled after harvest. Samples were taken to 24 inches in depth. Yields were taken by combining three of the center rows of the six-row plots on October 16, 1996. Plots size is 15 x 40'. Other soil tests were considered very high for P and K, organic matter was 3.5-4.0% and pH was 5.9.

RESULTS AND DISCUSSION: Soil nitrate-N was extremely low at the time of tillage in the Fall of 1995 (Table 1). It increased to 20 lb/ac - 2' and was stable until the six-leaf stage. After plants began using available nitrate-N, levels fell to those measured at the silk stage. The 150 lb N rate contained only 27 lb/ac at this stage. This could be due to plant use and/or use by microorganisms breaking down the soil residues (Table 1).

Yield response to nitrogen was dramatic. Very low yields were produced with no nitrogen. Obviously nitrogen was being immobilized very quickly. Yields may not have been maximized at the 150 N rate. Other nearby sites had yields of 170-180 bu/acre. The 150 lb N rate did show some N deficiency symptoms. At a yield goal of 160 bu/ac and with similar nitrate N levels, 180 lb N/ac would be recommended using the SDSU soil testing lab recommendations.

The harvest soil sample analysis are not yet complete. The fall tillage treatments were established on November 13, 1996. The tillage consisted of a chisel and disc. A light spring discing is anticipated for the spring of 1997.

Table 1. Influence of time of sampling on soil nitrate-N levels following tillage of a grass sod. SE Farm; 1996.

	- - - - - - - - - - - - - - - - - - -Time- -				
Depth	fall 1995	spring	planting	6-leaf	soil
inches	- - - - - - - - - - - - - - - - nitrate-N, lb/ac - - - - - - - - - - - - - - - -				
0-24	6	8	20	18	10

Soybean will be planted in 1997 with no N rates applied. Soil samples will again be taken periodically throughout the season.

In summary, if tillage is done late on CRP acres, large N applications are needed. Nitrogen recommendations should follow deep nitrate-N soil tests.

Table 2. Influence of nitrogen on corn grain yields after sod. SE Farm; 1996.

N Rate	Yield
lb/acre	bu/acre
o	45
30	62
60	102
90	117
120	138
150	162
Pr>5	0.0001
LSD	16.0
C.V. (%)	10.2

FERTILIZER POTASSIUM, SULFUR, ZINC, PHOSPHORUS AND LIME EFFECTS ON CORN YIELD ON HIGH TESTING SOIL

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Plant Science 9610

INTRODUCTION

Some farmers in South Dakota are using phosphorus, potassium, sulfur, zinc and lime on soils with very high soil tests. Research by soil fertility staff at South Dakota State University during the last 30 years has not shown consistent economical responses to these fertilizer nutrients or lime when soil test levels are very high. The SDSU Soil Testing Lab, therefore, does not recommend they be applied as fertilizer or lime unless soil test levels are lower. The demonstrations reported on here were established to show the effects of each of these commonly used nutrients and lime on corn and soybean yields when applied to high testing soils.

MATERIALS AND METHODS

Two experimental sites were established, one on the SE experiment farm near Beresford in 1988 and another on the agronomy farm near the SDSU campus in Brookings in 1990. Fertilizer treatments have continued at each location on the same plots since establishment. A corn-soybean rotation was followed at both locations. Corn was the 1996 crop.

The soil at the SE Farm site is an Egan silty clay loam. Egan soils are well drained soils formed in silty drift over glacial till. The soil at the Brookings Agronomy Farm is classified as a Vienna loam. Vienna soils are well drained medium textured loam and clay loam soils formed from glacial till. Both soils are typical upland soils for their respective areas in the state.

Fertilizer treatments were 50 lbs K_2O, 25 lbs sulfur (as elemental sulfur), 5 lbs zinc (as zinc sulfate) and lime at both locations (Table 1). In addition, the Brookings site had a 40 lb P_2O_5 treatment. The fertilizer treatments were applied each spring since the establishment year (1988 at Beresford and 1990 at Brookings) on the same plots. Lime was applied only once (the establishment year) at the SE Farm location and twice (1990 & 1992) at Brookings. All fertilizer materials were broadcast and followed by either discing or field cultivation. Herbicides were applied as needed at both locations.

An adapted corn hybrid (Pioneer 3556) was planted on May 1 at Beresford and Dekalb 471, a 97 day hybrid was planted at Brookings on May 21. Eighty-five pounds of nitrogen was applied to all plots at Brookings as ammonium nitrate at corn emergence. At Beresford, 95 pounds of nitrogen as urea was applied to all plots with the other fertilizer treatments and incorporated prior to planting.

Harvest was done at Beresford with a field combine taking three rows 50 feet long. At Brookings, 60 feet of row was hand harvested from the center of each plot.

A randomized complete block design with four replications was used at both sites. Plot size was 15 by 50 feet at Beresford and 20 by 40 feet at Brookings.

RESULTS AND DISCUSSION

Soil test levels from soil samples taken in fall 1995 at both sites are presented in Table 2. Potassium soil test levels were very high at both locations and no recommendation would have been made by the SDSU Soil Testing Lab. After 8 years of 50 lb annual K applications, the K soil test at Beresford has increased 63 ppm. After 6 years of K applications at Brookings, soil test levels increased 40 ppm.

The sulfur soil test in the check plots at Beresford was low, possibly due to leaching from very heavy rainfall in 1995. Sulfur would have been recommended on a trial basis by the SDSU soil testing lab for this soil type. The annual application of 25 lbs sulfur raised the soil test into the high range. The sulfur soil test was very high in both the check and treated plots at Brookings.

Zinc soil tests were high at both locations and no fertilizer recommendations would have been made. Zinc applications raised the zinc test from 0.95 ppm in the check to 4.9 ppm at Beresford and from 1.21 to 4.65 ppm at Brookings. The lime treatment raised the pH at the Beresford site from 6.0 to 6.6 and at the Brookings site from 6.5 to 7.3. The SDSU Soil Testing Lab would not have recommended lime at either site. The phosphorus soil test level at the Brookings site was very high prior to the phosphorus application and no phosphorus would have been recommended. The 40 lb annual phosphorus applications at this site raised the Olsen soil test level 2 ppm. There was no phosphorus treatment at Beresford.

Corn yields for both sites in 1996 are listed in Tables 3 and 4. Corn yields were good, about 155 bu/ac at both sites, but they were not significantly increased over the check by any of the applied nutrients or lime at either of the locations. The lack of response at both of these locations to the applied nutrients and lime is consistent with previous studies and current fertilizer recommendations made by SDSU.

Yield results and soil test levels from previous years for these two studies can be found in the SE Farm Progress Reports (1988-1995) and in the 1990-95 SDSU Plant Science Department Soil/Water Science Research Technical Bulletin Nos. 97 and 99.

Table 1. Fertilizer Treatments, Fertilizer and Lime Demonstration, Beresford and Brookings.

Treatment	Fertilizer Rates	
	Beresford[1]	Brookings[2]
	--------------------------------lb/ac------------------------------	
Check	0	0
Phosphorus (P_2O_5)	0	40
Potassium (K_2O)	50	50
Sulfur	25	25
Zinc	5	5
Lime	-----[3]	-----[4]

[1] Applied each spring, 1988-1996.
[2] Applied each spring, 1990-1996.
[3] 4000 lb $CaCO_3$ equivalent applied spring 1988.
[4] 2500 and 2400 lb $CaCO_3$ equivalent applied spring 1990 and 1992 respectively.

Table 2. Soil Test Levels, Fertilizer and Lime Demonstration, Beresford and Brookings

	Soil Test Level			
	Beresford[1]		Brookings[2]	
Soil Test	Check	Treatment	Check	Treatment
Potassium ppm, 0-6 in	242	305	162	202
Sulfur, lb/ac 6 in	2	8	26	4
lb/ac 2 ft	14	32	170	64
Zinc, ppm	0.95	4.9	1.21	4.65
pH, 0-6 in	6	6.6	6.5	7.3
Olson Phosphorus, ppm, 0-6 in	8	-----	19	21
NO_3-N, lb/ac 2 ft	22	-----	28	-----
Organic Matter, %	3.6	-----	2.9	-----
Salts, mmho/cm	0.20	-----	0.40	-----

[1] Sampled 10/10/95 [2] Sampled 11/13/95

Table 3. Fertilizer Effects on Corn Yield, Beresford, 1996.

Fertilizer Treatment[1]	Corn Yield
	bu/ac
Check	148
Potassium	155
Sulfur	155
Zinc	155
Lime	143
Prob of > F	0.31
C.V. %	5.9
LSD .05	13

[1] All plots received 95 lb N/ac

Table 4. Fertilizer Effects on Corn Yield, Brookings, 1996.

Fertilizer Treatment	Corn Yield
	bu/ac
Check	158
Phosphorus	157
Potassium	158
Sulfur	156
Zinc	154
Lime	160
Prob of > F	0.95
C.V. %	6.0
LSD .05	14

[1] All plots received 85 lb N/a

NITROGEN SOURCE AND AGROTAIN EFFECTS ON UREA VOLATILIZATION, BERESFORD, BROOKINGS, AND FRANKFORT SD 1996

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Plant Science 9611

INTRODUCTION

No-till acreage has increased dramatically during the last 10 years in SD. With the increase has come a shift towards non-incorporated broadcast applications of nitrogen fertilizer. Research in other states has shown surface applications of nitrogen to occasionally be less efficient due to possible volatilization losses of N. In some cases immobilization of N in the residue has also been implicated. In most cases these studies have been done where temperatures are warmer and therefore losses of N, especially volatilization of surface applied urea N, are more likely. To help stop volatilization losses, a chemical with the trade name of "Agrotain" was developed. Research in southern states has shown this to be effective in high loss situations. The studies reported on here were initiated to help determine the extent of N loss from surface application of urea in no-till under South Dakota conditions and if Agrotain would minimize these losses.

MATERIALS AND METHODS

Three sites were selected for this experiment; the SE Experiment Farm near Beresford, the Brookings Agronomy Farm and the Barry Muxen Farm near Frankfort. All three sites had soybeans as the previous crop and were not tilled. Soil test levels for the three sites are listed in Table 1. Nitrate soil test levels were high, ranging from 73 lb/ac 2 feet at the Frankfort site to 99 lb at Beresford. The phosphorus soil test level at Beresford was low and 25 lb/ac P_2O_5 was applied as a starter. Other soil test levels were adequate and no additional fertilizer was applied besides the nitrogen treatments.

Nitrogen treatments are listed in Table 2. Rates were 0, 40 and 80 lb/ac at all 3 locations. The Frankfort location also had a 120 lb/ac rate. Each rate of nitrogen was applied as both urea (46-0-0) and ammonium nitrate (34-0-0). The ammonium nitrate treatment was used as a "check" for urea volatilization since it will not volatilize. An additional treatment at the 40 lb/ac N rate at each location was urea treated with Agrotain. Agrotain was impregnated on the urea at the rate of 5 quarts per ton prior to application.

All nitrogen treatments were broadcast on the surface shortly after corn emergence (one to two leaf stage). No-tillage was done. Rainfall was monitored closely after N application since a significant rain would move nitrogen into soil and prevent urea volatilization losses. The date of N application and dates and amounts of rain during the two weeks following application are listed in Table 3. At Beresford, Brookings and Frankfort, 9, 8 and 12 days respectively elapsed between N application and the first significant precipitation. That length of time should have been adequate to allow significant urea volatilization loss of N if it was going to occur. The Frankfort site had 0.12 inches rain 3 days after fertilization. That is generally not considered adequate to move N into soil and prevent volatilization losses. In some cases, "small" rains like this can enhance loss as they rapidly evaporate from the soil and residue surfaces.

All treatments were replicated 4 times. Plot size was 15 feet by 40 feet at Brookings and Frankfort and 15 feet by 50 feet long at Beresford. The Frankfort plot had 22 in wide rows while the others were 30 in rows. The corn at Frankfort had been planted with a drill and the plant spacing was somewhat variable. The Beresford site was harvested by taking 3 rows 50 feet long with a combine. The Frankfort and Brookings sites were hand harvested by picking 80 feet of row at Frankfort and 60 feet at Brookings.

It was a good growing season, however, relatively dry conditions persisted most of the summer at Frankfort and the early parts of summer at Brookings. June, July and August precipitation totals were 3.34, 5.45 and 10.6 inches respectively for Frankfort, Brookings and Beresford. Maximum yields were close to 160 bushels at Frankfort and Brookings and 180 bushels at Beresford.

RESULTS AND DISCUSSION

Corn grain yields for the three sites are given in Table 2. At Beresford, yields ranged from 138 bushels per acre with no N to 178 bushels with 80 pounds per acre N. There was no difference in yield between the ammonium nitrate and urea treatment at either the 40 or 80 lb N rates, indicating volatilization losses did not occur at this location.

At Brookings, yields ranged from 115 bushels with no N fertilizer to 160 bushels per acre at the 80 pound N rate. Although yields at Brookings were slightly more variable, at the 40 pound N rate ammonium nitrate did yield more than urea, indicating some volatilization losses may have occurred. There was no difference between the materials of the high N rate, however at that rate nitrogen would be less limiting and a difference in yield less likely.

Yields at Frankfort were variable, possibly due to uneven variable plant spacing. Like the Beresford and Brookings sites, there was a large increase in yield due to nitrogen fertilizer (Tables 2, 4 and 5) with the check yields averaging about 125 bu/ac and the high N rate reaching nearly 170 bushels. Similar to the Beresford site, there was no difference between the urea and ammonium nitrate treatments, even though rainfall was minimal for 12 days after application.

Agrotain did not significantly increase yield at any of the locations (Table 6). However, at the Beresford and Frankfort sites, where urea volatilization was not detected, Agrotain was not needed. At Brookings, where volatilization losses were likely, the Agrotain treatment showed a trend toward increasing yield (possibly slowing volatilization) but still did not yield equal to the ammonium nitrate. Apparently some losses still occurred.

In summary, 2 of 3 sites did not show evidence of volatilization losses of surface applied urea nitrogen onto no-till even though conditions were "favorable" for loss. Surface applications could therefore be an acceptable management practice, however, some risk would be involved since one site did show evidence of volatilization losses. Agrotain, designed to help prevent volatilization losses may help in high loss situations.

It should be noted that losses are associated with temperature, and application made earlier in spring would be less likely to have volatilization losses.

The Frankfurt experiment also had one sulfur treatment (4 replications). The sulfur rate was 40 pounds per acre applied on the surface as ammonium sulfate (21-0-0-24). Non-incorporated applications of sulfate sulfur are acceptable because sulfate moves into soil with water and is readily available to plants. The total nitrogen level in this treatment was brought up to 120 pounds by the addition of ammonium nitrate. Corn yield from this treatment is compared to the 120 pound N rate without sulfur in Table 7. Sulfur did not increase yield. The sulfur soil test in the top 2 feet of soil was medium and no sulfur would have been recommended for this soil type.

Table 1. Soil Test Levels, Urea Volatilization Studies, Beresford, Brookings and Frankfort, 1996.

Test	Beresford	Brookings	Frankfort
NO_3-N, lb/ac 2 ft	99	85	73
Phosphorus, ppm	4	24	17
Potassium, ppm	291	197	833
Organic Matter, %	3.8	3.1	3.4
pH	6.1	6.8	6.7

Table 2. Urea Volatilization Study Corn Yields, Beresford, Brookings and Frankfort, 1996.

Nitrogen		Corn Yield		
Rate	Material[1]	Beresford	Brookings	Frankfort
lb/ac		--------------------------------------bu/ac	---------------------------------	
0	AN	-----	117 A B	134 B
0	U	138 A	113 A	113 A
40	AN	163 B	145 D E	134 B
40	U	161 B	128 B C	142 B C
40	U + Agr	160 B	134 C D	134 B
80	AN	178 C	160 F	154 C D
80	U	177 C	152 E F	149 B C
120	AN	-----	-----	169 D
120	U	-----	-----	158 C D
Pr > F		0.0001	0.0001	0.0001
CV %		4.3	5.6	8.4
LSD		10.5	11.3	17.6

[1] AN = ammonium nitrate (34-0-0), U = Urea (46-0-0), Agr = Agrotain

Table 3.Precipitation Events 14 Days Following Nitrogen Application, Urea Volatilization Studies, Beresford, Brookings and Frankfort, 1996.

Beresford		Brookings		Frankfort	
Date	Amount	Date	Amount	Date	Amount
June	inches	June	inches	June	inches
7	-----[1]	7	-----[1]	3	-----[1]
7	0.01	15	0.27	6	0.12
16	0.51	16	0.23	15	0.56
17	1.26	17	0.32		
18	0.11	20	0.23		
		21	0.09		

[1] Nitrogen application date

Table 4. Nitrogen Fertilizer Source and Rate Effect on Corn Yield, Frankfort, 1996.

Nitrogen Rate	Material 34-0-0				Material 46-0-0		
lb/ac	-------------------------bu/ac------------------------						
0	135	A			113	A	
40	134	A			142	A	
80	154		B		149	A	
120	169			C	158		B
Pr > F	0.0008				0.19		
CV %	5.8				5.1		
LSD .05	14				24		

Table 5. Nitrogen Fertilizer Source and Rate Effect on Corn Yield, Frankfort, 1996.

Nitrogen Rate	Material 34-0-0	Material 46-0-0	Average
lb/ac	--------------------------------bu/ac--------------------------------		
0	135	113	124
40	134	142	138
80	154	149	152
120	169	158	164
Average	148	140	

CV % = 8.6
Pr > F: fert. = 0.10, rate = 0.0001, fert. x rate = 0.14

Table 6. Agrotain Effects on Corn Yield, Beresford, Brookings and Frankfort, 1996.

Nitrogen Rate	Nitrogen Material[2]	Corn Yield[1] Beresford		Corn Yield[1] Brookings		Corn Yield[1] Frankfort	
lb/ac		---------------------------------bu/ac------------------------------					
40	AN	163	A	145	A	134	A
40	U	161	A	128	B	142	A
40	U + Agrotain	160	A	134	B	134	A
Pr > F		0.63		0.02		0.56	
CV		2.8		4.3		8.7	
LSD .05		8		10.1		21	

[1] 0 N rate yield = 138, 115 and 124 bu/ac for Beresford, Brookings and Frankfort respectively
[2] AN = ammonium nitrate (34-0-0), U = Urea (46-0-0)

Table 7. Sulfur Effect on Corn Yield, Frankfort, 1996

Fertilizer		
nitrogen	sulfur[1]	Corn Yield
---------------------lb/ac------------------		bu/ac
120	0	169 A
120	40	155 A
Pr > F		0.10
CV %		5.00
LSD 0.05		19

[1] SO_4 - S soil test, lb/ac: 0 - 2 feet = 22, 2 - 4 ft = 62

NITROGEN MANAGEMENT IN A CORN SOYBEAN ROTATION

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Plant Science 9612

INTRODUCTION

There is increasing concern about the effects of nitrogen fertilizer on the environment, especially groundwater quality. This concern has been intensified by reports of NO_3-N concentrations above the legal drinking standard of 10 ppm in several locations in eastern South Dakota, especially where aquifers are shallow and soils are very coarse. In some instances, nitrogen fertilizer moving below the root zone has been implicated.

This nitrogen management demonstration was established to show the effects of N rates in a corn-soybean rotation on nitrogen movement below the root zone. In most situations in South Dakota, if nitrogen moves below the root zone it stays there and only rarely moves back up. Therefore, once out of reach of crop roots, NO_3-N has the potential to move down to the groundwater with percolating water during wet periods.

MATERIALS AND METHODS

This nitrogen management demonstration was established on the SE South Dakota Experiment Farm near Beresford in 1988. It is located on an Egan silty clay loam soil. Egan soils are well drained soils formed in silty drift over glacial till.

Corn was planted on the site in even numbered years from 1988-1996 and soybean was planted in the odd numbered years, 1989-1995. The rates and timing of nitrogen fertilizer applied to the corn in 1996 are listed in Table One. The treatments included a check (no N), the recommended rate applied in fall, spring or split between spring and just prior to the last cultivation and 200 and 400 lb rates spring applied regardless of the previous soil test. These treatments were applied to the same plots each year that corn was planted in the rotation. The recommended rate, however was adjusted according to the NO_3-N soil test level and for credit given for the previous years' soybeans (1 lb N credit for 1 bushel beans). The recommended nitrogen rate was 123, 62, 90, 95 and 95 lb/ac respectively for 1988, 1990, 1992, 1994 and 1996. Nitrogen was broadcast as urea and immediately incorporated by tillage except for the fall application which was not incorporated.

Phosphorus, potassium and pH soil test levels at the site are 15 and 256 ppm and 5.8 respectively. A randomized complete block design was used on this experiment with four replications. Plot size was 15 feet by 50 feet.

Corn was planted on the site on May 8, 1996. Yields were obtained by direct combining 3 rows 50 feet long from each plot. Soil samples were taken to a depth of 6 feet in one foot increments on November 12, 1996 from the 0, spring recommended, 200 and 400 lb N rate treatments.

RESULTS AND DISCUSSIONS

Nitrate soil test results from samples taken in November of 1995 and 1996 are given in Table 2. Nitrate soil tests were less than 45 pounds per acre in the four foot profile for both the check and recommended rate treatments. The recommended nitrogen rate did not result in higher nitrate levels than the unfertilized check. This was likely due to high corn yields (140 bu/ac) in the fertilized plot.

The 400 pound nitrogen rate plot had 232 pounds nitrate nitrogen remaining in the top 4 foot of soil. When comparing the residual nitrogen profile of the 400 pound N rate in the fall of 1996 to that of 1995, it appears spring applied nitrogen moved down 2 or 3 feet in the soil profile in 1996. Rainfall of over 15.5 inches between May and August (Table 3) was likely the cause of N movement. It does not appear that nitrogen applied in the spring of 1996 moved below the 4 foot depth. There was elevated levels of nitrate N in the 4 to 6 foot level (145 lbs), however, there was already 193 lb/ac in that soil zone in the fall of 1995 (Table 2).

Corn grain yields for the spring applied nitrogen rates are given in Table 4. The recommended N rate (95 lb/ac) resulted in 140 bu/ac corn yield, a 58 bushel yield increase over the 0 N rate. The 200 lb N rate increased yield to 167 bu/ac. This yield increase over the recommended rate was likely due to the high yields in 1996. The recommended N rate was based on a yield goal of 130 bu/ac, which was reached with that N rate.

Corn yields from the spring and split applied rates were similar, indicating leaching from spring applied nitrogen did not occur. The fall applied nitrogen, however, resulted in lower yields then either the split or spring applied. The lowered yields may have been due to volatilization losses of the unincorporated fall applied area. Late fall and early winter moisture was very minimal (Table 3). This reduction in yield to fall applied yield was not consistent with previous years from this study. In those years, fall applied N resulted in equal yield to spring applied incorporated nitrogen.

These plots will be rotated back to soybean in 1997 and soil sampled in the fall to determine the amount and location of residual soil nitrate. Corn and soybean yields and soil tests from previous years of this study can be found in the SE Farm Progress Reports and in the Plant Science Department Soil/Water Science Research Annual Reports, 1988-1995.

Table 1. Nitrogen Fertilizer Treatments, Nitrogen Fertilizer Demonstration, Beresford, SD, 1996.

	Time of Application		
Treatment	Spring[1]	Split[2]	Fall[3]
No.	lb N/ac		
1	0	---	---
2	95	---	---
3	30	65	---
4	---	---	95
5	200	---	---
6	400	---	---

[1] May 1, 1996
[2] June 19, 1996
[3] November 8, 1995

Table 2. Fall Nitrate Soil Test Levels, Nitrogen Management Demonstration, Beresford, SD, 1996.

	Fertilizer N Applied, 1988, 1990, 1992, 1994, 1996, lb/ac							
	0		Recommended[1]		200		400	
Depth	1995	1996	1995	1996	1995	1996	1995	1996
feet	Soil NO_3-N, lb/ac[2]							
0 - 1	8	14	10	15	12	21	12	69
1 - 2	16	7	18	10	16	22	13	87
2 - 3	13	11	12	6	13	23	20	44
3 - 4	6	11	10	7	16	15	74	32
4 - 5	8	13	14	13	34	26	106	67
5 - 6	8	8	15	12	34	37	87	78

[1] Rates applied were 123, 62, 90, 95 and 95 lb N/acre in spring of 1988, 1990, 1992,1994, and 1996 respectively.
[2] Soil sampling dates: Nov. 3, 1995; Nov. 12, 1996

Table 3. Rainfall at the SE Experiment Farm, Beresford, Nov. 1, 1995 to Oct. 31, 1996.

Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct
					inches						
0.9	0.1	0.5	0.1	0.8	0.5	5.0	3.9	3.9	2.8	5.4	1.4

Table 4. Nitrogen Rate Effect on Corn Yield, Beresford, 1996.

Nitrogen Rate[1]	Yield
lb/ac	bu/ac
0	82 A
95	140 B
200	167 C
400	170 C
Pr > F	0.001
CV, %	4.3
LSD	9.6

[1] Applied May 1, 1996

Table 5. Nitrogen Timing Effect on Corn Yield, Beresford, 1996.

Time of N Application[1]		Corn Yield
		bu/ac
Fall	(Nov. 8, 1995)	121 A
Spring	(May 1, 1996)	140 B
Split	(30 lb May 1, 65 lb June 19, 1996)	149 B
Pr > F		0.005
CV, %		5.5
LSD 0.5		13.1

[1] 95 lb N/ac

ACID BASE, SEED PLACED, STARTER FERTILIZER EFFECTS ON CORN AND SOYBEAN

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Plant Science 9613

INTRODUCTION:

Starter fertilizer is one of the accepted practices for South Dakota row crop farmers. A standard starter fertilizer material has been ammonium polyphosphate (10-34-0). New sources of starter are available and need to be evaluated. One type of new fertilizer material has a phosphoric acid base (Advanced Prescription Fertilizer Inc., Hurley, SD). This project evaluated the effect of acid base fertilizer on soybean and corn. At the Southeast Farm at Beresford, starter fertilizers are not applied to soybean, but 10-34-0 is applied to corn. Therefore, a research project was initiated to evaluate the following objectives.

Objectives:

Determine and measure the effects of starter fertilizer applications on:

1: soybean and corn plant growth parameters and grain yield,
2: soil P and pH in and out of the fertilizer zone,
3: removal and maintenance of ortho-phosphate in the soil
4: economic returns for fertilizer application

MATERIALS AND METHODS:

The treatments for each crop, rates of fertilizer, analysis of fertilizer, application speed at planting, and cost for each starter fertilizer treatment are found in Table 1. This was a cooperative project between Southeast Research Farm and SDSU campus staff and was sponsored in part by Advanced Prescription Fertilizer Inc., (APF) Hurley, SD. A summary of cultural and management practices, including sampling protocol is included in table 2.

RESULT AND DISCUSSION:

Soil parameters:

The application of APF starter fertilizer on soybean increased the Olsen P soil test with the 10 gpa rate but not the 5 gpa rate when compared to the check plot and the non fertilized inter-row area (Table 3). The application of APF starter fertilizer on soybean did not change the soil pH compared to the check plot or the inter-row (no-band) sample.

The application of 5 and 10 gpa of APF starter fertilizer on corn had little or no effect on soil test Olsen P or pH when compared to the check plot or inter-row (no-band) samples (Table 4). However, the application of 20 gpa of APF starter and 10 gpa of 10-34-0 on corn did increase soil test Olsen P vs. the check plot and inter-row (no-band) samples, and the 10 gpa rate of 10-34-0 was better than the 20 gpa rate of APF (Table 4). The only significant pH change on corn occurred with the 20 gpa rate of APF fertilizer when compared to the inter-row (no-band) sample but not when compared to the check plot (Table 4). The APF starter fertilizer is marketed as an acidic fertilizer and therefore pH measurements were taken to determine the effect and magnitude of possible pH changes.

Growth parameters and grain yield of soybean:
Average for plant population, early bloom (EB) dry weight analysis and P concentrations, grain test weight, moisture and yield of soybean are shown in Table 5. The response affected by fertilizer application was plant population. Measured plant populations increased as APF starter fertilizer rates increased (Table 5). Planting speed could be an explanation for this (Table 1) although the check and 10 gpa rate were seeded at similar speeds. The presence of starter fertilizer during emergence could have helped some seedlings to survive. Emergence was hampered by cold, wet weather during May. There is no trend in EB dry weight by APF treatment, although EB P concentrations do increase, but not significantly (Table 5). Grain test weight, moisture, and yield were not affected by the APF starter fertilizer rates applied (Table 5). The Olsen P soil test levels are low to medium at this site (Table 3), so a yield response to P fertilization was expected.

Growth parameters and grain yield of corn:
Averages for the number of plants counted at the V6 growth stage, dry weight of V6 plants, V6 plant P concentration, ear leaf (EL) P concentration, plant population, grain moisture and yield are presented in Table 6. The number of V6 plants counted and the concentration of P in the EL sample were not influenced by the fertilizer rates tested (Table 6). Corn dry matter at the V6 growth stage did increase with higher applications of starter fertilizer, and with the 10-34-0 treatment resulted in the best growth. Phosphorus concentrations in the V6 sample also increased with greater fertilizer application, with the 10-34-0 treatment having the highest concentration (Table 6). As fertilizer rate increased grain moisture decreased (Table 6). Differences in plant population were also measured between the treatments and can be explained in part by differences in planting speed (Tables 6 and 1). There was also a trend for lower plant populations at higher applications of APF fertilizer (Table 6). The check and 10 gpa rate of 10-34-0 have similar populations, while corn with APF fertilizer were lower (Table 6). Grain yield increased with higher rates of starter fertilizer were applied. The yield response to higher rates of starter fertilizer is associated with the presence of more phosphorus in the soil (Table 1). The other nutrients in the APF fertilizer probably are not contributing to greater yield because 10-34-0 only contains P. The presence of nitrogen early in the growing season probably

did not contribute greatly to yield response because all plots were sidedressed with 28-0-0 on June 12 (Table 2).

Phosphorus application rates and crop removal:

Amounts of P_2O_5 applied, grain yield by crop and starter fertilizer treatment, P_2O_5 removed by each treatment yield, and the P_2O_5 fertilizer deficit are found in Table 7. The P_2O_5 deficit is P removed from the soil taking into account that amount applied in the fertilizer. The soil supplied a great amount of P_2O_5 when compared to the overall applications of P_2O_5 in the starter fertilizers. Applying 10 gpa of 10-34-0 reduced the P_2O_5 deficit by two thirds. None of the starter fertilizer treatments would be considered a maintenance application of P_2O_5. Another 5 gpa of 10-34-0 would be needed to replace all the P_2O_5 removed by the crop. However, 10 gpa of 10-34-0 can be safely placed with the seed. This indicates that using starter fertilizer needs to be supplemented with an additional supply of P for optimum corn production in this field.

Economic analysis of starter fertilizer application:

An economic analysis comparison of applying the different rates of APF and 10-34-0 starter fertilizers are found in table 8. Net return over costs for corn is figured by taking the wet bushels and subtracting the drying costs, seed cost and fertilizer cost. The net return over the check is figured by determining the difference between the treated plots and the check. Net return over costs for soybean is figured by taking the dry bushels and subtracting the seed and fertilizer costs. Net return over the check is determined the same as for corn. Applying starter fertilizer on corn paid for itself for every treatment but not on soybeans (Table 8). When thinking about these economic returns one really needs to keep in mind what significant differences there were between the yields. Statistics for yield indicated that the 10 gpa APF rate was similar to the check, and the 3 treatments with the highest starter fertilizer rates were the same (10gpa and 20gpa APF, and 10gpa 10-34-0)(Table 6). Using the economic analysis for soybeans one can see that neither starter fertilizer treatment had an advantage (Table 8). This type of economic analysis can only be considered for the current year, crop removal of phosphorus over many years will have to be addressed in the future.

SUMMARY:

1. Applications of starter fertilizers with higher rates of P_2O_5 did change soil test P levels of band soil samples when compared the check and inter-row samples.
2. Applications of starter fertilizers with higher rates of P_2O_5 did not significantly increase grain yield for soybean but did for corn.
3. Applying starter fertilizer was cost effective on corn, the highest being with 10 gpa of 10-34-0, but showed negative returns on soybean.

Reference:

Quantities of Plant Nutrients Contained in Crops, Extension Extra, South Dakota Cooperative Extension Service, #8009, January 1985.

Acknowledgments:
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Table 1. Nitrogen, phosphorus, potassium, sulfur, application speed, and cost of fertilizer materials and rates used in the comparison of two different sources of starter fertilizer materials at Beresford, SD (1996).

Crop	Treatment	Product	N	P205	K20	S	Speed	Cost
		-lb/ac-					mph	$/ac
Soybean[1]	0	0	0	0	0	0	5.0	0
	5	51	2	4	2	1	7.5	4.55
	10	102	4	8	4	2	5.5	9.10
Corn[2]	0	0	0	0	0	0	5.0	0
	5	51	4	4	2	1	7.5	5.15
	10	102	8	8	4	2	5.5	10.30
	20	153	16	16	8	4	2.7	20.50
	Check	110	11	37	0	0	5.5	15.60

[1] Advanced Prescription Fertilizer product 4-8-4-2 as sulfur @ 10.2 lbs/gal and $0.91/gal
[2] Advanced Prescription Fertilizer product 8-8-4-2 as sulfur @ 10.2 lbs/gal and $1.03/gal
[3] Ammonium polyphosphate (10-34-0) @ 11.0 lbs/gal and $1.56/gal
[4] All treatments applied in seed furrow.

Table 2. Cultural and Management practices used to evaluate acid based starter fertilizer materials at Beresford, SD (1996).

	Corn	Soybean
Tillage System	Ridge-till	Ridge-till
Previous Crop	Soybean	Soybean
Hybrid/Variety	Agri-Pro 422	'Sturdy'
Relative Maturity	104 day	Group II
Seeding rate (seeds/ac)	27,000	175,000
Planting date	May 16	May 17
Stand Counts	Jun 3	Jun 7
Herbicide	Banvel + Atrazine	Pursuit DG
Soil & Plant Samples	Jun 27, V6; Aug 1 EL	Jul 8 EB
Harvest Date	Oct 22	Sep 24

Table 3. Comparison of acid base seed placed starter fertilizer rates on soil test Olsen P and pH taken at the early bloom (EB) soybean growth stage between fertilizer rates and band (in-row) to no-band (inter-row) at Beresford, SD (July 8,1996).

Fertilizer	- - - - - - - - -Olsen P (ppm)- - - - - - - - -			- - - - - - - - - - - - -pH- - - - - - - - - - - - -		
Rate	In-Row	Inter-Row	LSD (0.10)[2]	In-Row	Inter-Row	LSD (0.10)[2]
gal/ac						
0	5.9 A[1]	7.0	NS	5.4	5.4	NS
5	6.6 A	5.6	NS	6.2	6.3	NS
10	14.9 B	5.5	1.2	6.2	6.3	NS
LSD (0.10)[2]	3.7	NS		NS	NS	

[1]/ Means with different letters are statistically different and only used in vertical comparisons
[2]/ LSD = Lease Significant Difference

Table 4. Comparison of acid base seed placed starter fertilizers on soil test Olsen P and pH taken at the V6 corn growth stage between fertilizer treatments and band (in-row) to no-band (inter-row) at Beresford, SD (June 27,1996).

Fertilizer	- - - - -- -Olsen P (ppm)- - - - - - - - -			- - - - - - - - - - - -pH- - - - - - - - - - - -		
Rate	In-Row	Inter-Row	LSD(0.10)[2]	In-Row	Inter-Row	LSD(0.10)
gal/ac						
0	5 A[1]	4	NS	5.2	5.3	NS
5	10 A	7	NS	5.4	5.4	NS
10	13 A	10	NS	5.3	5.4	NS
20	27 B	7	2	5.5	5.9	0.3
check 2[3]	41 C	7	25	5.2	5.5	NS
LSD (0.10)[2]	12	NS		NS	NS	

[1] Means with different letter are statistically different from each other and only used in vertical comparisons. NS = not significant
[2] LSD = Least Significant Difference.
[3] (10-34-0) Ammonium Polyphosphate at 10 gpa.

Table 5. Effect of acid based (APF) starter fertilizer on soybean production. Southeast Research Farm, Beresford, SD; (1996).

Fertilizer Rate	Plant Population	Plant dry matter	P Conc	Grain Test wt.	Harvest grain H_20	Grain[1] Yield
gal/ac	plants/ac	g/plant	ppm	lb/bu	%	bu/ac
0	119,412 A	2.63	2343	57.0	12.4	37.1
5	127,647 AB	2.98	2413	56.5	12.6	37.2
10	137,059 B	2.55	2513	57.2	12.8	38.2
LSD (0.10)	11,176	NS	NS	NS	NS	NS
CV %	6.8	21.1	9.2	1.4	2.4	3.1

Means with different letters are significantly different from each other.
[1] grain yield based on 13 % moisture

Table 6. Effect of two sources of seed placed starter fertilizers on corn production. Southeast Research Farm, Beresford, SD; (1996).

Fertilizer Rate	V6[1] plants	V6 Dry Matter	P Conc	EL[2] P Conc.	Harvest grain H_20	Plant population	Grain[3] Yield
gal/ac	plants/ac	g/plant	ppm	ppm	%	plants/ac	bu/ac
0)	30,056	5 A	34 A	1859	19.0 A	29,825 A	142 A
5	26,136	7 B	43 A	1834	18.6 AB	*	*
10	26,789	10 C	66 B	1861	18.4 B	24,386	147 AB
20		10 C	69B C	1880	18.3 B	25,614 BC	153 B
check [4]	30,056	11	79 C	1986	18.3	29,649 AB	154 B
LSD (0.05)	NS	1.2	12.23	NS	0.5	4,035	8
CV %	15.5	16.75	16.63	5.24	2.1	11.2	4.0

* Due to variations in plant stand, analysis was decided to be not representable.
[1] V6= 6th leaf vegetative growth stage
[2] EL= ear leaf sample
Means with different letters are significantly different from each other.
[3] Grain yield based on 15 % moisture
[4] (10-34-0) Ammonium Polyphosphate at 10 gpa

Table 7. Comparison of phosphorus application rates and crop removal of two starter fertilizers from corn and soybeans at Beresford, SD (1996)

Crop	Fertilizer Rates	Crop[1] Removal	Fertilizer[2] Deficit
	gal/ac	- - - - - - - - - -lb/P_2O_5/ac- - - - - - - - - -	
Corn	0	50	-50
	10	51	-43
	20	53	-37
	check[3]	54	-16
Soybean	0	29	-29
	5	29	-25
	10	29	-21

[1] corn = 0.35 lbs P_2O_5 /bu; soybeans = 0.77 lbs P_2O_5/bu (see reference at end of report)
[2] fertilizer applied - crop removal
[3] (10-34-0) Ammonium Polyphosphate at 10 gpa

Table 8. Economic analysis and return to cost of fertilizer considering grain yield, moisture, seed costs, and fertilizer costs in the comparison of two starter fertilizers at Beresford, SD (1996).

Crop	Treatment	Drying[1] Cost	Seeds[2] per/ac	Seed[3] costs	Net Return Costs[4]	Net Return Check[5]
		$/ac	lb/ac	- - - - - - $/ac- - - - - -		$/ac
Corn	0	29.64	29.8	26.82	314	0
	10	25.60	24.4	21.96	319	4.60
	20	26.00	25.6	23.04	324	10.32
	Check[6]	26.24	29.6	26.64	329	14.98
Soybean	0	0	49.75	15.34	226	0
	5	0	53.19	16.40	221	-4.96
	10	0	57.11	17.61	222	-4.22

1 - moisture % difference from 15 multiplied by $0.05/% multiplied by wet bushels
2 - corn = 1000 seeds/ac and soybeans = lbs/ac
3 - corn = $0.90/1000 seeds and soybeans = $18.50/60 lbs @ 2400 seeds/lb
4 - net return over costs using $2.50/bu corn and $6.50/bu soybeans
5 - net return over check plot 6 - (10-34-0) Ammonium polyphosphate at 10 gpa.

COST EFFECTIVENESS OF Bt CORN IN MANAGING EUROPEAN CORN BORER

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Plant Science 9614

INTRODUCTION

European Corn borer is one of the most destructive insect pests of corn in the Midwest. University research has indicated that for every corn borer larva that successfully tunnels into the corn stalk, producers lose an average of 5 percent yield. To prevent this loss corn producers must carefully manage corn borers by actively scouting fields and applying insecticides when an economic threshold is reached. Because corn borers complete two generations per year in South Dakota, conventional management of European corn borer requires significant investment in time and labor.

South Dakota and other corn belt states experienced an outbreak of corn borers in 1995. Producers in South Dakota must be prepared to actively manage European corn borer populations in 1996 and beyond.

Corn producers now have a new management option to reduce losses from corn borers. Genetically altered corn (commonly referred to as Bt corn) is available which confers high levels of resistance to corn borers. When a corn borer larva feeds on Bt corn, a gene within the corn plant produces a toxin inside the insect gut which results in death of the insect in approximately 24 to 72 hours. This new technology offers another management option for producers battling European corn borer.

Development of Bt corn and subsequent registration of this produced by the EPA has proceeded very rapidly. The development and commercialization of Bt corn has proceeded more quickly than anticipated, and the result is a lack of data comparing the economics of using Bt corn or conventional methods to manage corn borers. Preliminary data indicate that Bt corn does a very effective job in controlling corn borers, but several questions remain for producers. These questions include: (1) How do Bt hybrids compare to conventional hybrids in yield potential?; (2) How do yield of Bt hybrids and conventional hybrids compare in the absence of European corn borer?; and (3) Is using Bt corn cost effective over the long term?. Very little independent University data exists to answer these and other important questions.

METHODS

This study was designed to evaluate the economics of using Bt corn over a three year time period. The same corn hybrids with and without the Bt gene were evaluated in strip plot tests at the Southeast Farm. Plots were six rows wide by 90 feet long, replicated four times. Plots were planted on May 6, 1996 using a White 5700 planter at a seeding rate of 26,000 plants/ac. Four hybrids were planted in the study, two from Ciba seeds and two from Northrup King. For each replication of the experiment three plots of each hybrid were planted. Each plot was managed for corn borer in a different way, the three treatments being (1) conventional hybrid scouted and treated with an insecticide if economic thresholds for corn borer were reached, (2) transgenic hybrid containing the BT gene, and (3) conventional hybrid not treated for corn borer to serve as an untreated check.

Plots were maintained according to standard agronomic practices for the region. Corn borer damage from both the first and second generation was evaluated by splitting stalks and recording the number of cavities created by corn borers and the length of tunnels in the corn stalk created by corn borers. Ear shank tunneling was also evaluated for each of the treatments. Three rows of each six row plot were harvested for yield.

One of the treatments was to be treated for European corn borers with a conventional insecticide if an economic threshold was reached. In this experiment these plots were treated with Pounce 1.5G at a rate of 7 ;lb/ac for first generation corn borer, but no plots were treated for second generation borers.

RESULTS AND DISCUSSION

Results are presented in Table 1. Corn borers were present at moderate population densities at the Southeast Farm in 1996. Hybrids containing the BT trait significantly reduced the number of corn borer activities and the length of stalk tunneling for both first and second generation for each of the hybrids tested.

Corn hybrids containing the Bt gene and those treated with a conventional insecticide had significantly higher yields than those plots which were not treated for corn borers. Regardless of the management strategy used, management of corn borers resulted in yield increases of 9 to 17 bu/ac. Hybrids containing the Bt gene did not have significantly higher yields than those treated with an insecticide in this experiment.

Acknowledgment
This research was funded in part by the South Dakota Corn Utilization Council.

Table 1. Comparisons of Management Strategy for European Corn Borer in 1996, Southeast Farm, Beresford, South Dakota

	Number of cavities/ Stalk 1st Gen.	Cavity Length (inch) 1st Gen.	Number Cavities/ Stalk 1st & 2nd Gen.	Cavity Length 1st & 2nd Gen.	Ear Shank Tunneling	Moisture at Harvest	Yield Adj. to 15.5%
				inch	inch	%	bu/ac
Max 88 (BT)	0.0 a	0.0 a	0.4 a	0.4 a	0.11 a	17.8 a	192 a
Ciba 4273	1.1 b	1.2 b	2.3 b	2.9 b	0.27 a	17.6 a	177 b
Ciba 4273 + Insecticide	0.1 a	0.1 a	0.7 a	0.8 a	0.31 a	17.4 a	193 a
Max 21 (BT)	0.0 a	0.0 a	0.4 a	0.4 a	0.15 a	20.4 a	203 a
Ciba 4375	0.9 b	0.9 b	2.4 b	3.1 b	0.36 a	20.9 a	187 b
Ciba 4375 + Insecticide	0.1 a	0.1 a	0.7 a	0.8 a	0.18 a	21.2 a	204 a
NK 4242 (BT)	0.0 a	0.0 a	0.0 a	0.0 a	0.00 a	16.2 a	179 a
NK 4242	1.3 b	1.3 b	2.7 b	3.4 b	0.74 b	15.5 a	170 b
NK 4242 + insecticide	0.0 a	0.0 a	0.6 a	0.7 a	0.49 b	15.3 a	181 a
NK 4640 (BT)	0.0 a	0.0 a	0.0 a	00 a	0.00 a	18.0 a	190 a
NK 4640	0.6 b	0.6 b	1.7 b	1.6 b	0.41 b	16.8 b	179 b
NK 4640 + insecticide	0.1 a	0.1 a	0.5 a	0.4 a	0.21 b	17.4 a	196 a

Means within a hybrid group followed by the same letter are not significantly different.

SOYBEAN CYST NEMATODE STUDIES

James D. Smolik, James L. Jones and Roy A. Scott

Plant Science 9615

INTRODUCTION:

The soybean cyst nematode (SCN), ***Heterodera glycines***, is a very serious threat to South Dakota soybean production. It was first detected in South Dakota in Union County in 1995, and in 1996 it was also found in a number of fields in Turner County. It very likely is also present in several other southeastern SD counties. We sampled soybean fields at the Southeast Farm in 1996, but did not find SCN.

Nematodes are unsegmented roundworms, and most of the plant parasitic types are very small and feed on or in plant roots. The adult females of SCN are about 1/32 of an inch long and are visible to the unaided eye. The appendix of this report contains a guide to scouting for SCN that also includes a photo of SCN females attached to a soybean root.

Very low populations of this nematode do not cause obvious symptoms, and in a corn-soybean rotation it may take 8-12 years for SCN to increase to damaging levels. Continuous cropping of soybeans or rotating soybeans with another host such as dry beans will dramatically shorten this time interval. One of the indications that this nematode may be present is declining soybean yields in portions or all of a field. Other symptoms include stunting, yellowing, and early maturity. The presence of SCN can be confirmed by observing cysts attached to roots or by submitting a soil sample for cyst analysis.

The objective of this study was to determine the effect of SCN on soybean yields under SD conditions. With the aid of the SD Soybean Council a test plot was established in a cooperator's field in Union County.

METHODS:

The test plot was planted on 6 May. Soybeans were seeded at 150,000 seeds/ac in 30 inch rows. Individual plots were four rows wide and twenty feet long. The center two rows were harvested for yield on 23 October. Each of the 25 entries in the test was replicated five times. The test included private and public lines, and also included experimental material from the SDSU soybean breeding program. Nematode populations were measured at planting and harvest. Also, with the assistance of the cooperator, field length drill-width passes of 12 public and private lines were seeded in non-replicated strips adjacent to the test plot.

RESULTS:

The analyses of the data were incomplete at this writing, and thus results should be considered preliminary. Yields in the test plot ranged from 16.3 to 43.5 bu/ac (Table 1), with the highest yields generally associated with the resistant (R) entries. The seven public varieties in the test plot were also included in the Crop Performance Testing program (CPT) at the Southeast Farm. The field at the SE Farm was not infested with SCN and yields for the public varieties are also included in Table 1. The Union County plot was located approximately 20 miles southeast of the SE Farm. Although yields at the SE Farm are not directly comparable, they do provide a measure of the yield potential of the seven varieties in the absence of SCN. For instance, variety Sturdy yielded 70 bu/ac at the SE Farm and only 25.3 bu/ac in the test plot.

Populations of SCN at planting (Pi) ranged from high to very high (Table 1). A series of wet years had prevented corn planting in the test plot field and soybeans had been continuously cropped the previous three years, which contributed to the high SCN populations. High populations of SCN are very difficult to manage, even with resistant varieties. Resistant varieties prevent or slow the reproduction of SCN. However, they are invaded by the infective stage (the second-stage juvenile or J-2) of SCN, and thus suffer substantial damage in the presence of high SCN populations. Evidence of this damage is the yield of the resistant variety Bell in the test plot (36.3 bu/ac) versus the yield of Bell in the SE Farm plot (64 bu/ac).

Soybean yields in the test strips (Table 2) should be interpreted with some caution because the test was not replicated. The average yield of the susceptible (S) varieties was 17.0 bu/ac while the average yield of the resistant (R) varieties was 34.0 bu/ac - a 100% increase. Populations of SCN at harvest were considerably higher in the susceptible varieties. In general, the resistant varieties had more pods with seed per plant and more seeds per plant than did the susceptible varieties (Table 2).

CONCLUSION:

Populations of SCN in several of the Turner County fields detected in 1996 were also high to very high. Thus, it appears SCN has been responsible for very substantial soybean yield losses in at least two southeastern SD counties.

This nematode is best controlled by rotating to a non-host crop and by planting resistant soybean varieties. Non-hosts include corn, sorghum, small grains, and alfalfa. Dry beans are a good host for SCN and should not be rotated with soybeans. Populations of SCN will remain high in a corn-soybean rotation unless resistant soybean varieties are used. Also, it is a good practice to change the sources of resistance to prevent the build-up of SCN races capable of attacking formerly resistant varieties.

This nematode is moved with anything that moves soil, including tillage and harvest equipment, wind and water erosion, and soil peds in seed stocks. If SCN is present in only certain fields on a farm, the infested fields should be worked last and equipment should be power washed prior to moving to non-infested areas. Cultural practices that reduce wind and water erosion will also slow the spread of SCN, and only properly cleaned seed should be planted.

Table 1. 1996 Soybean yields and nematode populations in the Soybean Cyst Nematode (SCN) Test Plot, Union County.

Entry	Yield (Bu/ac) cA)	Maturity	Pi	Pf	Pf/Pi ratio	Respons e to SCN	SE Farm Yield
Pioneer 9234	43.5\[a]	II	12098\[b]	1950\[c]	0.16	R	--\[d]
SD94-495	42.5	I	8125	1285	0.16	R	--
Asgrow 2540	38.9	II	9827	3097	0.32	R	--
Jack	37.6	II	12610	2287	0.18	R	--
Bell	36.3	I	9876	2743	0.28	R	64
Kaup 227SCN	36.1	II	12794	1900	0.15	R	--
SD94-464	35.7	I	9614	2067	0.22	R	--
SD93-490	33.9	I	10908	2097	0.19	R	--
SD95-696	33.5	II	4250	8071	1.90	S	--
SD93-522	33.2	II	10082	2059	0.20	R	--
Freeborn	30.6	I	9433	2435	0.26	R	60
SD95-710	29.9	II	10980	13157	1.20	S	--
Faribault	29.2	I	11451	3481	0.30	R	52
Pioneer 9182	29.0	I	8666	2671	0.31	R	--
Corsoy 79	28.4	II	7770	5379	0.69	S	66
Parker	27.6	I	7932	11066	1.40	S	64
SD95-698	26.2	II	3875	5706	1.47	S	--
SD95-717	25.9	II	8378	5467	0.65	S	--
Sturdy	25.3	II	7472	6689	0.90	S	70
Hardin	24.4	I	7146	4405	0.62	S	59
SD95-722	23.4	II	8512	8709	1.02	S	--
SD95-726	22.3	I	11064	8278	0.75	S	--
SD95-689	18.8	I	6711	7740	1.15	S	--
SD95-724	18.1	I	10160	4012	0.39	S?	--
SD(M) 92-1233	16.3	0+	7251	9113	1.26	S	--
$Flsd_{.05}$ =	8.6		N.S.	4986			

\[a] Average of five replications
\[b] Pi = Initial number of SCN eggs and J-2 per 100 cm^3 soil at planting
\[c] Pf = Final number of SCN eggs and J-2 per 100 cm^3 soil at harvest
\[d] Yield of selected varieties included in the 1996 CPT (Crop Performance Test) plot at the Southeast Farm in a non-infested field. The overall CPT plot yield was 66 Bu/ac.

Table 2. Soybean yields and nematode populations in the Soybean Cyst Nematode (SCN) test strips, Union County, 1996 (not replicated).

	Yield (bu/ac)	Number of SCN at Harvest	Response to SCN	Pods per Plant	Seeds per Plant
Kaup 225SCN	40.5	1565\[a]	R	24.7	55.9
Latham CN522	40.5	1230	R	27.8	60.7
Asgrow 2540	36.7	308	R	26.3	65.3
Bell	36.2	282	R	20.7	50.0
Kaup 227SCN	34.4	1021	R	31.8	71.4
Jack	34.2	403	R	30.1	76.4
Pioneer 9234	33.0	492	R	20.6	67.5
Freeborn	26.3	1907	R	13.5	32.0
Faribault	23.1	1165	R	26.2	58.8
Corsoy 79	18.0	8186	S	14.2	29.4
Hardin	17.3	6120	S	14.1	29.6
Parker	15.8	10303	S	13.8	27.4

\[a] Number of SCN eggs and J-2 per 100 cm^3 soil
Average yield of susceptible (S): Corsoy 79, Hardin, and Parker = 17.0 Bu/ac
Average yield of resistant (R) = 34.0 Bu/ac (100% increase)

THE INFLUENCE OF P FERTILIZER & ROW SPACING ON GROWTH & GRAIN YIELD OF SOYBEAN VARIETIES

H. J. Woodard and A. Bly

Plant Science 9616

METHODS

This field experiment was established on an Egan silty clay loam soil at the Southeast Farm near Centerville, SD. On May 30, 1996, three soybean varieties from each of three maturity groups were planted at 200,000 seeds/ac into corn stubble. Treatments were tillage (no-till and conventional), P application (0 and 100 lb P_2O_5/ac), and plant row spacing (7", 14" and 28") randomized within four replicated blocks. The fertilizer P was applied as 10-34-0 perpendicular to row planting direction by a modified anhydrous injection knife. The varieties tested were Group 0: Dawson, Hendricks, and Lambert; Group I: Granite, Hardin, and Kasota; and Group II: Kenwood94, Marcus95, and Sturdy. All varieties were randomized within row spacing and P treatment, and treatments were replicated four times. Plot size was 5' x 42.5'. Weeds were controlled with early preplant herbicide applications (incorporated for conventional tillage treatments). Population as the percent of plants remaining in the plot at early bloom growth stage (first 2-5 blooms) were recorded. Soybean shoots were harvested within a 5.25 ft^2 area of the plot shortly thereafter. Plant tissue was dried and weighed. Grain was harvested with a small plot combine. Grain moisture and weight was determined and yield was calculated. Treatments were compared by statistics using SAS.

RESULTS AND DISCUSSION

Wet spring weather delayed soybean planting. Periodic showers after planting kept the field wet for many weeks. This weather delayed emergence since the soil temperature was cool and also encouraged the onset of ***Phytophthora*** spp. infection.

Tillage and maturity group significantly influenced both plant stand and grain yield (Table 1). Final plant population seemed to be related to the influence of the ***Phytophthora*** spp. infection which was extensive. Some of the plant stand reduction in the 7" rows reflects general emergence problems with the narrow row spacing. About 40% of plots were affected by the fungal infection (data not shown). Under no-till, both plant stand and yield increased significantly compared to the conventionally tilled system. No-tillage seemed to favor a more vigorous plant stand and may even have been helpful in thwarting some ***Phytophthora*** spp. infection. The additional moisture savings realized in the no-till compared to tilled plots later in the growing season at pod fill also may have in boosted yields compared to the tilled plots. Row spacing of greater than 14" seemed to reduce yields somewhat. Perhaps there was less competition for moisture in the tighter row spacings than with the 28" row spacing because the planting population was the same for all row spacings. The grain yield for Group I and II varieties was the greatest. The longer growing season of the later maturing varieties is more advantageous to yield increases. In addition, plant stand was related to the maturity group planted.

Table 1. Effects of variables on soybean stand and yield.
Southeast Research Farm; Beresford, SD; 1996.

Parameter	Plant Stand†	Grain Yield
	-%-	bu/ac
TILLAGE		
Conventional Till	59.0	32.2
No-Till	78.1	40.0
$LSD_{.05}$	1.4	1.2
ROW SPACING		
7"	69.0	37.2
14"	68.7	38.8
28"	67.9	32.3
$LSD_{.05}$	NS	1.4
FERTILIZER P		
0 lb. P_2O_5/ac	68.7	36.1
100 lb. P_2O_5/ac	68.4	36.1
$LSD_{.05}$	NS	NS
MATURITY		
Group O	47.3	13.8
Group I	83.3	46.9
Group II	75.1	47.5
$LSD_{.05}$	4.6	3.0

† Observed at early bloom growth stage (first 2-5 blooms). Most of the stand reduction was attributable to ***Phytophthora*** spp. infection.

The plant stand and grain yield of all three varieties of the maturity group O soybeans reflected the devastation caused by the ***Phytophthora*** spp. infection (Table 2). One variety of each Group I and II was also affected but not as much as the Group O varieties. Identifying and choosing varieties which have more resistance to ***Phytophthora*** spp. would have eliminated most of the variability in plant stand. The fertilizer P treatment seemed to increase yields for some (alpha =0.15 level), but not all varieties. This indicates the variability in P utilization-use efficiency among soybean varieties. Some varieties are able to reach their yield potential with less nutrient inputs than others, and an increase in nutrient levels do not increase yields any further for the more efficient varieties. Identifying and choosing more nutrient-use efficient varieties may increase profitability by avoiding excessive fertilization. However, the yield of Kenwood94 which was responsive to P fertilization was still higher than Marcus95 which showed no response to P. Yield potential is probably a better indicator of profitability than nutrient-use efficiency alone.

Table 2. Stand reductions caused by ***Phytophthora*** spp. infection and the effect of P on soybean varieties. Southeast Research Farm, Beresford, SD; 1996.

			Grain Yield		
	Maturity	Plant	P Applied (lb.P_2O_5/ac)		
Variety	Group	Stand†	0	100	$LSD_{.15}$
		-%-	------------ bu/ac ----------		
Dawson	O	6	17.3	13.5	3.2
Hendricks	O	2	16.7	16.0	NS
Lambert	O	2	11.8	7.8	3.0
Granite	I	92	47.3	48.4	NS
Hardin95	I	96	49.8	54.7	4.6
Kasota	I	69	41.7	39.8	NS
Kenwood94	II	100	60.8	63.6	2.7
Marcus95	II	100	49.8	52.0	NS
Sturdy	II	67	29.8	29.3	NS

† Observed at early bloom growth stage (first 2-5 blooms). Most of the stand reduction was attributed to ***Phytophthora*** spp. infection.

CONVENTIONAL AND NO-TILL SOYBEAN COMPARISONS OF SOUTH DAKOTA RECOMMENDED SOYBEANS AT THE SOUTHEAST RESEARCH FARM

Roy A. Scott and Greg Lammers

Plant Science 9617

Maturity group 0, I and II soybean varieties from the 1996 recommended list were tested in two different experiments at the Southeast research farm. Both tests were grown with an appropriate statistical design with four replicates on the same soil type. Each experiment contained the same set of five group II, seven group I and ten group 0 varieties. One experiment was grown without tillage and the other with conventional tillage. Plots consisted of four rows 17 feet long and spaced 30 inches apart. Plots were seeded at approximately 150 thousand seeds per acre. The two middle rows were harvested for yield evaluations.

RESULTS AND DISCUSSION

Maturity group II soybean varieties out-yielded group 0 and I, and were consistent across conventional and no-till experiments (Table 1). Four of the group II varieties appeared in the top six of both experiments, and all five appeared in the top 50%. It was not unexpected that group II soybeans were the highest yielding since we had a relatively long growing season in South Dakota and all varieties reached maturity before the first frost. Later maturing varieties are expected to take advantage of the long growing season and therefore should out-yield earlier varieties. Eight group 0 varieties ranked in the bottom 50% of the no-till test and seven in the conventional test. Group I varieties that ranked in the top 50% in the conventional test also ranked in the top 50% in the no-till test. Three group 0 varieties ranked in the top 50% of the conventional test and two in the no-till test, but only one was repeated in the top 50% of both tests.

Yields for seven of the 11 varieties in the top 50% of the no-till test were greater than their yields in the conventional test (Table 1). This included two group II, two group 0, and three group I varieties. This may indicate that higher yielding varieties, regardless of maturity group, may have the potential to perform better than lower yielding varieties in no-till production than in conventional. This observation, however, was based on only one year data and may not be consistent in other years. It was clear from these data that, given a choice, a later maturing variety (group II) should be selected over an earlier variety (group I or 0) for Southeast South Dakota to obtain more acceptable yields. If one is interested in pursuing an early harvest, however, there may be acceptable group I varieties available for this purpose, but some yield will be sacrificed.

Table 1. Conventional and no-till yield comparisons of recommended soybean varieties in South Dakota.

	YIELD		RANK	
NAME	NOTILL	TILL	NOTILL	TILL
DEKALB CX267 (II)	57.28	49.00	1	4
BURLISON (II)	56.85	50.95	2	2
ASGROW A2242 (II)	52.04	55.79	3	1
ARROWHEAD 8350 (0)	46.62	39.03	4	14
BERT(I)	45.51	40.08	5	11
TOP FARM TF2000 (II)	44.44	50.49	6	3
TOP FARM TF0100 (0)	43.83	40.73	7	10
BSR101 (I)	43.17	43.44	8	7
PARKER (I)	43.11	42.97	9	8
LESLIE (I)	42.20	39.86	10	12
STURDY (II)	40.73	43.63	11	6
ARROWHEAD 8450 (0)	35.05	38.29	12	16
DAWSON (0)	34.02	33.50	13	21
HENDRICKS (0)	33.69	34.55	14	19
HARDIN 91(I)	33.51	37.74	15	17
SIBLEY (I)	32.97	38.75	16	15
MUSTANG M1050 (0)	30.87	41.47	17	9
KASOTA (I)	29.68	39.75	18	13
LAMBERT (0)	29.19	36.64	19	18
DEKALB CX096 (0)	27.87	48.67	20	5
SIMPSON (0)	25.57	30.60	21	22
PIONEER 9071 (0)	25.31	34.38	22	20
GRAND MEAN	38.79	41.38		
CV	14.51	14.72		
LSD	7.96	8.61		
GROUP 0 MEAN	33.20	37.79		
GROUP I MEAN	32.09	40.37		
GROUP II MEAN	50.27	49.97		

Maturity group in parentheses after variety name.

1996 OATS FOLIAR FUNGICIDE TRIAL

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Plant Science 9618

INTRODUCTION: Oats are subject to attack from a variety of foliar diseases. Some of these diseases can be controlled or reduced through application of foliar fungicides. The purpose of the following study was to determine the effects of various foliar fungicide treatments on disease ratings, yield and test weight of oats.

MATERIALS AND METHODS: Trials were conducted at the Southeast Research Farm, the Brookings Agronomy Farm and the Northeast Research Farm during 1996. The variety Don was used in this study. The foliar fungicide treatments and number of plots were the same at all 3 locations. Treatments were replicated 4 times.

Fungicides used in the study were Tilt (propiconazole) and Dithane DF (mancozeb). Tilt is not currently labelled on oats and was applied as an experimental compound in a single application of 4 fl oz/A at flag leaf emergence (5/22/96 at Southeast Farm, 6/11/96 at Brookings, 6/25/96 at Northeast Farm). Three mancozeb treatments were used (rates reflect amount of product per acre): Mancozeb I: 1 lb/ac early (6/10/96 at Southeast Farm, 6/18/96 at Brookings, 7/1/96 at Northeast Farm); Mancozeb II: 1 lb/ac at boot (06/10/96 at Southeast Farm, 6/22/96 at Brookings, 7/1/96 at Northeast Farm), and again 10 days later; and Mancozeb III: 1 lb/ac early, 2 lbs/ac at boot and again 10 days later.

Plots were rated for amount of disease on the flag leaf (i.e. non-green tissue) on 7/22/96 at Southeast Farm, on 7/10/96 at Brookings and on 7/11/96 at Northeast Farm.

Plots were harvested at the end of the season. Yields (bu/ac) and test weights (lb/bu) were calculated.

RESULTS AND DISCUSSION: Results were more variable in 1996 than in recent years of this study. Although treatments Mancozeb II and III significantly reduced the disease ratings at SE Farm, none of the treatments had any effect on yield or test weight. At Brookings, Tilt and Mancozeb II and III all significantly reduced the disease ratings, but only Mancozeb III significantly increased yield and test weight. At Northeast Research Farm, none of the treatments reduced the disease ratings, but all significantly increased yield, and Mancozeb III increased test weight.

Crown rust has been a problem in recent years on oats. Studies over the last several years have shown that yields and test weights in oats can be increased through the use of foliar fungicides by controlling foliar disease pressure. Mancozeb products are currently the only effective, labelled products on oats. However, they have performed very well in our tests. This year, 1996, results were more variable, but still indicated the potential value of foliar fungicide on oats.

Table 1: 1996 OATS FOLIAR FUNGICIDE TRIAL

	Disease Rating* Scale 0-5	Yield (bu/ac)	Test Weight (lb/bu)
SOUTHEAST FARM			
Untreated	3.1	103.3	34.1
Tilt III	2.9	104.1	34.2
Mancozeb I	3.4	98.2	33.6
Mancozeb II	2.1	104.3	34.3
Mancozeb III	2.3	102.5	34.9
LSD $_{(.05)}$	0.4	12.8	0.9
BROOKINGS			
Untreated	1.5	73.0	31.1
Tilt III	1.0	85.8	32.8
Mancozeb I	1.4	67.3	30.3
Mancozeb II	1.0	85.9	33.6
Mancozeb III	1.0	91.0	33.4
LSD $_{(.05)}$	0.4	15.0	2.3
NORTHEAST FARM			
Untreated	0.9	61.8	33.2
Tilt III	0.8	74.4	33.6
Mancozeb I	1.0	69.0	33.9
Mancozeb II	0.8	79.9	33.9
Mancozeb III	0.9	78.9	34.3
LSD $_{(.05)}$	0.4	5.0	10

* 0 = no disease; 5 = 100% affected

IDENTIFICATION OF RFLP MARKERS FOR QUANTITATIVE TRAITS OF OAT

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Plant Science 9619

A common difficulty in breeding programs is the interaction of genotype and environment particularly dealing with agronomically important traits. DNA markers have allowed researchers to study individual genes affecting these characters. Inheritance of these characters is complex and usually assumed to involve numerous genetic factors (Tanksley, 1993). Marker assisted selection (MAS) is a promising tool for improving these traits. Genetic linkage maps of RFLP (restriction fragment length polymorphism) markers make it possible to identify the associations between markers and QTLs (quantitative trait loci) that expresses the traits. Once those associations are determined MAS can be used to help select for quantitative traits.

The objectives of this study was to identify RFLP markers linked to seven quantitative traits. Four oat lines were used to develop two F2-derived populations. The population from a cross of Cayuse and Froker included 173 F2 3 families. The other population from a cross of PI 539874 and Nodaway 70 included 159 F2 3 families. This report presents the results of the PI 539874 and Nodaway 70 cross. All families were tested using randomized complete block design with two replications over two years in two South Dakota locations (South East Farm, Brookings) and Aberdeen, Idaho. Each entry consisted of 20 seeds planted in a short row. Traits analyzed included days to heading, plant height, tiller number (no. of tillers in 8 inches of row), groat weight, hull weight, seed weight and percent hull. The last four traits were measured on 30 hand picked and dehulled primary seeds. Seventy-two RFLP markers identified 89 loci that were used to construct a linkage map using MAPMAKER ver. 3.0 (Lander et al., 1987). Single factor analysis was utilized to identify marker loci linked to the traits (SAS, 1988), then stepwise multiple regression analysis was conducted for the significant loci using QGene software (Nelson, 1994).

Correlation among phenotypic values of the traits was highly significant ($P < 0.0001$) except groat weight, plant height and percent hull (Table 1). Many marker loci were linked to the traits. Fifteen, thirty-two, six, eight, nineteen, twelve, and eleven marker loci were found to be linked ($P<0.01$) to plant height, days to heading, tiller number, groat weight, hull weight, seed weight and percent hull respectively. Some marker loci showed pleitropic effects.

Multiple regression analysis (Table 2) revealed most significant markers for the traits. R2 values indicates percent variation of a trait explained by the markers included in the model. UMN361 and ISU1146 marker loci were found to be major QTLs for days to heading, plant height and hull weight. These markers may be used for indirect selection of those traits.

Table 1. Phenotypic correlations among traits.

	Days to heading	Plant Ht	Tiller No	Groat Wt.	Hull Wt	Seed Wt
% Hull	.18	-.05NS	.12	-.4NS	.65	.23
Seed Wt	.35	.19	.58	.90	.87	
Hull Wt.	.35	.12	.51	.72		
Groat Wt.	.26	.19	.54			
Tiller No.	.07 (P<0.01)	.25				
Plant Ht	.25					

All values are significant (P< 0.0001), except as indicated in table.
N=1908

Table 2. Multiple regression models and adjusted R^2 values for the traits

Trait	Best Model	R2
Days to Heading	UMN361 + ISU1146	.75
Plant Ht.	UMN361 + ISU2184 + UMN441a + ISU1755	.31
Tiller No.	ISU1507 + ISU1574 + UMN341 + ISU19OOb	.18
Groat Wt.	ISU2184 + CD0676 + CD0341a	.21
Hull Wt.	UMN361 + ISU1146	.20
Seed Wt.	ISU2184 + CD0341a	.26
% Hull	CD0718 + UMN853 + ISU1719 + BCD929b	.13

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OAT RESEARCH

Dale Reeves and Lon Hall

Plant Science 9620

Oat research at the Southeast Research Farm is used for variety release, oat foliar fungicide screening, and RFLP research. The oat foliar fungicide research is a cooperative effort with Extension pathologist Dale Gallenberg. There was no increase in yield of the variety Don This year at the Southeast Research Farm. This was probably due to the rust coming in too late to have a major effect on yield. Yield increases of 12 and 17 bu/ac were obtained at Brookings and Watertown respectively. Test weight was increased over 2 lb/but at Brookings.

The most important characteristics for variety release are yield, yield stability, and test weight; however, there may be several factors that will contribute to the increase of these characteristics. Lodging resistance, Barley Yellow Dwarf resistance, crown rust, and stem rust resistance all contribute to increased yield and test weight. Some other characteristics that are considered when releasing a variety are hull percentage, oil percentage, plant height, maturity, hulled or hulless, and hull color.

The quality of the oat may determine the consumer. The millers want low oil and high protein; whereas, the livestock producer wants a high oil, high protein, and tall variety. The race horse industry wants a white hulled variety.

A total of 954 plots were grown at the southeast location, they included nine breeding nurseries, standard variety oats, and oat foliar fungicide trial. The Uniform Early Nursery was made up of 31 advanced early lines from several states. We had three entries in this test this year. These lines are grown in several states with the data collected providing information needed for varietal release. The Tri-State nursery is made up of 30 lines and 6 checks. The 30 lines consist of 10 advanced lines each from Minnesota, North Dakota, and South Dakota. The best lines will be entered in either the Uniform Early Nursery or the Uniform Midseason Nursery the following year.

ALFALFA CULTIVAR YIELD TEST

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Plant Science 9621

An alfalfa cultivar yield experiment was conducted at the SE station during 1996. This study was planted April 22, 1994 and has 32 entries. Most of the alfalfa cultivars were entered by seed companies, whereas other entries were entered by plant breeders at SDSU other universities. Check entries were also included as a consistent baseline among the alfalfa variety trials in the state. The check entries were ‘Vernal’, ‘Riley’, ‘Baker’, and ‘Saranac AR’. This test was conducted to determine yield performance of alfalfa cultivars and experimental lines for use in SE South Dakota.

There was heightened concern for alfalfa stands following the winter of 1995/96. Widespread mortality of alfalfa stands occurred throughout eastern South Dakota. Few (if any) residents remember more damage than what became evident in 1996. Despite the widespread winterkill in southeastern South Dakota, all alfalfa varieties in the yield experiment exhibited satisfactory spring growth and there were no visible differences among varieties in spring recovery.

Four harvests were obtained from this study during 1996. The first harvest was delayed by about 1 week because of cool wet weather during spring. Average four-cut total yield in 1996 was 4.77 T/A, and significant cultivar differences were detected for all four harvests (Table 1). Average yields for the four harvests in 1996 ranged from 0.97 T/A for the fourth harvest to 1.59 T/A for the first harvest. Yields for the public cultivars Vernal, Riley, and Baker ranked low.

An important role of the South Dakota Alfalfa Cultivar Yield Test is to evaluate lines that are in experimental stages of breeding programs. Companies and universities often enter promising alfalfa lines to test their suitability to stressful conditions in South Dakota. There are 9 experimental entries in the current experiment at the SE station. Results for experimental lines must be interpreted with caution, however. Seed for these lines are in early generations of the seed production process and natural inbreeding depression is expected as these lines are advanced to seed production stages. In essence, commercial seed derived from experimental lines may not have the same yield potential that was observed in a state variety trial.

Table 1. Forage yield of 32 alfalfa cultivars planted April 22, 1994, at the Southeastern Experiment Station, Beresford, SD. Plots were fertilized on July 5, 1996 with 30 lb. P_2O_5, according to soil analysis recommendations.

Cultivar	1995 3-Cut Total	1996 Cut 1 7-Jun	1996 Cut 2 5-Jul	1996 Cut 3 12-Aug	1996 Cut 4 1-Oct	1996 4-Cut Total	95-96 Average	% (2-yea Averag
	tons DM / acre							- %
ICI 630	4.61	1.73	1.17	1.38	1.14	5.42	5.02	11
ICI 631	4.61	1.78	1.14	1.36	1.11	5.39	5.00	11
Viking 1	4.49	1.84	1.11	1.29	1.12	5.35	4.92	10
Multi-plier	4.43	1.86	1.04	1.32	1.18	5.39	4.91	10
Flagship 75	4.45	1.83	1.10	1.29	1.07	5.29	4.87	10
MS9301 (experimental entry[a])	4.54	1.59	1.09	1.29	1.09	5.06	4.80	10
Proof	4.41	1.73	1.09	1.27	1.04	5.13	4.77	10
MS9304 (experimental entry)	4.42	1.66	1.09	1.25	1.07	5.06	4.74	10
ABI923AA (experimental entry)	4.56	1.60	1.06	1.24	0.97	4.87	4.72	10
ICI Brand 645	4.36	1.62	1.13	1.32	0.97	5.03	4.69	10
Pioneer Brand 5262	4.23	1.69	1.07	1.28	1.04	5.08	4.65	10
91-12 (experimental entry)	4.49	1.55	1.00	1.24	1.00	4.80	4.64	10
Magnum III-Wet	4.21	1.63	1.06	1.25	1.02	4.96	4.58	10
Allegro	4.34	1.48	1.02	1.26	1.05	4.80	4.57	10
LegenDairy	4.23	1.63	1.06	1.19	0.99	4.87	4.55	10
ICI Brand 620	4.40	1.59	1.05	1.17	0.88	4.69	4.55	10
Evolution	4.30	1.58	1.04	1.19	0.97	4.78	4.54	10
3452-ML	4.19	1.63	1.08	1.24	0.94	4.88	4.53	10
DK 122	4.22	1.57	1.06	1.19	0.98	4.80	4.51	10
PC431 (experimental entry)	4.12	1.61	1.10	1.24	0.95	4.89	4.51	10
Avalanche	4.31	1.52	1.08	1.22	0.87	4.68	4.49	10
Magnum IV	4.45	1.38	1.01	1.15	0.97	4.51	4.48	10
4J12 (experimental entry)	4.20	1.59	1.00	1.17	0.92	4.68	4.44	9
ABI9237 (experimental entry)	4.26	1.46	0.95	1.12	1.00	4.54	4.40	9
Defiant	4.27	1.46	1.02	1.14	0.88	4.49	4.38	9
Saranac AR	4.07	1.57	0.97	1.18	0.97	4.68	4.38	9
Pioneer Brand 5454	4.27	1.41	1.05	1.10	0.86	4.42	4.34	9
Riley	3.89	1.52	0.90	1.08	1.05	4.55	4.22	9
ABI9236 (experimental entry)	4.16	1.42	0.93	1.06	0.81	4.22	4.19	9
Vernal	3.87	1.49	0.83	1.10	0.82	4.24	4.05	9
Baker	3.80	1.49	0.81	1.11	0.89	4.29	4.05	9
SD44 (experimental entry)	2.46	1.28	0.41	0.84	0.37	2.90	2.68	5
AVERAGE	4.24	1.59	1.02	1.20	0.97	4.77	4.51	
Maturity[b]		4.0	4.2	3.8	3.9			
CV (%)	9.4	13.7	8.6	10.5	13.9	9.6	7.3	
LSD (P=0.05)	0.56	0.30	0.12	0.18	0.19	0.64	0.52	

(a) Data for experimental lines should be used with caution. Commercial seed for these lines may not perform similarly

(b) Kalu and Fick (1983) maturity index, mean stage by count.

CROP PERFORMANCE TRIALS OAT, CORN AND SOYBEAN

R.G.Hall

Plant Science 9622

OAT:

Test results for 1996 are shown in Table 1. Yields averaged 119 bushels for 1996 compared to 94 bushels per acre for 1994-96. The top-yielders for 1996 include 'Dane', 'Don', 'Jerry','Jim',' Newdak' and the experimentals SD92057 and SD92287. The top-yielders for 1994-96 include 'Belle', 'Dane', 'Don', 'Hazel', 'Jerry', 'Newdak', 'Settler', 'Troy', and 'Valley'.

Table 1. Oat yield and bushel weight averages, 1994-96.

	Yield - Bu/Acre		Bushel Wt - Lbs	
	1996	1994-96	1996	1994-96
Variety				
Belle	101	83	36	32
Dane	132	98	34	32
Don	127	94	36	34
Hazel	122	88	37	35
Hytest	107	77	41	38
Jerry	131	105	39	36
Jim	126		37	
Monida	105		30	32
Newdak	131	100	36	33
Settler	115	95	36	34
Troy	107	98	36	32
Valley	115	99	37	34
SD91008	105			
SD91228	124			
SD92057	126			
SD92125	115			
SD92287	128			
Test Average:	119	94	37	34
LSD (5%):	7	17		
CV (%):	4	7		

CORN:

Test results for 1996 and 1995-96 are shown in Table 2 and 3. In the early maturity test of 110 days relative maturity or less there are 28 hybrids in the top-yielding group for 1996. Entries had to yield 193 bushel or higher to be in the top-yielding group for 1996. Entries in sequence from Seed Mart 1112 down to Kaystar KX-777 are in the top-yielding group for 1996. Entries had to yield 169 bushels or higher to be in the top-yielding group for 1995-96. Grain moistures and bushel weight differences of more than 1 and 3 respectively, are significant for 1996. There are no significant differences in plants per acre at harvest.

In the late test (111 days relative maturity or higher) there are 18 hybrids in the top-yielding group for 1996. Entries yielding 197 bushels for higher are in the top-yielding group for 1996. All entries in sequence from Fontanelle 5335 down to Ciba 4494 are in the top-yielding group for 1996. Entries had to yield 168 bushels or higher to be in the top-yielding group for 1995-96. Grain moistures and bushel weight differences of more than 1 and 2 respectively, are not significant for 1996. There are no significant differences in plants per acre at harvest.

In 1996 the performance differences between the two relative maturity tests (early vs. late) are as expected. The late test averaged 4 bushel per acre higher than the early test, but the early test averaged 2% lower in grain moisture and 1 pound higher in bushel weight.

SOYBEAN:

Group-I - There are 6 varieties in the top-yielding group for 1996 (Table 4). Entries yielding 76 bushels or higher are the top-yielders for 1996. Entries in sequence from Latham 390 down to Terra TS194 are the top-yielders for 1996. Entries yielding 59 bushels or higher for 1995-96 and 50 bushels or higher for 1994-96 are the top-yielders.

Group-II - There are 86 varieties in the top-yielding group for 1996 (Table 5). Entries yielding 70 bushels or higher are the top-yielders for 1996. Entries in sequence from Hoegemeyer 202 down to Desoy D2424 are the top-yielders for 1996. Entries yielding 56 bushels for both 1995-96 and 1994-96.are the top-yielders.

TABLE 2. 1996 CORN HYBRID TRIAL, EARLY MATURITY - 110 DAYS OR LESS.

BRAND & HYBRID	YIELDS AT 15.5% MOIST. 1996 (Bu/A)	2-YR (Bu/A)	1996 GRAIN MOIST. (%)	BU. WT. (lb)	PLANTS PER ACRE	STALKS LODGED (%)
Seed Mart 1112	213	.	20	54	25795	.
Croplan Genetics 661	212	.	21	56	25683	.
Dekalb DK586	212	.	20	57	26130	.
Kruger K9614A	208	.	22	57	26130	.
Fontanelle 5306	207	.	22	56	26130	.
Terra TR 1087	207	188	20	55	26130	.
Pioneer P3411	206	.	20	57	26130	.
Stauffer 2436	204	.	20	55	26130	.
Kruger K9513	204	179	20	57	26130	.
Asgrow RX601	204	.	19	60	26130	.
Dekalb DK580	204	175	19	57	26130	.
Cargill 5677	202	171	20	55	26130	.
Domestic DX720	202	178	19	58	25795	.
Garst N3526	202	.	20	54	26130	.
Dekalb DK560	198	177	19	59	26130	.
Cargill 6303	197	176	20	58	26130	.
Pioneer P3489	197	178	18	59	25348	.
Dairyland DST-10803	196	.	20	56	26130	.
Pioneer P3568	196	.	17	60	26130	.
Dekalb DK566	194	185	19	59	26130	.
Golden Harvest H-2502	194	169	20	56	26130	.
Terra E1066	194	.	19	55	26130	.
Wilson 1581	194	166	20	58	26130	.
Sands SOI 9045	193	170	19	57	26130	.
Terra E1106	193	.	23	56	26130	.
Kruger K9714PT	193	.	21	58	26130	.
Asgrow RX701	193	.	20	57	26130	.
Kaystar KX-777	193	187	21	55	26130	.
ENTRIES APPEARING ABOVE THIS LINE ARE IN THE TOP-YIELD GROUP FOR 1996						
Jacobsen JS4678	191	.	20	56	26130	.
Epley EX2422	191	.	18	59	26130	.
M-W Genetics G 7610	190	172	20	57	26130	.
Northrup King N6800	189	.	21	59	26130	.
Asgrow RX623T	187	174	19	60	26130	.
Northrup King N6423	187	.	21	53	21887	.
Mycogen 2616IMI	187	.	19	59	26130	.
Garst N3525IT	187	.	19	59	26130	.
Payco 734	187	163	19	57	26130	.

TABLE 2(CONTINUED), EARLY MATURITY.

BRAND & HYBRID	YIELDS AT 15.5% MOIST. 1996 (Bu/A)	2-YR (Bu/A)	1996 GRAIN MOIST. (%)	BU. WT. (lb)	PLANTS PER ACRE	STALKS LODGED (%)
Kaystar KX-711	186	.	18	61	26130	.
Dairyland ST-1407	185	.	19	59	25572	.
Hoegemeyer 2614	185	.	18	60	26130	.
Mycogen 2674	185	.	18	61	26130	.
Garst 8565	184	.	18	58	26130	.
Cargill 4277	183	164	19	59	26130	.
Mycogen 2689	183	164	21	57	26130	.
Kruger K9711	182	.	19	57	26130	.
Jacobsen JS4575	181	.	19	57	25795	.
Ciba 4394	181	166	19	59	25795	.
LG Seeds NB471	180	.	20	59	26130	.
Golden Harvest H-2468	178	.	19	60	26130	.
NC+ 3588	178	.	18	63	26130	.
Asgrow RX510	178	160	19	56	26130	.
Sands SOI 9061	177	159	20	59	26130	.
Seed Mart 1107	177	.	18	61	26130	.
Wilson 1371	177	155	20	56	23115	.
Hoegemeyer 2591	176	.	17	61	26130	.
Hoegemeyer 2613	176	.	19	59	26130	.
Kruger K9612	175	165	21	57	26130	.
Cargill 5547	175	162	19	58	26130	.
Garst 8541	175	158	20	57	25907	.
M-W Genetics G 7480	175	161	18	60	26130	.
Pioneer P3559	174	.	19	61	26130	.
Sands SOI 9057	173	.	18	61	26130	.
Croplan Genetics 599	171	163	20	58	26130	.
NC+ 3869	171	.	19	61	26130	.
Jacobsen JS4476	171	.	19	60	26130	.
Garst N3580	170	.	17	58	26130	.
Kaystar X6103	168	.	19	59	26130	.
Epley EX1500	167	154	18	61	26130	.
Golden Harvest H-2478	166	.	21	56	26130	.
LG Seeds LG2511	162	.	20	59	26130	.
Epley EX2417	162	153	19	59	26130	.
Domestic DX602	162	155	19	59	26130	.
Kruger K9712	161	.	22	58	24902	.
Hoegemeyer 2575	153	.	18	60	26130	.
Terra TR 1091	145	137	22	57	22557	.
AVERAGE:	185	167	20	58	25925	.
LSD (5%):	20	19	1	3		.
COEF. OF VARIATION#:	7	7				

TABLE 3. 1996 CORN HYBRID TRIAL, LATE MATURITY - 111 DAYS OR MORE.

BRAND & HYBRID	YIELDS AT 15.5% MOIST. 1996 (Bu/A)	YIELDS AT 15.5% MOIST. 2-YR (Bu/A)	1996 GRAIN MOIST. (%)	1996 BU. WT. (lb)	1996 PLANTS PER ACRE	1996 STALKS LODGED (%)
Fontanelle 5335	218	.	22	58	26130	0
Mycogen 7250	215	189	22	57	26130	0
Sands SOI 9126	213	.	22	57	26130	1
Epley EX3608	212	.	20	58	26130	1
Kaystar X6112	211	.	22	57	26130	1
Epley EX3242	211	.	20	58	26130	3
Croplan Genetics 674	208	192	20	57	26130	0
Stauffer 2207	208	.	22	57	26130	0
Golden Harvest H-2547	207	193	22	57	26130	0
Dekalb DK626	206	.	21	56	26130	4
Cargill 6888	205	.	22	57	26130	1
M-W Genetics G 7711	204	.	22	58	26130	0
Kruger EX-115	203	.	24	54	26130	2
Pioneer P3373	202	.	22	57	26130	0
Jacobsen JS56	198	.	22	57	26130	0
Mycogen 2725	198	.	22	57	25125	0
Great Lakes GL 591	197	.	22	58	26130	1
Ciba 4494	197	.	22	58	26130	1
ENTRIES APPEARING ABOVE THIS LINE ARE IN THE TOP-YIELD GROUP FOR 1996						
Kruger K9614	195	178	21	56	26130	0
M-W Genetics X 41131	195	.	21	55	26130	2
Kaltenberg K7001	194	186	21	56	26130	2
Cargill 7770	194	.	23	57	26130	0
Fontanelle 5325	192	.	23	57	26130	2
Terra E1136	183	.	22	54	26130	0
Cargill 6997	182	167	23	58	26130	1
Terra TR 1126	173	156	22	59	26130	1
Terra TR 1130	170	159	25	57	26130	1
Sands SOI 9115	151	153	21	59	16527	1
AVERAGE:	198	175	22	57	25751	1
LSD (5%):	21	25	1	2		2
COEF. OF VARIATION#:	6	7				

TABLE 4. SOYBEAN MATURITY GROUP-I TRIAL, SEEDED MAY 7, 1996.

--- BRAND / ENTRY ---	--- YIELD --- '96	2YR	3YR	-- 1995 -- PROT.	OIL	----- 1996 ----- HT.	LDG.# RES.	MAT.$
	--- bu/a ---			-- %	--	in.		days
Latham/390	82	.	.	.	.	37	2	6
Stine/1690	78	68	.	33.9	19.5	39	2	3
Prairie Br./PB-197	77	66	.	35.3	17.4	38	2	7
Kaup/KS1977	76	64	.	35.4	18.0	39	3	9
Prairie Br./PB-214E	76	.	.	.	.	37	2	8
Terra/TS194	76	63	.	35.7	17.9	37	2	5
ENTRIES APPEARING ABOVE THIS LINE ARE IN THE TOP-YIELD GROUP FOR 1996								
Latham/EX-392	75	.	.	.	.	35	2	7
Mustang/M-1192	75	62	.	34.9	18.2	34	2	6
Stine/1970	73	65	.	35.8	17.6	36	2	8
Coyote/9519	73	.	.	.	.	39	2	3
Asgrow/A1923	72	64	.	35.3	18.4	35	2	2
Prairie Br./PB-192	72	.	.	.	.	42	2	6
Jacobsen/J669	72	.	.	.	.	33	2	4
Latham/250	72	.	.	.	.	38	2	5
Terra/TS174	70	60	.	35.5	18.0	33	2	3
M-W Genetics/G1912	70	.	.	.	.	39	2	6
Stine/1980	70	.	.	.	.	34	1	5
Public/STURDY,II-CK*	70	61	57	34.2	18.9	41	3	6
Mustang/M-1197	69	.	.	.	.	35	2	5
Mustang/M-1190	69	60	.	35.7	18.1	38	2	3
Garst/D180	69	.	.	.	.	35	1	3
Latham/410	69	.	.	.	.	34	1	7
Public/IA1006	68	.	.	.	.	42	3	4
Sexauer/SX-1871	67	.	.	.	.	35	3	5
Top Farm/TF6175	66	.	.	.	.	35	1	0
Garst/D190	66	.	.	.	.	35	2	4
Public/Bert	65	57	51	34.3	18.3	48	3	3
Pioneer/9172	65	59	.	33.5	19.0	38	2	1
Pioneer/9163	65	58	.	31.7	19.1	40	3	2
Public/PARKER,I-CK*	64	60	55	34.2	18.9	41	4	0
Public/Granite	64	57	56	35.6	18.0	44	3	6
Public/Bell-SCN	64	56	53	36.6	17.9	38	3	7
Pioneer/9151	63	.	.	.	.	34	3	-3
Dekalb/CX173	62	.	.	.	.	41	2	2
Sexauer/SX-1471	62	.	.	.	.	43	3	-1
Sexauer/SX-1432	60	.	.	.	.	43	3	0
Public/Leslie	60	55	55	35.1	18.6	41	3	8
Public/Freeborn-SCN	60	.	.	.	.	39	2	2
Public/Hardin	59	55	49	34.4	18.6	40	3	1

TABLE 4. SOYBEAN MATURITY GROUP-I TRIAL (CONTINUED).

--- BRAND / ENTRY ---	--- YIELD --- '96	2YR	3YR	-- 1995 -- PROT.	OIL	----- 1996 ----- HT.	LDG.# RES.	MAT.$
	--- bu/a ---			-- % --		in.		days
Public/Kasota	58	52	48	35.9	18.9	38	3	1
Public/Fairbault-SCN	52	.	.	.	.	35	4	6
Public/DAWSON,0-CK*	50	48	46	33.3	19.2	38	3	-6
TEST AVERAGE:	66	59	52	34.8	18.5	39	2	3
LSD(5%) VALUE:	6	9	7					
CV$$:	6	6	7					

* CK = CHECK VARIETY FOR THE INDICATED MATURITY GROUP.
$ EARLIER (-), EQUAL TO (0), OR LATER THAN THE CHECK - PARKER.
# 1 = EXCELLENT, 5 = POOR.

TABLE 5. SOYBEAN MATURITY GROUP-II TRIAL, SEEDED MAY 7, 1996.

--- BRAND / ENTRY ---	--- YIELD --- '96	2YR	3YR	-- 1995 -- PROT.	OIL	----- 1996 ----- HT.	LDG.# RES.	MAT.$
	--- bu/a ---			-- % --		in.		days
Hoegemeyer/202	78	.	.	.	.	37	3	0
Sexauer/SX-2785	78	61	.	32.3	18.9	44	3	2
Payco/9225	77	61	58	35.6	17.8	34	2	0
Kruger/K2162	77	64	63	33.7	19.5	38	3	0
Prairie Br./PB-247	77	61	60	35.6	17.4	42	3	3
Kruger/K2162+	77	64	63	33.9	19.3	39	3	-2
Jacobsen/J756	77	.	.	.	.	42	3	3
Coyote/9525	76	.	.	.	.	47	3	3
ProfiSeed/PS2000	76	.	.	.	.	39	3	0
Prairie Br./PB-267	76	.	.	.	.	36	2	2
Kruger/K2525	76	62	59	36.0	17.7	36	2	0
Renze/R2896	76	.	.	.	.	35	1	4
Mustang/M-2220	75	.	.	.	.	35	2	-1
Mycogen/5269	75	.	.	.	.	48	2	2
Latham/480	75	62	.	33.9	19.1	38	3	-3
Mycogen/J-251	74	61	59	35.3	17.9	36	2	-1
M-W Genetics/G2440	74	60	59	35.4	17.6	36	2	-1
Prairie Br./PB-2440	74	.	.	.	.	39	3	0
Mustang/M-2200	74	64	.	35.3	17.3	39	3	0
Sands/SOI 268A	74	56	.	36.7	17.6	35	1	3
Mustang/M-2215	74	61	.	32.9	19.6	39	3	-1
Sands/SOI 276	74	.	.	.	.	34	3	1
Asgrow/A2242	74	63	60	34.3	17.9	36	3	0
Sands/EXP9629	74	.	.	.	.	36	3	4
Great Lakes/GL2415	74	61	58	36.9	25.0	37	2	0
Garst/D260	74	60	59	36.0	17.4	35	1	-1
DeSoy/D2727+	74	.	.	.	.	35	3	1
Dekalb/CX229	74	.	.	.	.	37	2	1
Sands/SOI 264	74	59	.	35.5	17.4	42	3	3
Terra/TS253	73	60	.	35.6	17.7	36	2	0
Dekalb/CX232	73	62	57	35.7	17.8	35	2	-5
Kaup/KS2275	73	.	.	.	.	39	3	-1
AgriPro/AP2724	73	.	.	.	.	40	2	3
Prairie Br./PB-202	73	.	.	.	.	39	3	0
Croplan Genet./L2094	73	.	.	.	.	36	1	-2
Hoegemeyer/253	73	.	.	.	.	36	2	0
Renze/R2297	73	.	.	.	.	37	3	1
DeSoy/D2606	73	.	.	.	.	48	3	3
Payco/9625	73	.	.	.	.	36	2	0
ProfiSeed/PS2556	73	.	.	.	.	37	3	1

TABLE 5. SOYBEAN MATURITY GROUP-II TRIAL (CONTINUED).

--- BRAND / ENTRY ---	--- YIELD --- '96	2YR	3YR	-- 1995 -- PROT.	OIL	----- 1996 ----- HT.	LDG.# RES.	MAT.$
	--- bu/a ---			-- % --		in.		days
Jacobsen/J865	73	.	.	.	.	34	3	2
Kruger/K2625	73	62	.	35.4	17.5	36	3	1
Garst/D236	73	.	.	.	.	37	3	0
Jacobsen/BIG RED	73	.	.	.	.	36	3	2
DeSoy/D2555	73	.	.	.	.	35	2	1
Mycogen/5248	73	.	.	.	.	36	2	0
Kruger/K2121+	73	.	.	.	.	41	3	0
Terra/TS285	73	56	.	36.6	18.0	35	1	5
Great Lakes/GL2656	73	.	.	.	.	35	2	5
Kaltenberg/KB254	73	61	60	35.7	17.5	41	2	0
Stine/2686	72	.	.	.	.	36	3	2
Fontanelle/EX 8330	72	.	.	.	.	46	3	0
Latham/680	72	.	.	.	.	40	3	2
Stine/2250	72	.	.	.	.	35	1	0
Hoegemeyer/225	72	58	57	35.5	17.4	35	2	1
Terra/TS210	72	60	.	34.3	19.1	36	2	-2
DeSoy/D2790	72	60	.	32.5	18.8	45	3	3
Terra/TS200	72	59	.	34.1	18.5	34	1	-1
Kaltenberg/KB241	72	61	57	34.7	18.2	33	2	-1
DeSoy/D2818+	72	.	.	.	.	37	2	2
Prairie Br./PB-266	71	.	.	.	.	39	3	3
Prairie Br./PB-2120	71	59	57	35.2	17.5	35	2	2
Hy-Vigor/2400	71	54	.	33.1	18.8	46	3	2
Mustang/M-2262	71	59	.	35.6	16.9	40	3	4
Renze/R2397	71	.	.	.	.	38	3	0
Renze/R2097	71	.	.	.	.	34	2	-4
Prairie Br./PB-236	71	61	.	35.1	17.6	36	3	1
Kaup/KS2474	71	60	.	35.1	17.7	36	2	0
Roll.Meadow/RM9427	71	.	.	.	.	47	3	3
Ciba/3276	71	.	.	.	.	37	2	3
Jacobsen/J750	71	61	.	35.9	17.7	38	3	0
Kruger/K2220	71	.	.	.	.	36	2	0
Golden Harv./H-1269	71	59	.	35.3	17.9	40	2	1
Terra/TS294	71	55	.	34.2	18.4	48	3	4
Latham/660	71	61	58	35.5	17.6	38	2	-2
Roll.Meadow/RM9621	71	.	.	.	.	37	2	0
Latham/720	70	57	.	34.8	18.1	38	2	2
Ciba/3253	70	.	.	.	.	38	2	1
Kruger/K2818	70	57	59	35.4	17.8	36	3	1
Renze/R2797	70	.	.	.	.	38	3	4

TABLE 5. SOYBEAN MATURITY GROUP-II TRIAL (CONTINUED).

--- BRAND / ENTRY ---	--- YIELD --- '96	2YR	3YR	-- 1995 -- PROT.	OIL	----- 1996 ----- HT.	LDG.# RES.	MAT.$
	--- bu/a ---			-- %	--	in.		days
Coyote/EX 9004	70	.	.	.	.	38	2	-1
DeSoy/D2333	70	59	58	35.0	18.6	42	2	-1
M-W Genetics/G2150	70	61	.	34.5	19.2	38	2	0
Terra/TS255	70	57	.	36.1	17.2	40	3	3
Mycogen/5205	70	.	.	.	.	36	3	-2
DeSoy/D2424	70	.	.	.	.	36	3	1
ENTRIES APPEARING ABOVE THIS LINE ARE IN THE TOP-YIELD GROUP FOR 1996								
Kruger/K2101	69	.	.	.	.	35	2	-2
Prairie Br./PB-214L	69	.	.	.	.	39	2	-2
DeSoy/D2595	69	.	.	.	.	40	2	4
G.Country/HADLEY	69	.	.	.	.	42	3	-1
Golden Harv./H-1218	69	56	.	35.7	17.3	33	2	-2
Great Lakes/GL2772	69	.	.	.	.	38	2	1
Dekalb/CX267	69	56	55	34.4	17.4	47	3	4
G.Country/REDWOOD	69	.	.	.	.	36	2	-2
C&D/CD273	69	56	.	33.3	18.9	44	2	0
Public/IA2008R	69	.	.	.	.	47	3	0
Prairie Br./PB-246	69	.	.	.	.	32	2	-1
Mustang/X-250	68	.	.	.	.	44	3	0
Sands/SOI 238	68	.	.	.	.	42	3	3
Golden Harv./H-1295	68	.	.	.	.	45	3	4
Sexauer/SX-2351	68	59	55	33.9	19.2	43	3	1
Coyote/9123	68	.	.	.	.	44	2	0
Prairie Br./PB-217	68	.	.	.	.	34	2	-2
AgriPro/AP2220	68	.	.	.	.	36	2	-2
Public/STURDY,II-CK*	68	54	53	33.7	19.1	44	3	0
Pioneer/9233	68	.	.	.	.	40	3	2
C&D/CD222	68	58	57	36.1	17.6	42	3	-2
Renze/R2597	67	57	.	35.5	17.0	38	2	1
Public/IA2021	67	56	.	32.5	19.5	33	3	-2
DeSoy/D2333+	67	.	.	.	.	35	3	-3
Hoegemeyer/232	67	58	56	33.5	19.7	45	3	-1
Roll.Meadow/RM9625	67	.	.	.	.	39	3	3
Stine/2870	67	.	.	.	.	36	3	3
Jacobsen/J742	67	58	57	34.9	18.3	39	2	-1
Prairie Br./PB-260	67	.	.	.	.	38	3	5
Dekalb/CX228	67	57	56	34.3	17.8	43	2	1

TABLE 5. SOYBEAN MATURITY GROUP-II TRIAL (CONTINUED).

--- BRAND / ENTRY ---	--- YIELD --- '96	2YR	3YR	-- 1995 -- PROT.	OIL	----- 1996 ----- HT.	LDG.# RES.	MAT.$
	--- bu/a ---			-- % --		in.		days
Kruger/K2343+	67	.	.	.	.	38	3	0
Garst/D213	67	.	.	.	.	39	2	-3
Stine/2560	66	56	.	35.4	17.7	35	2	1
Renze/R2196	66	.	.	.	.	38	2	-2
Public/Kenwood 94	66	54	51	35.2	17.9	46	3	-1
Kaup/KS2164	66	57	.	34.8	18.6	37	2	-2
Mustang/X-266	66	.	.	.	.	40	3	4
C&D/EX 1921	66	.	.	.	.	40	3	-1
Sexauer/SX-2171STS	66	.	.	.	.	39	3	0
Dekalb/CX278	66	56	.	33.8	18.5	45	3	2
Latham/590	66	.	.	.	.	36	2	-4
Dairyland/DSR-246/STS	66	.	.	.	.	35	2	1
Public/Corsoy 79	66	54	48	34.6	18.1	44	4	-2
G.Country/SPRINGFIELD	66	.	.	.	.	34	1	-4
Northrup King/S23-06	66	.	.	.	.	41	2	-4
Kaup/KS2774	66	.	.	.	.	39	3	3
Roll.Meadow/RM9623	65	.	.	.	.	35	2	-2
Latham/610	65	53	.	36.6	17.7	34	3	-3
Coyote/EX 9005	64	.	.	.	.	38	2	0
Dairyland/DSR-220/STS	64	.	.	.	.	40	3	-1
C&D/CD205	63	54	.	36.8	17.5	34	2	1
Hy-Vigor/2050	63	.	.	.	.	41	3	-1
Northrup King/S29-18	63	.	.	.	.	39	3	6
C&D/EX 1927	63	.	.	.	.	42	3	3
Public/PARKER,I-CK*	63	57	52	34.0	18.8	41	4	-7
Fontanelle/EX 9402	63	.	.	.	.	41	3	3
Payco/9629	63	.	.	.	.	43	3	3
Top Farm/TF2000	63	55	53	33.1	19.2	43	4	-1
Mustang/E-2272	62	.	.	.	.	39	3	3
Mustang/X-230	61	.	.	.	.	36	3	-2
Fontanelle/2221	60	.	.	.	.	37	3	-2
Public/RESNIK,III-CK*	60	45	48	34.8	17.7	42	3	7
Dyna-Gro/3210	59	55	.	36.0	17.4	37	2	-7
Pioneer/9234	58	.	.	.	.	38	3	-2
Kruger/K2323+	57	50	52	34.9	18.9	37	2	1
TEST AVERAGE:	70	58	57	34.9	18.2	39	3	0
LSD(5%) VALUE:	8	8	7					
CV$$:	7	7	7					

* CK = CHECK VARIETY FOR THE INDICATED MATURITY GROUP.
$ EARLIER (-), EQUAL TO (0), OR LATER THAN THE CHECK - STURDY.
# 1 = EXCELLENT, 5 = POOR.

WEED CONTROL DEMONSTRATIONS AND EVALUATION TESTS, 1996

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INTRODUCTION

Weed evaluation and extension demonstration plots provide weed control data for counties served by the Southeast Experiment Farm. The station is the major site for many corn and soybean weed control studies. The tests provide information on special local weed problems and management systems typical for producers in the area.

The tests provide data and are a source of training material for extension programs. The information is utilized in county extension meetings and for statewide programs.

1996 Evaluation/Demonstration Tests

Field tests are designed to provide comparative performance data for labeled herbicides and products that may be registered in the near future. Some tests are designed to evaluate control of specific weeds, such as cocklebur, velvetleaf, common waterhemp, and foxtail.

Plots are visually evaluated for weed control and crop response. Weed control ratings less than 70% are considered unsatisfactory; 85% control would be commercially acceptable in many situations; however at least 90-95% control is desired if seed production is to be minimized. Visual crop response ratings (VCRR) of 20% or less usually represent an acceptable level of stunting, discoloration or other effect. Ratings over 30% are considered excessive; 100% represents complete kill. Yields are harvested and reported for studies designed with replication.

Extended wet conditions in 1996 delayed planting for several tests; however crop development was excellent for the season. Several additional tests were relocated to the station from other sites that could not be planted. Weed flush, especially foxtail, was heavier than expected. Common waterhemp has spread over many research blocks.

Studies listed below are summarized in the following tables. Information for each study is included as part of the summary.

1. Corn Herbicide Demonstration
2. Premergence Acetanilide Comparisons
3. Velvetleaf Demonstration Corn
4. Herbicide Rates with Cultivation - Corn
5. Herbicide Resistant Corn
6. 3X Soybean Rate/Carryover to Corn
7. 1X or 3X Herbicide - Corn PPI/Pre
8. 1X or 3X Herbicide - Corn Post
9. Soybean Herbicide Demonstration
10. Velvetleaf Control - Soybeans
11. Cocklebur Demonstration - Soybeans
12. Waterhemp Demonstration - Soybeans
13. Authority for Waterhemp - Soybeans
14. Cobra for Waterhemp - Soybeans
15. Sencor for Waterhemp - Soybeans
16. Reduced Herbicide Rates - No-Till Soybeans
17. Reduced Herbicide Rates - Soybeans
18. Foxtail Removal Timing - Soybeans
19. Roundup Ready Weed Control
20. 1X and 3X Herbicide Soybeans - PPI/Pre
21. 1X and 3X Herbicide Soybeans - Post
22. 3X Corn Rate/Carryover to Soybeans
23. Alfalfa Burndown
24. STS and Normal Soybean
25. No-Till Corn Demonstration
26. No-Till Soybeans - Stalks
27. No-Till Soybeans - Stubble
27. Alfalfa Burndown

<u>Other Herbicide Tests</u>

Precise, small plot tests are established to evaluate experimental herbicdes or to define rate comparisons. Treatments showing promise in these tests are moved forward into standard demonstration plots if industry continues development. Tests in 1996 include:

Herbicide Resistant Crops

1. Total Post Weed Control in SR Corn
2. Weed Control in SR Corn
3. Herbicide Tolerant Soybeans
4. Stellar Tank-mixes in STS Soybeans
5. Weed Control in Liberty Link Soybeans
6. Tolerance on Roundup Ready Soybeans

Experimental Herbicides

7. Broadleaf Weed Control with F8426
8. Broadleaf Weed Control with Action
9. Weed Control in Corn with Axiom
10. Weed Control in Corn with Balance
11. Early Preplant Weed Control with Balance
12. No-Till Burndown with Balance
13. Preemergence Weed Control with Balance in No-Till
14. Early Preplant Weed Control with Balance in No-Till
15. Common Waterhemp Control with Stellar
16. Evaluation of Sethoxydim Formulations
17. Velvetleaf Control in Soybeans with Expert and Action
18. Waterhemp Control in Soybeans with FirstRate
19. Weed Control in Soybeans with Axiom

Weed Management

20. Formulation Comparisons of Cyanazine Compounds
21. Comparison of Bromoxynil Formulations
22. Broadleaf Weed Control with Buctril in Corn
23. Weed Control with Sencor
24. Waterhemp Control in Corn
25. Broadleaf Weed Control with Exceed
26. Weed Control with Accent and Reduced Rates of Other Herbicides
27. Labeled Resource Tank-mixes for Weed Control
28. Burndown in No-Till with Select
29. Prepack Comparisons for Weed Control in Corn
30. Grass Control in Corn
31. Broadleaf Weed Control with Broadstrike Plus and Scorpion III
32. Weed Control with Resource Tank-mixes
33. Evaluation of Roundup Drift
34. Effect of Adjuvants on Pursuit and Galaxy Weed Control
35. Evaluation of Early Post Rates in Soybeans
36. Weed Control in No-Till Soybeans
37. Resource Tank-mix Combinations
38. Soybean Row Spacing with Herbicide Rates
39. Evaluation of Pursuit and Various Adjuvants

The cooperation and direct assistance from station personnel is acknowledged. Field equipment and management of the plot areas are important contributions to the project. Extension agents provide assistance with tours and utilize the data in direct producer programs.

NOTE: Data reported in this publication are results from field tests that include product uses, experimental products or experimental rates, combinations or other unlabeled uses for herbicide products. Users are responsible for applying herbicide according to label directions. Refer to the appropriate weed control fact sheet available from county extension offices for herbicide recommendations.

Table 1. Corn Herbicide Demonstration

Demonstration
Variety: Pioneer 3357
Planting Date: 5/1/96
PPI, SPPI: 5/1/96
PRE: 5/1/96
EPOST: 6/3/96
POST: 6/13/96
Soil: Silty clay; 3.5% OM; 6.0 pH

Precipitation: 1st week 0.48 inches
2nd week 0.28 inches

Grft = Green foxtail
Colq = Common lambsquarter
Pesw = Pennsylvania smartweed

COMMENTS: Heavier grass pressure than anticipated. Soil applied treatments

Treatment	Rate/A	% Grft 7/26/96	% Colq 7/26/96	% Pesw 7/26/96	2-Yr. Avg. % Gr	%Bdlf
Check	----	0	0	0	0	0
PREPLANT INCORPORATED						
Eradicane	4.75 pt	78	80	25	89	74
Eradicane+Extrazine II	3.6 pt+2.2 lb	88	93	92	92	94
DoublePlay	5 pt	85	90	80	--	--
Eradicane+Frontier	4 pt+1 pt	80	84	38	--	--
SHALLOW PREPLANT INCORPORATED						
Dual II	2.5 pt	70	80	35	81	80
Lasso	3 qt	60	74	35	76	79
Frontier	2 pt	55	75	30	71	80
Harness	2.3 pt	65	78	50	76	81
Surpass	2.5 pt	70	78	45	79	80
SHALLOW PREPLANT INCORPORATED & POSTEMERGENCE						
Bladex&Accent+COC+28% N	2.2 lb&.67 oz+1%+4 qt	88	88	68	91	93
PREEMERGENCE						
CGA-77102	1.5 pt	94	84	60	--	--
Dual II	2.5 pt	93	62	65	95	74
Lasso	3 qt	92	80	60	95	86
Prowl	3.6 pt	58	89	80	72	88
Harness	2.3 pt	92	90	64	95	94
Surpass	2.5 pt	91	88	60	94	92
Frontier	2 pt	93	85	0	95	90
Axiom	22 oz	92	94	20	--	--
Balance	2 oz	83	92	68	--	--
Balance+Surpass	2 oz+1.25 pt	93	97	99	--	--
Broadstrike/Dual	2.25 pt	88	88	40	89	93
Ramrod+Broadstrike Plus	4 qt+.3 lb	70	92	72	--	--
Axiom+atrazine	20 oz+1.1 lb	91	99	98	--	--
Acetochlor+Extrazine II	1.67 pt+2.2 lb	88	99	99	94	99
Lasso+atrazine	2 qt+1.1 lb	80	99	99	90	99
Lasso+Bladex	2 qt+2.2 lb	89	99	99	93	99
Bicep Lite	4.8 pt	91	99	99	89	99

Table 1. Corn Herbicide Demonstration (Continued) . . .

Treatment	Rate/A	% Grft 7/26/96	% Colq 7/26/96	% Pesw* 7/26/96	2 Yr. Avg. % Gr	2 Yr. Avg. % Bdlf
PREEMERGENCE & POSTEMERGENCE						
Dual II&Marksman	2 pt&2.5 pt	95	99	98	93	99
Check	----	0	0	0	0	0
EARLY POSTEMERGENCE						
Prowl+Marksman	3.6 pt+3.5 pt	55	97	98	71	96
Prowl+Marksman+Bladex	3 pt+2 pt+1.1 lb	62	98	97	--	--
Prowl+Accent+Banvel+ X-77+28% N	3 pt+.33 oz+.5 pt+ .25%+4 qt	58	97	93	--	--
Basis+COC+28% N	.33 oz+1%+4 qt	50	95	60	--	--
Accent+COC+28% N	.67 oz+1%+4 qt	60	83	22	--	--
Extrazine II+Veg Oil	2.2 lb+1 qt	55	91	96	69	94
Marksman+X-77	2.9 pt+.5%	40	96	97	50	96
Frontier+Accent+Clarity+ X-77+28% N	1.25 pt+.3 oz+.8 pt+ .25%+4 qt	51	97	96	69	96
Basis+Marksman+ COC+28% N	.33 oz+1 pt+ 1%+4 qt	55	97	98	--	--
Tough+Accent+Beacon+ COC+28% N	.75 pt+.33 oz+.38 oz+ 1%+4 qt	71	96	72	--	--
PREEMERGENCE & EARLY POSTEMERGENCE						
Ramrod&Tough+atrazine	4 qt&.75 pt+.75 lb	81	98	60	90	99
Ramrod&Clarity	4 qt&1 pt	78	99	99	88	98
PREEMERGENCE & POSTEMERGENCE						
Ramrod&Banvel	4 qt&.5 pt	75	98	98	85	98
Ramrod&2,4-D amine	4 qt&1 pt	74	95	97	84	95
Ramrod&Laddok S-12+ COC+28% N	4 qt&1.67 pt+ 1 qt+1 qt	81	96	99	--	--
Ramrod&Laddok S-12+ Clarity+28% N	4 qt&1.33 pt+ .25 pt+2 qt	78	98	99	--	--
Ramrod&Buctril	4 qt&1.5 pt	68	97	96	80	94
Ramrod&Buctril+atrazine	4 qt&1 pt+.56 lb	80	98	98	87	98
Ramrod&Marksman	4 qt&2.5 pt	70	98	97	82	98
Ramrod&Sencor+Buctril	4 qt&2 oz+1 pt	68	97	96	83	97
Ramrod&Shotgun	4 qt&3 pt	75	98	95	86	99
Ramrod&Shotgun+Buctril	4 qt&1.5 pt+.75 pt	60	97	96	--	--
Ramrod&Permit+X-77	4 qt&.67 oz+.5%	62	94	68	76	97
Ramrod&Exceed+X-77	4 qt&1 oz+1 qt	77	98	93	--	--
Ramrod&Beacon+COC+28% N	4 qt&.38 oz+1 qt+4 qt	78	91	48	--	--
Ramrod&Scorpion III+ X-77+28% N	4 qt&4 oz+ .25%+2.5%	72	98	82	--	--
Ramrod&Broadstrike Plus+ X-77+28% N	4 qt&1.6 oz+ .25%+2.5 %	77	99	98	--	--
Ramrod&Resource+atrazine+ COC+28% N	4 qt&4 oz+.56 lb+ 1 pt+2 qt	80	96	20	--	--
LSD (.05)					16	9

Table 2. Preemergence Acetanilide Comparisons

RCB: 4 reps
Variety: Pioneer 3556
Planting Date: 5/6/96
EPP: 4/26/96
PRE: 5/6/96
Soil: Silty clay; 3.9% OM; 7.0 pH

Precipitation: 1st week .16 inches
2nd week .40 inches

Yeft = Yellow foxtail
Colq = Common lambsquarter

COMMENTS: Foxtail control was similar for all herbicides compared; however lambsquarter control varied. Axiom provided excellent lambsquarter control; Surpass and Harness were superior to other related herbicides for lambsquarter control.

Treatment	Rate/A	% Yeft 7/23/96	% Colq 7/23/96	% Yeft 9/12/96	% Colq 9/12/96	Yield bu/A
Check	----	0	0	0	0	76
EARLY PREPLANT						
Dual II	2.5 pt	88	56	85	44	154
CGA-77102	1.6 pt	85	53	84	40	142
PREEMERGENCE						
CGA-77102	1.3 pt	89	48	85	35	155
CGA-77102	1.6 pt	90	53	84	45	148
Dual II	2 pt	89	46	85	41	148
Dual II	2.5 pt	89	45	84	54	137
Surpass	2 pt	89	78	85	78	161
Harness	2 pt	89	77	85	77	178
Frontier	1.75 pt	89	53	84	61	142
Axiom	22 oz	86	97	84	97	180
LSD (.05)		3	12	2	11	24

Table 3. Corn Velvetleaf Demonstration

RCB: 2 reps
Variety: Pioneer 3751 IR
Planting Date: 5/1/96
PPI, SPPI: 5/1/96
PRE: 5/1/96
EPOST: 6/4/96
POST: 6/27/96
LPOST: 7/8/96
Soil: Silty clay loam; 3.0% OM; 6.9 pH

Precipitation: 1st week .48 inches
2nd week .28 inches

Yeft = Yellow foxtail
Vele = Velvetleaf

COMMENTS: Heavy velvetleaf. Performance in 1996 was favorable; several treatments exceeded 90% control. Eleven treatments provided 90% or greater control for the 2-year average.

Treatment	Rate/A	% Yeft 8/1/96	% Vele 8/1/96	2 Year Average % Vele
Check	-----	0	0	0
PREPLANT INCORPORATED				
Eradicane	7 pt	7	43	49
Eradicane+atrazine	5 pt+1.1 lb	78	73	74
Contour	1.33 pt	85	93	91
Atrazine	2.2 lb1	55	83	82
SHALLOW PREPLANT INCORPORATED				
Broadstrike/Dual	2 pt	72	88	86
PREPLANT INCORPORATED & EARLY POSTEMERGENCE				
Eradicane&atrazine+COC	5 pt&1.1 lb+1 qt	87	84	91
PREPLANT INCORPORATED & POSTEMERGENCE				
Eradicane&2,4-D amine	5 pt&1 pt	72	65	81
PREEMERGENCE				
Lasso+Bladex	2 qt+2.2 lb	90	76	76
Dual II+atrazine	2 pt+1.1 lb	93	74	79
Dual II+atrazine	2 pt+2.2 lb	96	89	90
Broadstrike/Dual	2 pt	92	98	91
Balance	2 oz	93	98	---
PREEMERGENCE & POSTEMERGENCE				
Balance&Buctril+atrazine	2 oz&1 pt+.56 lb	96	98	---
PREEMERGENCE				
Axiom	21 oz	96	90	---
Ramrod+Broadstrike Plus	5 qt+.3 lb	91	97	95

Table 3. Corn Velvetleaf Demonstration (Continued) . . .

Treatment	Rate/A	% Yeft 8/1/96	% Vele 8/1/96	2 Year Average % Vele
EARLY POSTEMERGENCE				
Prowl+atrazine	3.5 pt+1.1 lb	81	97	95
Accent+atrazine+Scoil+28% N	.67 oz+.56 lb+1%+4 qt	84	73	---
Extrazine II+X-77	2.2 lb+.5%	85	86	90
Resolve SG+X-77+28% N	5.33 oz+.25%+1 qt	80	73	---
PREEMERGENCE & EARLY POSTEMERGENCE				
Ramrod&atrazine+COC	5 qt&1.1 lb+1 qt	87	73	---
Ramrod&Tough+ atrazine+COC	5 qt&2 pt+1.1 lb+1 qt	90	91	---
Ramrod&atrazine+COC	5 qt&2.2 lb+1 qt	88	91	---
Ramrod&Clarity	5 qt&1 pt	79	89	85
PREEMERGENCE & POSTEMERGENCE				
Ramrod&Buctril+atrazine	5 qt&1 pt+.56 lb	72	80	---
Ramrod&Marksman	5 qt&3 pt	81	81	83
Ramrod&Laddok S-12+28% N	5 qt&1.66 pt+4 qt	72	85	91
Ramrod&Shotgun	5 qt&2 pt	74	86	82
Ramrod&2,4-D amine	5 qt&1 pt	71	85	77
Ramrod&Buctril	5 qt&1.5 pt	78	74	79
Ramrod&Beacon+X-77+28% N	5 qt&.76 oz+1%+4%	81	43	60
Ramrod&Exceed+X-77	5 qt&1 oz+.5%	80	63	68
Ramrod&Sencor+2,4-D amine	5 qt&2 oz+.5 pt	73	74	79
PREEMERGENCE & POSTEMERGENCE & LATE POSTEMERGENCE				
Ramrod&Buctril+atrazine&Buctril	5 qt&1 pt+1 pt&1 pt	74	92	---
PREEMERGENCE & POSTEMERGENCE				
Ramrod&Permit+X-77	5 qt&.67 oz+.25%	73	60	63
Ramrod&Scorpion III+ X-77+28% N	5 qt&.25 lb+.25%+2.5%	81	79	81
Ramrod&Resource+COC	5 qt&4 oz+1 qt	79	90	90
Ramrod&Sencor+Buctril	5 qt&2 oz+1 pt	75	86	86
Ramrod&Action+COC	5 qt&1.5 oz+1 qt	74	98	98
Ramrod&Resource+ atrazine+COC	5 qt&4 oz+.56 lb+1 qt	74	74	81
PREEMERGENCE & EARLY POSTEMEREGENCE				
Ramrod&F8426+COC	5 qt&1 oz+1%	72	82	88
PREEMERGENCE & LATE POSTEMERGENCE				
Ramrod&Banvel	5 qt&.5 pt	78	73	80
Ramrod&Resource+COC	5 qt&4 oz+1 qt	74	96	91
Ramrod&Action+COC	5 qt&1.5 oz+1 qt	80	96	---
LSD (.05)		9	12	12

Table 4. Demonstration of Herbicide Rates with Cultivation - Corn

Demonstration
Variety: Pioneer 3357
Planting Date: 5/1/96
PPI, PRE: 5/1/96
EPOST: 6/3/96
Soil: Silty clay; 3.5% OM; 6.0 pH

Precipitation: 1st week .48 inches
2nd week .28 inches

Yeft = Yellow foxtail

COMMENTS: Demonstration to compare full and reduced herbicide rates with and without row cultivation.

Treatment	Rate/A	% Yeft No Cultivation 8/1/96	% Yeft Cultivation 8/1/96
Check	----	0	40
PREPLANT INCORPORATED			
Eradicane	4.75 pt	70	85
Eradicane	2.38 pt	60	85
PREEMERGENCE			
Harness	2.3 pt	95	98
Harness	1.15 pt	90	95
EARLY POSTEMERGENCE			
Accent+COC+28% N	.67 oz+1%+4 qt	50	70
Accent+COC+28% N	.33 oz+1%+4 qt	40	60

Table 5. Herbicide Resistant Corn

Demonstration
Variety: Transgenic, SR, IMI
Planting Date: 5/1/96
PPI, PRE: 5/1/96
EPOST: 6/3/96
POST: 6/13/96
Soil: Silty clay, 3.5% OM; 6.0 pH

Precipitation: 1st week .48 inches
2nd week .28 inches

Yeft = Yellow foxtail
Cowh = Common waterhemp

COMMENTS: Treatments include herbicide tolerant seed for "IMI", Transgenic and SR hybrids. Treatments with soil applied/postemergence split applications provided better weed control than postemergence only treatments. Rates of 2X included; no adverse crop response noted.

Table 5. Herbicide Resistant Corn (Continued) . . .

Treatment	Rate/A	% Yeft 7/19/96	% Cowh 7/19/96	2-Loc. Avg. % Gr	2-Loc. Avg. %Bdlf
CHECK (Liberty Link Corn)	**----**	**0**	**0**	**0**	**0**
EARLY POSTEMERGENCE					
Liberty	1.75 pt	59	63	68	72
Liberty	5.25 pt	69	73	---	---
Atrazine+Liberty	1.1 lb+1.75 pt	77	86	84	90
PREEMERGENCE & EARLY POSTEMERGENCE					
Atrazine&Liberty	1.1 lb&1.75 pt	87	97	89	97
Surpass&Liberty	1.67 pt&1.75 pt	96	84	95	88
CHECK (IMI Corn)	**----**	**0**	**0**	**0**	**0**
PREPLANT INCORPORATED					
Contour	1.33 pt	83	98	82	98
Contour	4 pt	96	99	---	---
EARLY POSTEMERGENCE					
Prowl+Resolve SG+ X-77+28% N	3.6 pt+5.3 oz+ .25%+2 qt	85	98	85	98
Resolve SG+X-77+28% N	5.3 oz+.25%+2 qt	78	84	79	89
CHECK (SR Corn)	**----**	**0**	**0**	**0**	**0**
PREEMERGENCE & EARLY POSTEMERGENCE					
Surpass&Poast Plus+ Laddok S-12+COC+28% N	1.25 pt&1.5 pt+ 1.67 pt+1 qt+2 qt	94	99	93	98
Atrazine&Poast Plus+ 2,4-D ester+COC+28% N	1.1 lb&1.5 pt+ .5 pt+1 qt+2 qt	83	98	88	98
EARLY POSTEMERGENCE					
Poast Plus+Laddok S-12+ COC+28% N	1.75 pt+1.75 pt+ 1 qt+2 qt	85	93	85	93
EARLY POSTEMERGENCE & POSTEMERGENCE					
Poast Plus+Clarity+COC& Poast Plus+Laddok S-12+ COC+28% N	.5 pt+3.2 oz+1 pt& 1 pt+1.33 pt+ 1 qt+2 qt	91	99	91	99
POSTEMERGENCE					
Poast Plus+COC+28% N	4.5 pt+1 qt+2 qt	99	0	---	---
LSD (.05)				10	9

Table 6. 3X Soybean Rate/Carryover to Corn

RCB; 4 reps
Planting Date: 6/15/95; Soybean Variety: Kenwood
Planting Date: 5/30/96; Corn Variety: Pioneer 3357
PPI, PRE: 6/15/95
POST: 7/14/95
Soil: Silty clay; 3.5% OM; 6.6 pH

VCRR = Visual Crop Response Rating

COMMENTS: Purpose to evaluate crop tolerance using several herbicide treatments at 3X normal use rates. Crop tolerance is considered adequate at normal rates under normal conditions. Visual crop response ratings (VCRR) are not necessarily correlated with yield. Differential weed competition was not completely eliminated as a major factor in 1995 treatment differences. Yield reported for corn planted in 1996 over 1995 treatments. Most treatments at 3X rate in 1995 did not affect corn yield under favorable conditions of 1996 season. Lasso at 2 lb/A applied preemerge for grass control in 1996.

1995 Treatment	1995 Rate/A	Soybean % VCRR 8/17/95	Soybean Yield bu/A 10/17/95	1996 Corn Yield bu/A
Check	----	0	19	117
PREPLANT INCORPORATED				
Treflan	3 qt	8	37	122
Prowl	9 pt	11	35	134
Command	3 qt	0	40	120
Broadstrike/Treflan	6.75 pt	11	37	143
PREEMERGENCE				
Lasso	9 qt	0	36	130
Dual II	7.5 pt	0	33	143
Frontier	4.8 pt	3	36	138
Sencor	2 lb	6	27	139
PREPLANT INCORPORATED				
Treflan+Scepter	1 pt+2 pt	4	37	124
Treflan+Pursuit	1 pt+.75 pt	10	37	138
PREPLANT INCORPORATED & POSTEMERGENCE				
Treflan&Classic+X-77	1 pt&2.25 oz+.25%	0	41	143
Treflan&Pinnacle+X-77	1 pt&.75 oz+.25%	1	38	143
Treflan&Cobra+COC	1 pt&2.4 pt+.5 qt	15	34	135
Treflan&Blazer+X-77	1 pt&4.5 pt+.5%	0	37	141
Treflan&Basagran+COC	1 pt&3 qt+1 qt	6	30	150
POSTEMERGENCE				
Resource+COC	1.5 pt+1 qt	8	28	126
LSD (.05)		7	8	22

Table 7. 1X or 3X Herbicide - Corn PPI/Pre

RCB; 4 reps
Variety: Pioneer 3357
Planting Date: 5/1/96
PPI, PRE: 5/1/96
Soil: Silty clay; 3.7% OM; 6.4 pH

Precipitation: 1st week 0.48 inches
2nd week 0.28 inches

VCRR = Visual Crop Response Rating

COMMENTS: Purpose to evaluate crop response to X and 3X rates of soil applied herbicides. Crop tolerance at X rates was excellent under favorable

Treatment	Rate/A	% VCRR 8/1/96	Yield bu/A
Check	----	0	147
PREPLANT INCORPORATED			
Eradicane	5.33 pt	0	159
Eradicane	16 pt	0	168
Atrazine	2.78 lb	0	163
Atrazine	5.55 lb	0	161
PREEMERGENCE			
Lasso	3 qt	0	148
Lasso	9 qt	0	145
Dual II	2.5 pt	0	143
Dual II	7.5 pt	0	141
Surpass	3 pt	0	145
Surpass	9 pt	0	143
Harness	2.86 pt	0	149
Harness	8.6 pt	0	152
Frontier	1.6 pt	0	143
Frontier	4.8 pt	0	145
Broadstrike/Dual	2.25 pt	6	154
Broadstrike/Dual	6.75 pt	24	138
Balance	2.5 oz	0	156
Balance	7 oz	25	137
Axiom	24 oz	0	166
Axiom	72 oz	20	137
LSD (.05)		5	25

Table 8. 1X or 3X Herbicide - Corn Post

RCB; 4 reps
Variety: Pioneer 3357
Planting Date: 5/1/96
EPOST: 6/4/96
POST: 6/13/96
Soil: Silty clay; 3.7% OM; 6.4 pH

Precipitation: POST: 1st week 1.57 inches; 2nd week 1.06 inches

VCRR = Visual Crop Response Rating

COMMENTS: Purpose to evaluate crop response to X and 3X postemergence herbicide rates. Crop tolerance was not affected by labeled rates; most 3X rates did not affect yield in this test.

Treatment	Rate/A	% VCRR 8/1/96	Yield bu/A
Check	----	0	122
POSTEMERGENCE			
Accent+COC+28% N	.67 oz+1%+4 qt	0	135
Accent+COC+28% N	2 oz+1%+4 qt	0	126
Beacon+X-77	.76 oz+.25%	5	122
Beacon+X-77	2.3 oz+.25%	3	126
2,4-D amine	.5 qt	0	119
2,4-D amine	1.5 qt	11	119
Banvel	.5 qt	0	129
Banvel	1.5 qt	3	106
Buctril	1.5 pt	0	126
Buctril	4.5 pt	0	127
Permit+X-77	.67 oz+.25%	0	119
Permit+X-77	2 oz+.25%	0	136
Exceed+COC	1 oz+1 qt	3	118
Exceed+COC	3 oz+1 qt	0	122
EARLY POSTEMERGENCE			
Basis+X-77+28% N	.33 oz+.25%+2 qt	0	130
Basis+X-77+28% N	1 oz+.25%+2 qt	5	128
POSTEMERGENCE			
Action+COC+28% N	1.5 oz+2 pt+4 qt	0	132
Action+COC+28% N	4.5 oz+2 pt+4 qt	0	119
Scorpion III+X-77+28% N	4 oz+.25%+2.5%	0	128
Scorpion III+X-77+28% N	12 oz+.25%+2.5%	5	123
LSD (.05)		4	16

Table 9. Soybean Herbicide Demonstration
Demonstration
Variety: Kenwood
Planting Date: 5/21/96
PPI, PRE: 5/21/96
POST: 6/29/96
LPOST: 7/8/96
Soil: Silty clay; 3.4% OM; 6.2 pH

Precipitation: 1st week 2.16 inches
2nd week .67 inches

Yeft = Yellow foxtail
Cowh = Common waterhemp

COMMENTS:Evaluations are for uncultivated plots. Three-year average data (plowed) provides a measure of consistency. Fifteen treatments provided at least 90% control of both grass and broadleaved weeds for the 3-year average.

Treatment	Rate/A	% Yeft Plowed 8/1/96	% Cowh Plowed 8/1/96	% Yeft Chiseled 8/1/96	% Cowh Chiseled 8/1/96	3-Yr. Avg. Gr	3-Yr. Avg. Bdlf
Check	----	0	0	0	0	0	0
PREPLANT INCORPORATED							
Prowl+Pursuit DG	2.1 pt+1.44 oz	90	88	90	80	91	93
Pursuit DG	1.44 oz	88	80	88	50	88	91
Treflan	1.5 pt	92	88	92	85	91	88
Sonalan	2.67 pt	90	88	94	86	91	91
Prowl	3 pt	90	85	90	80	89	86
Treflan+Sen/Lex	1.5 pt+.5 lb	94	96	94	90	90	92
Treflan+Command	1.5 pt+1.5 pt	92	85	92	85	89	88
Treflan+Pursuit DG	1.5 pt+1.44 oz	94	95	94	90	93	96
Broadstrike/Treflan	2 pt	94	96	92	94	92	93
Prowl+Pursuit DG	3 pt+.72 oz	92	94	92	88	91	94
Pursuit Plus+Scepter	2.5 pt+.33 pt	92	90	92	85	--	--
Treflan+FirstRate	1.5 pt+.75 oz	96	96	96	96	--	--
SHALLOW PREPLANT INCORPORATED							
Broadstrike/Dual	2.25 pt	94	96	94	92	90	87
Lasso+Treflan	2 qt+.5 pt	88	90	86	80	85	87
SHALLOW PREPLANT INCORPORATED & POSTEMERGENCE							
Command&Pursuit DG+ Sun-It II+28% N	1.5 pt&.72 oz+ 1 qt+1 qt	94	94	92	60	94	96
PREPLANT INCORPORATED & PREEMERGENCE							
Treflan+Sen/Lex&Sen/Lex	1.5 pt+.33 lb&.5 lb	94	98	94	98	94	98
Treflan&Sen/Lex	1.5 pt&.67 lb	95	98	95	98	92	96
PREPLANT INCORPORATED & POSTEMERGENCE							
Prowl&Pursuit DG+ Sun-It II+28% N	3 pt&1.44 oz+ 1 qt+1 qt	92	95	92	82	93	96
PREEMERGENCE							
Sen/Lex	.5 lb	50	90	0	60	--	--
Dual II+Sen/Lex	2 pt+.67 lb	92	90	84	92	90	89
Lasso	3 qt	90	85	90	75	80	68
Dual II	2.5 pt	90	75	92	60	87	52
Frontier	2 pt	92	78	88	65	85	66
Broadstrike/Dual	2.25 pt	92	92	90	88	85	74
Pursuit DG	1.44 oz	90	90	85	60	83	73

Table 9. Soybean Herbicide Demonstration (Continued) . . .

Treatment	Rate/A	% Yeft Plowed 8/1/96	% Cowh Plowed 8/1/96	% Yeft Chiseled 8/1/96	% Cowh Chiseled 8/1/96	3-Yr. Avg. Gr	3-Yr. Avg. Bdlf
PREEMERGENCE (Continued)							
Lasso+Sen/Lex	2 qt+.67 lb	90	94	88	94	87	91
Lasso+Pursuit DG	2 qt+1.44 oz	92	90	88	85	89	89
Lasso+Lorox	2 qt+1 qt	90	90	82	88	83	89
Dual II+Pursuit DG	1.25 pt+1.44 oz	94	95	90	85	89	90
Frontier+Pursuit DG	2 pt+1.44 oz	92	95	92	90	85	88
Axiom	22 oz	94	96	92	88	--	--
Authority+Command ME	8 oz+2 pt	94	96	94	96	--	--
PREEMERGENCE & POSTEMERGENCE							
Lasso&Pursuit DG+ Sun-It II+28% N	2 qt&1.44 oz+ 1 qt+1 qt	92	96	92	94	92	91
Lasso&Scepter+X-77	2 qt&.33 pt+.5%	92	90	92	85	90	91
Lasso&Basagran+COC	2 qt&1 qt+1 qt	90	85	85	80	83	83
Lasso&Blazer+X-77	2 qt&1.5 pt+.5%	92	90	90	85	85	92
Lasso&Stellar+COC+28% N	2 qt&5 oz+.5%+2.5%	92	90	88	88	--	--
Lasso&Cobra+COC	2 qt&.8 pt+.5 qt	92	85	92	80	85	89
Lasso&Flexstar+28% N	2 qt&2 pt+2.5%	92	90	92	88	--	--
Lasso&Galaxy+X-77	2 qt&2 pt+.5%	92	94	92	90	90	93
Lasso&Pinnacle+X-77	2 qt&.25 oz+.25%	92	94	88	90	86	89
Lasso&Classic+X-77	2 qt&.75 oz+.25%	88	90	84	86	85	89
Lasso&Concert+ X-77+28% N	2 qt&.5 oz+ .25%+1 qt	92	95	85	92	85	92
Lasso&Basagran+ Pursuit DG+COC	2 qt&1 pt+ .72 oz+1 qt	92	94	90	92	90	94
Lasso&Pinnacle+ Pursuit DG+X-77	2 qt&.25 oz+ 1.08 oz+.25%	92	94	94	96	91	94
Lasso&Expert+X-77+28% N	2 qt&1.5 oz+.5%+2 qt	94	96	94	96	--	--
POSTEMERGENCE							
Poast Plus+COC	1.5 pt+1 qt	95	0	95	0	93	0
Poast Plus	1.5 pt	92	0	90	0	92	0
Option II+COC	15 oz+1 qt	95	0	95	0	95	0
Select+COC	6 oz+1 qt	95	0	95	0	95	0
Fusilade DX+COC	12 oz+1 qt	94	0	90	0	94	0
Fusion+COC	8 oz+1 qt	95	0	95	0	94	0
Assure II+COC	7 oz+1 qt	95	0	95	0	95	0
Raptor+Sun-It II+28% N	4 oz+.75 qt+1 qt	85	80	86	40	--	--
Pursuit DG+Sun-It II+28% N	1.44 oz+1 qt+1 qt	80	60	75	40	87	82
Pursuit DG	1.44 oz	88	70	85	50	73	78
Poast Plus+Galaxy+COC	2.25 pt+2 pt+1 qt	94	80	92	75	91	86
POSTEMERGENCE & LATE POSTEMERGENCE							
Galaxy&Poast Plus+COC	2 pt&2.25 pt+1 qt	94	75	94	78	91	83
Poast Plus+COC&Galaxy	2.25 pt+1 qt&2 pt	94	80	94	50	88	84
LSD (.05)						8	14

Table 10. Velvetleaf Control in Soybeans

RCB; 2 reps
Variety: Kenwood
Planting Date: 5/21/96
PPI, PRE: 5/21/96
POST: 6/29/96
LPOST: 7/9/96
Soil: Silty clay loam; 3.0% OM; 6.9 pH

Precipitation: 1st week 2.16 inches
2nd week .67 inches

Yeft = Yellow foxtail
Vele = Velvetleaf

COMMENTS: Heavy velvetleaf. No cultivation. Several treatments provided excellent control in 1996. Eleven treatments provided 95% or greater velvetleaf cont Three-year average provides a measure of consistency.

Treatment	Rate/A	% Yeft 8/1/96	% Vele 8/1/96	Yield bu/A	3-Yr. Avg. % Vele	3-Yr. Avg. bu/A
Check	----	0	0	25	0	0
PREPLANT INCORPORATED						
Prowl	3 pt	83	35	32	26	29
Treflan+Sen/Lex	1.5 pt+.5 lb	84	72	46	77	38
Command+Treflan	1.5 pt+1.5 pt	88	83	48	---	---
Command+Treflan	2 pt+1.5 pt	87	84	46	---	---
Treflan+Scepter	1.5 pt+.67 pt	88	83	34	71	36
Prowl+Pursuit DG	2.12 pt+1.44 oz	91	96	43	78	37
Prowl+Pursuit DG	2.12 pt+.72 oz	90	88	39	77	39
Treflan+Pursuit DG+Sen/Lex	1.5 pt+.72 oz+.33 lb	90	93	46	85	43
PREPLANT INCORPORATED & POSTEMERGENCE						
Treflan+Command& Pursuit DG+Sun-It II+28% N	1.5 pt+1 pt& .72 oz+1 qt+1 qt	93	95	45	---	---
PREPLANT INCORPORATED						
Broadstrike/Treflan	2 pt	91	93	49	93	44
Treflan+Command+ Sen/Lex+Pursuit DG+ Scepter	1.5 pt+.5 pt+ .167 lb+.36 oz+ .17 pt	89	87	45	90	40
Pursuit Plus+Scepter	2.5 pt+.33 pt	93	96	46	---	---
PREPLANT INCORPORATED & PREEMERGENCE						
Treflan&Sen/Lex	1.5 pt&.67 lb	95	94	35	89	35
Treflan+Sen/Lex&Sen/Lex	1.5 pt+.33 lb&.5 lb	93	91	48	92	39
SHALLOW PREPLANT INCORPORATED						
FirstRate+Treflan	.6 oz+1.5 pt	87	94	45	---	---
Broadstrike/Dual	2.25 pt	83	96	32	88	37

Table 10. Velvetleaf Control in Soybeans (Continued) . . .

Treatment	Rate/A	% Yeft 8/1/96	% Vele 8/1/96	Yield bu/A	3-Yr. Avg. % Vele	3-Yr. Avg. bu/A
PREEMERGENCE						
Dual II+Sen/Lex	2 pt+.67 lb	95	97	44	90	39
Lasso+Pursuit DG	2 qt+1.44 oz	92	96	43	87	37
Command	2 pt	94	97	45	95	37
Command ME+Authority	2 pt+.5 lb	94	98	43	---	---
Lasso+Lorox	2 qt+2 lb	85	55	42	67	37
PREPLANT INCORPORATED & POSTEMERGENCE						
Treflan&Blazer+28% N	1.5 pt&1.5 pt+4 qt	92	87	39	79	39
Treflan&Galaxy+28% N	1.5 pt&1 qt+4 qt	86	84	35	91	40
Treflan&Basagran+28% N	1.5 pt&1 qt+4 qt	85	95	38	96	42
PREPLANT INCORPORATED & LATE POSTEMERGENCE						
Treflan&Basagran+28% N	1.5 pt&1 qt+4 qt	85	88	41	86	40
PREPLANT INCORPORATED & POSTEMERGENCE & LATE POSTEMERGENCE						
Treflan&Basagran+28% N& Basagran+28% N	1.5 pt&1 pt+4 qt& 1 pt+4 qt	87	97	44	96	45
PREPLANT INCORPORATED & POSTEMERGENCE						
Treflan&Cobra+COC	1.5 pt&.8 pt+.5 qt	85	75	36	69	37
Treflan&Classic+28% N	1.5 pt&.75 oz+4 qt	84	81	50	78	40
Treflan&Concert+ X-77+28% N	1.5 pt&.5 oz+ .125%+1 qt	87	81	48	78	41
Treflan&Pursuit DG+ Sun-It II+28% N	1.5 lb&1.44 oz+ 1 qt+4 qt	93	93	44	95	44
Treflan&Pursuit DG+Scepter+ Sun-It II+28% N	1.5 pt&1.44 oz+.17 pt+ 1 qt+4 qt	96	93	50	---	---
Treflan&Basagran+ Pursuit DG+COC+28% N	1.5 pt&1 pt+ .72 oz+1 qt+4 qt	93	89	38	92	43
Treflan&Pursuit DG+Cobra+ Sun-It II+28% N	1.5 pt&1.44 oz+4 oz+ 1 qt+4 qt	95	94	40	88	44
Treflan&Action+COC	1.5 pt&1.5 oz+1 qt	92	98	42	97	43
Treflan&Resource+COC	1.5 pt&4 oz+1 qt	91	87	41	87	42
Treflan&Stellar+COC	1.5 pt&5 oz+.5 qt	91	88	48	---	---
Treflan&Expert+ X-77+28% N	1.5 pt&1.5 oz+ .25%+4 pt	93	91	51	---	---
Treflan&FirstRate+ X-77+28% N	1.5 pt&.3 oz+ .125%+2.5%	88	79	40	---	---
PREPLANT INCORPORATED & LATE POSTEMERGENCE						
Treflan&Action+COC	1.5 pt&1.5 oz+1 qt	90	97	44	---	---
Treflan&Resource+COC	1.5 pt&4 oz+1 qt	90	88	42	---	---
Check	----	0	0	15	---	---
LSD (.05)		4	7	14	12	9

Table 11. Cocklebur Soybean Demonstration

RCB: 2 reps
Variety: Kenwood
Planting Date: 5/30/96
PPI, PRE: 5/30/96
POST: 6/27/96
LPOST: 7/8/96
Soil: Loam; 2.9% OM; 6.5 pH

Precipitation: 1st week 1.18 inches
2nd week 0.00 inches

Cocb = Common cocklebur

COMMENTS: Very heavy weed pressure. Treatments increased yield 15-20 bu/A. Herbicide performance has been outstanding.

Treatment	Rate/A	% Cocb 7/18/96	Yield bu/A	3-Yr. Avg. % Cocb	3-Yr. Avg. bu/A
Check	----	0	12	0	13
PREPLANT INCORPORATED					
Pursuit DG	1.44 oz	62	34	47	29
Broadstrike/Treflan	2.25 pt	59	32	42	25
PREPLANT INCORPORATED & PREEMERGENCE					
Sen/Lex&Sen/Lex	.5 lb&.33 lb	67	46	57	37
PREEMERGENCE					
Authority+Command ME	8 oz+2 pt	74	55	---	---
POSTEMERGENCE					
Basagran+COC	1 qt+1 qt	98	53	95	46
Cobra+COC+28% N	.8 pt+.5 qt+4 qt	97	57	96	42
Blazer+X-77	1.5 pt+.5%	70	37	65	36
Classic+X-77	.75 oz+.125%	98	48	97	47
Pursuit DG+Sun-It II+28% N	1.44 oz+1 qt+1 qt	98	52	97	51
Concert+X-77	.5 oz+.125%	86	52	81	50
Scepter+X-77	.33 pt+.25%	96	56	91	51
Basagran+Pursuit DG+ COC+28% N	1 pt+.72 oz+ 1 qt+2 qt	98	50	95	51
Basagran+COC	1 pt+1 qt	95	46	79	41
Pursuit DG+Sun-It II+28% N	.72 oz+1 qt+1 qt	91	58	92	49
Raptor+Sun-It II+28% N	4 oz+1.5 pt+1 qt	83	56	---	---
FirstRate+X-77+28% N	.3 oz+.125%+2.5%	98	58	---	---
Expert+X-77+28% N	1.5 oz+.25%+4 pt	94	57	---	---
Reliance STS+COC+28% N	.5 oz+1%+2 qt	98	45	---	---
POSTEMERGENCE & LATE POSTEMERGENCE					
Basagran+COC&Basagran+COC	1 pt+1 qt&1 pt+1 qt	98	50	97	45
LSD (.05)		17	14	9	9

Table 12. Common Waterhemp Demonstration in Soybeans

RCB; 4 reps
Variety: Kenwood
Planting Date: 6/3/96
PPI, PRE: 6/3/96
POST: 6/29/96
LPOST: 7/8/96
Soil: Clay loam; 2.7% OM; 6.6 pH

Precipitation: 1st week 0.51 inches
2nd week 1.57 inches

Cowh = Common waterhemp

COMMENTS: Light-moderate waterhemp density. Very good control with several combination treatmen Weather delayed postemergence applications; weed size larger than optimum.

Treatment	Rate/A	% Cowh 8/1/96
Check	----	0
PREPLANT INCORPORATED		
Treflan	1.5 pt	74
Sonalan	3 pt	77
Prowl	3 pt	70
Treflan+Sen/Lex	1.5 pt+.5 lb	94
Broadstrike/Treflan	2 pt	93
Pursuit DG	1.44 oz	89
PREEMERGENCE		
Command+Authority	1.5 pt+.5 lb	95
Broadstrike/Dual	2 pt	97
Pursuit DG	1.44 oz	93
PREPLANT INCORPORATED & POSTEMERGENCE		
Treflan&Galaxy+X-77	1.5 pt&2 pt+.5%	87
Treflan&Blazer+X-77	1.5 pt&1.5 pt+.5%	95
Treflan&Cobra+COC	1.5 pt&.8 pt+1 pt	95
POSTEMERGENCE		
Pursuit DG+Sun-It II+28% N	.72 oz+1 qt+1 qt	81
Pursuit DG+Sun-It II+28% N	1.44 oz+1 qt+1 qt	90
LATE POSTEMERGENCE		
Pursuit DG+Sun-It II+28% N	1.44 oz+1 qt+1 qt	75
POSTEMERGENCE		
Raptor+COC+28% N	5 oz+1 qt+1 qt	91
Concert+X-77+28% N	.5 oz+.25%+1 qt	95
Cobra+COC	.8 pt+1 pt	90
Pursuit DG+Cobra+Sun-It II+28% N	1.44 oz+4 oz+1 qt+4 qt	95
Pursuit DG+Blazer+X-77+28% N	1.44 oz+.5 pt+.5%+1 qt	85
Pursuit DG+Blazer+X-77+28% N	1.44 oz+1 pt+.5%+1 qt	85
LSD (.05)		10

Table 13. Authority for Waterhemp Control in Soybeans

RCB: 3 reps
Variety: Kenwood
Planting Date: 5/30/96
PPI: 5/30/96
PRE: 5/30/96
POST: 7/2/96
Soil: Clay loam; 2.7% OM; 6.6 pH

Precipitation: 1st week 1.18 inches
2nd week 0.00 inches

Grft = Green foxtail
Cowh = Common waterhemp

COMMENTS: Common waterhemp control was excellent with Authority treatments.

Treatment	Rate/A	% Grft 7/18/96	% Cowh 7/18/96	% VCRR 8/16/96	% Cowh 8/16/96	Yield bu/A
Check	----	0	0	0	0	12
PREPLANT INCORPORATED & POSTEMERGENCE						
Command&Pursuit DG& Sun-It II+28% N	1.5 pt&.72 oz+ 1 qt+1 qt	82	60	7	68	50
PREEMERGENCE						
Authority+Command ME	8 oz+2 pt	87	96	3	96	55
Authority+Sencor+Dual II	8 oz+4.8 oz+2.5 pt	95	98	3	99	55
PREEMERGENCE & POSTEMERGENCE						
Authority+Command ME& Pursuit DG+Sun-It II+ 28% N	8 oz+2 pt& .72 oz+1 qt+ 1 qt	93	97	17	97	52
Authority+Sencor+ Dual II&Pursuit DG+ Sun-It II+28%N	8 oz+4.8 oz+ 2.5 pt&.72 oz+ 1 qt+1 qt	95	98	13	98	53
Authority+Sencor& Pursuit DG+Sun-It II+ 28% N	8 oz+4.8 oz& 1.08 oz+1 qt+ 28% N	91	95	13	99	57
PREPLANT INCORPORATED						
Authority+Command ME	8 oz+2 pt	93	98	3	95	51
Authority+Sencor+ Command	8 oz+4.8 oz+ 1.5 pt	85	93	3	87	46
PREPLANT INCORPORATED & POSTEMERGENCE						
Authority+Command ME& Pursuit DG+Sun-It II+ 28% N	8 oz+2 pt& .72 oz+1 qt+ 1 qt	95	98	7	99	52
Authority+Sencor+ Command&Pursuit DG+ Sun-It II+28% N	8 oz+4.8 oz+ 1.5 pt&.72 oz+ 1 qt+1 qt	90	95	7	99	49
LSD (.05)		3	3	10	4	8

Ttable 14. Cobra for Common Waterhemp Control in Soybeans

RCB; 3 reps
Variety: Kenwood
Planting Date: 6/11/96
POST: 7/9/96
Soil: Clay loam; 2.7% OM; 6.6 pH

Precipitation: 1st week 0.63 inches
2nd week 3.03 inches

Yeft = Yellow foxtail
Cowh = Common waterhemp
VCRR = Visual Crop Response Rating

COMMENTS: Cobra combinations provided very good common waterhemp control.

Treatment	Rate/A	% VCRR 7/18/96	% Yeft 7/18/96	% Cowh 7/18/96	% Yeft 9/17/96	% Cowh 9/17/96
Check	----	0	0	0	0	0
POSTEMERGENCE						
Cobra+COC+28% N	6 oz+.5%+1 qt	15	0	81	0	86
Cobra+COC+28% N	8 oz+.5%+1 qt	15	0	86	0	86
Cobra+COC+28% N	10 oz+.5%+1 qt	20	0	92	0	93
Cobra+COC+28% N	12 oz+.5%+1 qt	20	0	93	23	93
Cobra+Pursuit+ COC+28% N	4 oz+4 oz+ .5%+1 qt	17	94	96	82	94
Cobra+Pursuit+ COC+28% N	6 oz+4 oz+ .5%+1 qt	20	94	96	85	94
Cobra+Pursuit+ COC+28% N	8 oz+4 oz+ .5%+1 qt	18	87	94	76	94
Cobra+Pursuit+Classic+ COC+28% N	4 oz+4 oz+.5 oz+ .5 oz+.5%+1 qt	20	87	90	87	95
Cobra+Classic+ COC+28% N	6 oz+.5 oz+ .5%+1 qt	10	25	87	0	93
Cobra+Classic+ COC+28% N	8 oz+.5 oz+ .5%+1 qt	20	25	90	0	93
Pursuit+COC+28% N	4 oz+.5%+1 qt	3	81	85	91	70
Classic+COC+28% N	.5 oz+.5%+1 qt	12	8	84	0	85
LSD (.05)		5	6	3	3	10

Table 15. Sencor for Waterhemp Control in Soybeans

RCB; 3 reps
Variety: Kenwood
Planting Date: 6/11/96
PPI: 6/11/96
POST: 7/9/96
Soil: Clay loam; 2.7% OM; 6.6 pH

Precipitation: 1st week 1.57 inches
2nd week 1.06 inches

Yeft = Yellow foxtail
Cowh = Common waterhemp
Cocb = Common cocklebur
VCRR = Visual Crop Response Rating

COMMENTS: Combination treatments provided very good to excellent common waterhemp control; treatments alone were less effective.

Treatment	Rate/A	% Yeft 7/18/96	% Cowh 7/18/96	% VCRR Delay 8/20/96	% Cocb 8/20/96	%cowh 8/20/96
Check	----	0	0	0	0	0
PREPLANT INCORPORATED						
Sencor	5.33 oz	0	60	0	35	47
Sencor	8 oz	0	74	0	89	62
Treflan	1.5 pt	91	79	0	52	65
Treflan+Sencor	1.5 pt+2.67 oz	93	85	3	43	79
Treflan+Sencor	1.5 pt+5.33 oz	93	85	17	45	65
Treflan+Sencor	1.5 pt+8 oz	93	93	37	86	90
Prowl+Sencor	3 pt+5.33 oz	90	90	13	60	89
Command+Sencor	1.5 pt+5.33 oz	92	84	0	88	83
PREPLANT INCORPORATED & POSTEMERGENCE						
Treflan&Pursuit DG+ Sun-It II+28% N	1.5 pt&.72 oz+ 1 qt+1 qt	93	93	3	95	89
Treflan+Sencor& Pursuit DG+Sun-It II+ 28% N	1.5 pt+2.67 oz& .72 oz+1 qt+ 1 qt	93	95	3	97	93
Treflan+Sencor& Pursuit Dg+Sun-It II+ 28% N	1.5 pt+5.33 oz& .72 oz+1 qt+ 1 qt	96	99	0	96	96
LSD (.05)		2	10	10	13	13

Table 16. Evaluation of Reduced Rate/Cost Herbicide in No-Till

RCB: 4 reps
Variety: Kenwood
Planting Date: 5/30/96
EPOST: 6/22/96
POST: 7/2/96
LPOST: 7/8/96
Soil: Clay; 3.1% OM; 7.1 pH

Precipitation: EPOST — 1st week 0.39 inches; 2nd week 0.16 inches

Grft = Green foxtail
Cowh = Common waterhemp

COMMENTS: Roundup burndown 1 pt/A at planting; new weed emergence in no-till was delayed. Split applications provided greater waterhemp control. Other broadleaf species were anticipated as part of the broadleaf spectrum; an additional component would have i

Treatment	Rate/A	% Grft 7/25/96	% Cowh 7/25/96	Yield bu/A
Check	----	0	0	27
EARLY POSTEMERGENCE				
Pursuit+Sun-It II+28% N	1 oz+1 qt+1 qt	70	58	39
POSTEMERGENCE				
Pursuit+Sun-It II+28% N	2 oz+1 qt+1 qt	73	46	42
POSTEMERGENCE & LATE POSTEMERGENCE				
Pursuit+Sun-It II+28% N& Pursuit+Sun-It II+28% N	2 oz+1 qt+1 qt& 2 oz+1 qt+1 qt	87	74	43
EARLY POSTEMERGENCE & POSTEMERGENCE				
Pursuit+Sun-It II+28% N& Pursuit+Sun-It II+28% N	1 oz+1 qt+1 qt& 1 oz+1 qt+1 qt	86	75	43
LATE POSTEMERGENCE				
Pursuit+Sun-It II+28% N	4 oz+1 qt+1 qt	78	53	42
LSD (.05)		6	18	4

Table 17. Reduced Rate Weed Control in Soybeans

RCB: 1 rep
Variety: Kenwood
Planting Date: 5/21/96
PPI, PRE: 5/21/96
Soil: Silty clay; 3.4% OM; 6.2 pH

Precipitation: 1st week 2.16 inches
2nd week 0.67 inches

Grft = Green foxtail
Cowh = Common waterhemp

COMMENTS: Higher weed densities developed on minimum till; control with reduced rates was
unsatisfactory for several treatments.

Treatment	Rate/A	% Grft Plowed 8/1/96	% Grft Min.Till 8/1/96	% Cowh Plowed 8/1/96	% Cowh Min.Till 8/1/96
PREPLANT INCORPORATED					
Sonalan	1.33 pt	96	96	84	50
Sonalan	2.67 pt	99	98	89	74
Prowl	1.5 pt	95	95	76	30
Prowl	3 pt	98	98	84	60
Treflan	.75 pt	96	94	65	40
Treflan	1.5 pt	99	98	92	68
Pursuit DG	.72 oz	92	95	45	20
Pursuit DG	1.44 oz	98	98	60	35
Treflan+Pursuit DG	.75 pt+.72 oz	99	98	70	55
Treflan+Pursuit DG	1.5 pt+1.44 oz	99	99	91	86
PREEMERGENCE					
Lasso	1.5 qt	98	97	89	78
Lasso	3 qt	99	98	94	85
Dual II	1.25 pt	97	95	80	74
Dual II	2.5 pt	98	96	85	76
Frontier	1 pt	98	96	84	70
Frontier	2 pt	99	98	92	79

Table 18. Foxtail Removal Timing in Soybeans

RCB; 4 reps
Variety: Kenwood
Planting Date: 6/3/96
2 WEEKS: 6/15/96
3 WEEKS: 6/22/96
4 WEEKS: 6/29/96
5 WEEKS: 7/8/96
6 WEEKS: 7/14/96
Soil: Silty clay; 3.9% OM; 7.0 pH

Precipitation: 1st week 0.51 inches
2nd week 1.57 inches

Yeft = Yellow foxtail

COMMENTS: Very heavy foxtail pressure. Late planting. Early competition in 1996 caused greater yield reduction than in some previous years. Slow early-season crop growth reduced ability for crop to compete with the grass in 1996.

		% Yeft	Yield	3-Yr. Avg.	
Treatment	Rate/A	7/25/96	bu/A	% Gr	bu/A
Check	----	0	16	0	16
PREPLANT INCORPORATED					
Treflan	1.5 pt	83	57	79	48
PREPLANT INCORPORATED & 3 WEEKS					
Treflan&Poast Plus+ COC+28% N	1.5 pt&1 qt+ 1.25%+2.5%	95	68	96	60
PREEMERGENCE					
Dual II	2.5 pt	95	75	---	---
POSTEMERGENCE					
Poast Plus+COC+28% N	1 qt+1.25%+2.5%				
2 Weeks		96	50	89	53
3 Weeks		96	39	93	45
4 Weeks		95	30	95	46
5 Weeks		89	26	90	45
6 Weeks		65	20	76	37
LSD (.05)		5	12	5	8

Table 19. Weed Control in Roundup Ready Soybeans

RCB; 4 reps
Variety: Roundup Ready
Planting Date: 6/3/96
EPOST: 7/2/96
POST: 7/8/96
Soil: Silty clay; 3.3% OM; 6.7 pH

Precipitation: 1st week 0.16 inches
2nd week 0.63 inches

COMMENTS: Roundup provided excellent weed control. Control with other treatments

Treatment	Rate/A	% Yeft 7/18/96	% Cowh 7/18/96	% Yeft 9/18/96	% Cowh 9/18/96
Check	----	0	0	0	0
EARLY POSTEMERGENCE					
Roundup Ultra+AS	1 pt+8.5 lb/100 gal	95	97	84	85
Roundup Ultra+AS	1.5 pt+8.5 lb/100 gal	96	98	83	87
Roundup Ultra+AS	2 pt+8.5 lb/100 gal	97	98	85	92
Pursuit DG+Sun-It II+28% N	1.44 oz+1 qt+1 qt	79	76	70	78
EARLY POSTEMERGENCE & POSTEMERGENCE					
Roundup Ultra+AS& Roundup Ultra+AS	1.5 pt+8.5 lb/100 gal& 1 pt+8.5 lb/100 gal	97	98	85	94
POSTEMERGENCE					
Roundup Ultra+AS	1 pt+8.5 lb/100 gal	95	95	85	94
Roundup Ultra+AS	1.5 pt+8.5 lb/100 gal	97	98	83	95
Roundup Ultra+AS	2 pt+8.5 lb/100 gal	97	98	84	95
Poast Plus+Galaxy	1.5 pt+2 pt	85	92	49	87
LSD (.05)		3	6	7	6

Table 20. 1X & 3X Soybean Rate PPI/Pre

RCB; 4 reps
Variety: Kenwood
Planting Date: 5/21/96
PPI, PRE: 5/21/96
Soil: Silty clay; 3.5% OM; 6.6 pH

Precipitation: 1st week 2.16 inches
2nd week 0.67 inches

VCRR = Visual Crop Response Rating

COMMENTS: Purpose to evaluate crop response and identify crop response symptoms to X and 3X rates of soil applied herbicides. Crop safety was not affected by herbicides at normal use rates; triple rates were safe for most treatments under these favorable conditions. Check yield affected by light weed pressure.

Treatment	Rate/A	% VCRR 8/1/96	Yield bu/A
Check	----	0	31
PREPLANT INCORPORATED			
Treflan	1 qt	0	49
Treflan	3 qt	21	46
Sonalan	2.67 pt	0	47
Sonalan	8 pt	23	42
Prowl	3 pt	0	46
Prowl	9 pt	8	47
Command	1 qt	0	45
Command	3 qt	3	51
Broadstrike/Treflan	2.25 pt	3	46
Broadstrike/Treflan	6.75 pt	24	46
PREEMERGENCE			
Lasso	3 qt	0	52
Lasso	9 qt	0	50
Dual II	2.5 pt	0	51
Dual II	7.5 pt	4	51
Frontier	2 pt	5	51
Frontier	6 pt	15	44
Sencor	.67 lb	0	52
Sencor	2 lb	41	34
PREPLANT INCORPORATED			
Treflan+Scepter	1 pt+.67 pt	3	49
Treflan+Scepter	1 pt+2 pt	19	49
Treflan+Pursuit	1 pt+4 oz	0	51
Treflan+Pursuit	1 pt+12 oz	0	54
PREPLANT INCORPORATED & PREEMERGENCE			
Treflan&Authority	1 pt&8 oz	4	54
Treflan&Authority	1 pt&24 oz	9	51
LSD (.05)		8	8

Table 21. 1X & 3X Soybean Rate Post

RCB; 4 reps
Variety: Kenwood
Planting Date: 5/21/96
POST: 6/29/96
Soil: Silty clay; 3.5% OM; 6.6 pH

Precipitation: 1st week 0.16 inches
2nd week 0.63 inches

VCRR = Visual Crop Response Rating

COMMENTS: Purpose to evaluate crop tolerance and produce response symptoms from postemergence herbicides used at X and 3X rates. Early visual response did not affect yields - favorable conditions. Labeled rates did not affect yield.

Treatment	Rate/A	% VCRR 8/1/96	Yield bu/A
Check	----	0	41
POSTEMERGENCE			
Classic+X-77	.75 oz+.25%	5	47
Classic+X-77	2.25 oz+.25%	20	46
Pinnacle+X-77	.25 oz+.25%	4	47
Pinnacle+X-77	.75 oz+.25%	19	43
Cobra+COC	.8 pt+.5 qt	5	50
Cobra+COC	2.4 pt+.5 qt	10	48
Blazer+X-77	1.5 pt+.5%	0	51
Blazer+X-77	4.5 pt+.5%	5	51
Basagran+COC	1 qt+1 qt	0	46
Basagran+COC	3 qt+1 qt	5	48
Resource+COC	.5 pt+1 qt	0	52
Resource+COC	1.5 pt+1 qt	5	51
Action+X-77+28% N	1.5 oz+.25%+4 pt	0	47
Action+X-77+28% N	4.5 oz+.25%+4 pt	3	45
FirstRate+X-77+28% N	.3 oz+.125%+2.5%	0	50
FirstRate+X-77+28% N	.9 oz+.125%+2.5%	3	51
LSD (.05)		7	7

Table 22. 3X Corn Rate/Carryover to Soybeans

RCB; 4 reps
Planting Date: 6/15/95; Corn Variety: AgriPro 164
Planting Date: 5/30/96; Soybean Variety: Kenwood
PPI, PRE: 6/15/95
POST: 7/8/95
Soil: Silty clay; 3.5% OM; 6.6 pH

VCRR = Visual Crop Response Rating

COMMENTS: Purpose to evaluate crop response to herbicides applied at 3X normal use rates as a means of evaluating tolerance and producing symptoms. Weed control was not a factor for most treatments when compared to the check. Soybeans were evaluated for visual response and yields determined. Lasso applied at 2 lb/A in 1996; weeds were not a factor based on 1996 check and treatment yields. Yield data refl

1995 Treatment	1995 Rate/A	Corn % VCRR 9/7/95	1996 Soybean % VCRR 8/1/96	1996 Soybean Yield bu/A
Check	----	0	0	50
PREPLANT INCORPORATED				
Eradicane	14.25 pt	0	0	55
Atrazine	5.5 lb	0	0	55
Bladex	9.9 lb	0	0	56
PREEMERGENCE				
Lasso	9 qt	0	0	52
Dual II	7.5 pt	0	0	59
Surpass	9.4 pt	0	0	53
Harness	8.6 pt	0	0	56
Frontier	4.8 pt	0	0	53
Broadstrike/Dual	6.75 pt	0	0	54
Battalion	24 oz	0	11	52
POSTEMERGENCE				
Accent+COC+28% N	2 oz+1%+4 qt	0	0	59
Beacon+X-77	2.3 oz+.25%	3	30	44
2,4-D amine	1.5 qt	25	0	45
Banvel	1.5 qt	24	0	42
Buctril	4.5 pt	0	0	48
Permit+X-77	2 oz+.25%	9	0	51
Exceed+COC	3 oz+1 qt	13	68	17
Basis+X-77+28% N	1 oz+.25%+2 qt	60	0	48
LSD (.05)		8	14	10

Table 23. Evaluation of Alfalfa Burndown

RCB; 3 reps
FALL: 10/20/95
ESPRING: 5/6/96
SPRING: 5/21/96
Soil: Silty clay; 3.7% OM; 6.6 pH

ALFZ = Alfalfa

COMMENTS: Treatments evaluated for alfalfa burndown prior to no-till cropping. Falll treatments were not effective; plants were damaged by freeze. Banvel + 2,4-D ester was the most consistent treatment, but this combination or Curtail cannot be used prior to planting soybeans.

Treatment	Rate/A	% VCRR 8/1/96	% ALFZ 8/1/96
FALL			
2,4-D ester	1 qt	0	18
Banvel+2,4-D ester	.5 pt+1 pt	0	15
Roundup	1 qt	0	20
EARLY SPRING			
2,4-D ester	1 qt	0	95
Banvel+2,4-D ester	.5 pt+1 pt	0	95
Roundup	1 qt	0	71
Check	----	0	0
SPRING			
2,4-D ester	1 qt	0	92
Roundup	1 qt	0	75
2,4-D ester+Banvel	1 pt+.5 pt	42	95
Roundup+2,4-D ester	1 pt+1 pt	0	87
Curtail	1 qt	0	70
LSD (.05)		4	14

Table 24. Weed Control in Regular & STS Soybeans

RCB; 3 reps
Variety: Kenwood & Stine STS
Planting Date: 5/30/96
PPI: 5/30/96
POST: 6/29/96
Soil: Loam; 2.9% OM; 6.5 pH

Precipitation: 1st week 1.18 inches
2nd week 0.00 inches

Cocb = Common cocklebur
VCRR = Visual Crop Response Rating

COMMENTS: Heavy cocklebur pressure. % VCRR on 9/17/96 was for non-STS variety and indicated delayed leaf drop. (1) indicated delayed leaf drop and (0) indicated no delay. Weed control similar for "regular" and STS soybean variety.

Table 25. No-Till Corn Demonstration

RCB; 3 reps
Variety: Curry IMI
Planting Date: 5/1/96
FALL: 10/30/95
EPP: 4/9/96
PRE: 5/1/96
EPOST: 6/3/96
POST: 6/13/96
Soil: Silty clay loam; 3.4% OM; 5.8 pH

Precipitation:
EPP 1st week 0.36 inches
2nd week 0.04 inches
PRE 1st week 0.48 inches
2nd week 0.28 inches

Cowh = Common waterhemp
Yeft = Yellow foxtail

COMMENTS: Broadleaf control was excellent with all treatments. Late, wet spring conditions reduced grass control for fall application compared to early spring.

Table 26. No-Till Soybeans in Corn Stalks Demonstration

RCB: 1 rep
Variety: Kenwood
Planting Date: 6/3/96
FALL: 10/30/95 PRE
EPP: 4/9/96
PRE: 6/3/96
POST: 6/29/96 Yeft = Yellow foxtial
Soil: Silty clay loam;
3.4% OM; 5.8 pH

Precipitation:

EPP	1st week	0.36 inches	
	2nd week	0.04 inches	
1st week	0.51 inches		
	2nd week	1.57 inches	

Cowh = Common waterhemp

COMMENTS: Waterhemp control distinct treatment response. Excellent comparison for grass control.

Table 27. No-Till Soybeans in Stubble Demonstration

RCB: 1 rep
Variety: Kenwood
Planting Date: 6/3/96
FALL: 10/30/95 PRE
EPP: 4/9/96
PRE: 6/3/96
POST: 6/29/96 Grft = Green foxtail
Soil: Silty clay loam;
3.4% OM; 5.8 pH

Precipitation:

EPP	1st week	0.36 inches	
	2nd week	0.04 inches	
1st week	0.51 inches		
	2nd week	1.57 inches	

Cowh = Common waterhemp

COMMENTS: Fall Roundup burndown. Uniform, moderate weed density. Common watertemp differences reflect timing and rates.

Table 24. Weed Control in Regular & STS Soybeans with ALS

Treatment	Rate/A	Regular % VCRR 7/16/96	STS % VCRR 7/16/96	% Cocb Regular 7/16/96	% Cocb STS 7/16/96	Regular % VCRR Delayed 9/17/96	Regular Yield bu/A	STS Yield bu/A
PREPLANT INCORPORATED & POSTEMERGENCE								
Prowl&Pursuit DG+ COC+28% N	3 pt&1.44 oz+1 qt+1 qt	0	0	91	91	1	56	58
POSTEMERGENCE								
Galaxy+Poast Plus+COC	2 pt+2 pt+1 qt	8	7	96	96	0	48	52
Raptor+COC+28% N	5 oz+1 qt+1 qt	0	0	86	85	1	53	54
Concert+Assure II+ COC+28% N	.5 oz+8 oz+ 1 qt+1 qt	17	0	90	90	0	45	53
Classic+Pinnacle+Assure II+ COC+28% N	.32 oz+.18 oz+8 oz+ 1 qt+1 qt	8	0	93	94	0	43	48
Classic+Pinnacle+Assure II+ COC+28% N	.63 oz+.216 oz+8 oz+ 1 qt+1 qt	20	0	93	94	1	38	49
PREPLANT INCORPORATED & POSTEMERGENCE								
Prowl&Pursuit DG+Pinnacle+ COC+28% N	3 pt&1.44 oz+.125 oz+ 1 qt+1 qt	23	18	92	93	0	51	55
Check	----	0	0	0	0	1	16	18
Prowl&Classic+Pinnacle+ Assure II+COC+28% N	3 pt&.32 oz+.18 oz+ 8 oz+1 qt+1 qt	28	0	95	95	0	51	57
LSD (.05)		9	4	3	3	---	7	5

Table 25. No-Till Corn Demonstration

FALL	EARLY PREPLANT	PREEMERGENCE	EARLY POST	POSTEMERGENCE	% Yeft 7/26/96	% Cowh 7/26/96	'94 & '96 2-Yr. Avg. % Gr	% Bdlf
Atrazine(1.1 lb)+ Dual II(2.75 pt)				73	95	70	95	
Atrazine(1.1 lb)	Dual II(2.75 pt)				83	95	85	95
Atrazine(1.1 lb)		Dual II(2.75 pt)			96	99	90	97
	Atrazine(1.1 lb)+Dual II(2.75 pt)				88	98	88	98
	Atrazine(1.1 lb)+MicroTech(3.25 qt)				82	97	83	97
	Atrazine(1.1 lb)+Frontier(1 qt)				79	96	83	97
	Atrazine(1.1 lb)+TopNotch(6 pt)				86	98	---	---
	Atrazine(1.1 lb)+Harness(2.75 pt)				83	98	86	98
	Broadstrike/Dual (2.5 pt)			85	96	85	96	
	Contour(1.33 pt)				91	99	90	98
			Contour(1.33 pt)+ Banvel(.5 pt)+X-77(.25%)	95	99	---	---	
	Atrazine(1.1 lb)		Resolve SG(5.3 oz)+ X-77(.25%)+28% N(2 qt)	97	97	---	---	
	Extrazine II(2.2 lb)		Extrazine II(2.2 lb)+VegOil(1 qt)		98	98	98	98
		Roundup(1 qt)+ AS(17 lb/100 gal)+ Harness(2.25 pt)+atrazine(1.1 lb)			97	99	---	---
		Roundup(1 qt)+AS(17 lb/100 gal)+ Balance(2 oz+Topnotch(2.5 pt)	Buctril(1 pt)+	atrazine(.55 lb)	99	99	---	---
		Gramoxone Extra(1.6 pt)+ X-77(.5%)+	Prowl(2.75 pt)+Accent(.33 oz)+ Beacon(.38 oz)+X-77(.25%)+ 28% N (4 qt)		96	98	---	---
		Gramoxone Extra(1.6 pt)+ X-77(.5%)+ Extrazine II(2.2 lb)+Topnotch(5 pt)		97	99	---	---	
		Gramoxone Extra(1.6 pt)+ X-77(.5%)+Microtech(2.5 qt)	Atrazine(1.5 qt)+COC(1 qt)	96	99	94	97	
		Gramoxone Extra(1.6 pt)+ X-77(.5%)		Accent(.67 oz)+ Banvel(.5 pt)+ X-77(.25%)+ 28% N(2 qt)	55	96	65	94
LSD (.05)							12	3

Table 26. No-Till Soybeans in Corn Stalks Demonstration

FALL	EARLY PREPLANT	PREEMERGENCE	POSTEMERGENCE	% Grft 7/24/96	% Cowh 7/26/96	'94 & '96 2-Yr.Avg. % Gr	% Bdlf
Prowl(3.65 pt)		Pursuit(1.44 oz)+Sun-It II(1 qt)+					
		28% N(1 qt)	96	95	---		---
Command(1 qt)	Pursuit(1.44 oz)+						
	Sun-It II(1 qt)+28% N(1 qt)		98	58	96		67
	Command(2 pt)			58	43	69	54
	Authority(.5 lb)+Command(1.5 pt)		86	98	---		---
	Command(1.5 pt)+Sen/Lex(.67 lb)		85	58	---		---
	Command(1.5 pt)		Pursuit(1.44 oz)+Sun-It II(1 qt)+				
		28% N(1 qt)	98	65	---		---
	Pursuit(1.44 oz)+Prowl(2.1 pt)			97	64	93	75
	Prowl(3.65 pt)	Pursuit(1.44 oz)+Sun-It II(1 qt)+					
		28% N(1 qt)	90	97	92		97
	Frontier(2 pt)+Sen/Lex(.5 lb)	Sen/Lex(.44 lb)		87	98	84	96
	Dual II(2.5 pt)+Sen/Lex(.5 lb)	Sen/Lex(.44 lb)		82	97	86	97
	Treflan(1 qt)+Sen/Lex(.5 lb)	Sen/Lex(.44 lb)		53	89	---	---
	Prowl(3.65 pt)+Sen/Lex(.5 lb)	Sen/Lex(.44 lb)		90	98	86	
	MicroTech(3 qt)	Sen/Lex(.44 lb)					
	Sen/Lex(.5 lb)			82	89	78	91
	Roundup(1 pt)+AS(17 lb/100 gal)+						
	MicroTech(3 qt)+Sen/Lex(.67 lb)97		99	---		---	
	Gramoxone Extra(1.6 pt)+						
	X-77(.5%)+Dual II(2.5 pt)+						
	Sen/Lex(.67 lb)		97	99	97		98
	Sencor(.5 lb)+	Poast Plus(2.25 pt)+					
	2,4-D ester).5 pt)+	Galaxy(1 qt)+COC(1 qt)					
	Roundup(.75 pt)+						
	AS(17 lb/100 gal)		98	99	97		99

Table 26. No-Till Soybeans in Corn Stalks Demonstration (Continued) . . .

FALL	EARLY PREPLANT	PREEMERGENCE	POSTEMERGENCE	% Grft 7/24/96	% Cowh 7/26/96	'94 & '96 2Yr. Avg. % Gr	% Bdlf
	Roundup(.75 pt)+ 2,4-D ester (.5 pt)+ AS(17 lb/100 gal)	Poast Plus(2.25 pt)+ Galaxy(1 qt)+COC(1 qt)	91	97	---		---
	Select(4 oz)+ 2,4-D ester(1 pt)	Poast Plus(2.25 pt)+ Galaxy(1 qt)+COC(1 qt)	94	97	---		---
		Poast Plus(2.25 pt) Galaxy(1 qt)+COC(1 qt)	73	83	74		82
	LSD (.05)				14		16

Table 27. No-Till Soybeans in Stubble Demonstration

FALL	EARLY PREPLANT	PREEMERGENCE	POSTEMERGENCE	% Grft 7/24/96	% Cowh 7/26/96	94 & '96 2-Yr. Avg. % Gr	94 & '96 2-Yr. Avg. % Bdlf
Pursuit DG(1.44 oz)+ Prowl(3.65 pt)				94	82	93	87
Pursuit DG(1.44 oz)+ Prowl(2.1 pt)				80	60	83	74
Pursuit DG(1.44 oz)				68	54	66	67
Preview(.56 lb)+ Dual II(2.75 pt)				60	97	---	---
	Pursuit DG(1.44 oz)+ Prowl(3.65 pt)			98	97	98	98
	Pursuit Plus(2.5 pt)+ Scepter(.33 pt)			96	98	---	---
	Broadstrike/Dual(2.5 pt)		98	97	94		96
	Pursuit DG(1.44 oz)			88	65	92	81
	Prowl(3.65 pt)		Raptor(4 oz)+Sun-It II(1 qt)+ 28% N(1 qt)	95	84	---	---
	Prowl(3.65 pt)		Pursuit DG(1.44 oz)+ Sun-It II(1 qt)+28% N(1 qt)	99	98	99	99
	Prowl(3.65 pt)		Pursuit DG(.72 oz)+ Sun-It II(1 qt)+28% N(1 qt)	99	88	---	---
	Prowl(3.65 pt)		Pinnacle(.25 oz)+Pursuit DG(.72 oz)+ Sun-It II(1 qt)+28% N(1 qt)	98	98	99	98
		Roundup(.75 pt)+ AS(17 lb/100 gal)+ 2,4-D ester(.5 pt)	Pursuit DG(1.44 oz)+ Sun-It II(1 qt)+ 28% N(1 qt)	96	98	96	98
	Pursuit DG(.72 oz)		Pursuit DG(.72 oz)+ Sun-It II(1 qt)+28% N(1 qt)	97	83	97	88
	Dual II(1 pt)		Pursuit DG(1.44 oz)+ Sun-It II(1 qt)+28% N(1 qt)	98	89	97	90
			Pursuit DG(1.44 oz)+ Sun-It II(1 qt)+28% N(1 qt)	96	85	95	69
		Roundup(.75 pt)+ 2,4-D ester(.5 pt)+ AS(17 lb/100 gal)	Reliance STS(.5 oz)+ Poast Plus(2.25 pt)+ COC(1%)+28% N(4 qt)	98	99	---	---
LSD (.05)						6	27

EFFECT OF INCREASING LEVELS OF CONDENSED CORN DISTILLERS SOLUBLES ON PERFORMANCE OF FINISHING STEERS

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ANIMAL SCIENCE 9624

Summary

A trial was conducted as a randomized block design to assess the effects of condensed corn distillers solubles (CCDS) on performance and carcass merit of yearling steers fed 90% concentrate finishing diets (n=216). CCDS was included at 0 (MSBM), 5 (5CCDS), 10 (10CCDS), and 20% (20CCDS) of diet DM, replacing soybean meal, molasses, and corn. Average daily gain increased (P<.05) for steers fed CCDS but, along with a numerical trend (P=.14) of increasing DMI, resulted in no increase in F/G (P>.20). Steers were harvested on day 108. Carcass weight and dressing percent for steers fed CCDS were greater than control steers (P<.01). Other carcass characteristics did not differ by treatment (P>.20). Ruminal fluid was collected by stomach tube from steers (n=72) at -.5, +1, +4, and +7 hours from feeding. Values reported are means across sampling times. Ruminal fluid pH was higher for CCDS fed cattle than MSBM (P<.05). Butyrate increased with increasing CCDS level (P<.05). Differences in acetate, propionate, and NH_3N were not significant (P>.20). The CCDS was an effective protein and energy source in 10% roughage corn-based finishing diets. Maximum inclusion rate is at least 20% of diet DM.

Key Words: Condensed Corn Distillers Solubles, Finishing Diets, Steers

Introduction

The fermentation of corn grain to ethanol produces, in addition to ethanol, distillers grains and a liquid fraction called sweet water or thin stillage. This liquid fraction is often condensed to a syrup with approximately 30 to 50% DM, 10 to 20% fat, and 20 to 30% protein known as condensed corn distillers solubles (CCDS).

Although the feeding of distillers solubles is not a recent development, limited work has been conducted to determine optimum and maximum levels of CCDS as currently produced in the upper Midwest. This study was designed to meet the following objectives: (1) to determine the effects of increasing levels of CCDS on feedlot performance and carcass characteristics of cattle fed finishing diets and (2) to determine effects on rumen function.

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Materials and Methods

Two hundred sixteen crossbred yearling steers (initial weight 858 lb) were randomly allotted within breed type to 24 pens (9 steers/pen, 6 pens/treatment) and fed 90% concentrate diets (Table 1) containing either CCDS at 0 (MSBM), 5 (5CCDS), 10 (10CCDS, or 20% (20CCDS) of the diet DM.

Diets were mixed and fed once daily at 8:30 a.m. Steers were allowed to consume feed ad libitum during the trial. A receiving diet was fed prior to and for the first 2 days of the trial. Four step-up diets were fed for 5 days each. The finishing diets were formulated to contain 12.5% protein, .70% Ca, .65% P, and 1.08% K. Steers received monensin at 30.8 mg/kg of diet DM. High moisture corn was replaced with dry corn starting on day 59 because supplies were depleted. Feed ingredients were sampled weekly and stored frozen for later analysis for DM and Kjeldahl N.

Table 1. Finishing trial diet composition (% DM)

Ingredient	MSBM	5CCDS	10CCDS	20CCDS
Dry rolled corn	38.00	38.89	37.29	32.58
High moisture corn	38.00	38.89	37.29	32.58
Alfalfa hay	10.00	10.00	10.00	10.00
Soybean meal	5.30	3.90	2.52	—
Molasses	5.00	—	—	—
CCDS	—	5.00	10.00	20.00
Limestone	.16	.45	.70	1.15
Dicalcium phosphorus	1.70	1.25	.80	.80
Potassium chloride	.90	.70	.50	—
Urea	.35	.35	.35	.35
Trace mineral salt	.50	.50	.50	.50
Premix	.09	.07	.05	2.04
Chemical analysis				
DM, %	82.02	75.96	70.09	61.37
CP, %	12.59	12.58	12.52	12.42

Initial and final weights were determined after an overnight shrink off feed and water. All steers were vaccinated for IBR, BVD, PI3, BRSV, and black leg and received ivermectin and a trenbalone acetate-estradiol implant. One steer died 32 days into the study due to causes not related to treatment.

Ruminal fluid was collected by stomach tube from nine animals per treatment on day 69 and day 70 of the trial. Samples were collected .5 hours before and 1, 4, and 7 hours after feeding, strained through cheesecloth, analyzed immediately for pH, and then acidified and frozen for later analysis for VFA and NH_3N. Values reported are means across sampling times.

Performance and carcass variables were analyzed as a randomized block design using the GLM procedures of SAS. Variables were tested for linear, quadratic, and cubic effects of CCDS level. Treatment means were separated by the PDIFF option of LSMEANS when F was significant. Block represented pen type (confinement vs open, dirt lots). Mean ruminal pH, NH_3N and VFA concentrations were analyzed as a completely random design using GLM procedures.

The steers were fed for a total of 108 days. They were harvested 1 day after the off-test weight was taken. Carcass data were collected for determination of quality and yield grades.

Results and Discussion

Average daily gain increased (P<.05) for steers fed CCDS (Table 2) but, along with a numerical trend (P=.14) of increasing DMI, resulted in no increase in feed efficiency (P>.20).

Mean ruminal fluid pH (Table 3) was higher for cattle fed finishing diets containing CCDS than MSBM (P<.05). Molar proportion of butyrate increased with increasing CCDS level (P<.05), but differences in acetate, propionate and NH_3N were not significant(P>.20).

Carcass weight and dressing percent for steers fed CCDS were greater than control steers (P<.10). Other carcass characteristics (Table 4) did not differ by treatment (P>.20). CCDS used in this study was an effective protein and energy source in 10% roughage, corn-based finishing diets. When replacing soybean meal, molasses and corn, CCDS apparently results in increased gain, a trend toward greater intake, similar feed efficiency, and increased dressing percent. Based on performance, maximum inclusion rate is at least 20% of diet DM.

Table 2. Feedlot performance data

Item	MSBM	5CCDS	10CCDS	20CCDS
DMI, lb/day	20.81	21.63	22.24	21.58
CPI, lb/day	2.62	2.71	2.78	2.67
ADG, lb/day	3.48[a]	3.68[b]	3.81[b]	3.70[b]
F/G	5.95	5.88	5.81	5.85

[a,b]P<.05.

Table 3. Rumen fermentation data[a]

Item	MSBM	5CCDS	10CCDS	20CCDS
pH	5.75[d]	6.07[ef]	6.18[e]	5.99[f]
Mean NH_3N[b]	4.18	3.01	2.87	1.57
Acetate[c]	52.18	51.65	50.87	49.71
Propionate[c]	34.63	36.74	35.23	34.86
Butyrate[c]	9.13[ef]	7.50[d]	9.96[ef]	11.11[f]

[a]Means across sampling times.
[b]mg/d1.
[c]Molar percentage.
[d,e,f]$P<.05$.

Table 4. Carcass data

Item	MSBM	5CCDS	10CCDS	20CCDS
Carcass wt, lb	780[b]	802[c]	818[c]	820[c]
Dressing percent	63.0[b]	63.8[c]	64.0[c]	65.0[d]
Rib fat, in.	.44	.48	.45	.48
Rib eye area, $in.^2$	14.04	14.17	14.19	14.11
Kidney, pelvic, heart fat	1.94	2.11	2.16	2.07
Yield grade	2.47	2.64	2.62	2.73
Quality grade[a]	5.11	5.22	5.01	5.03

[a]5.00 = low choice.
[b,c,d]$P<.01$.

EFFECT OF INCREASING LEVELS OF CONDENSED CORN DISTILLERS SOLUBLES ON PERFORMANCE OF GROWING STEERS

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ANIMAL SCIENCE 9625

Summary

A trial was conducted as a randomized block design to assess the effects of condensed corn distillers solubles (CCDS) on performance of steer calves fed 40% concentrate growing diets (n=200). CCDS was included at 0 (MSBM), 5 (5CCDS), 10 (10CCDS), and 20% (20CCDS) of diet DM, replacing soybean meal, molasses, and corn. A corn silage/supplement diet was also included (SIL). Dry matter intakes at higher CCDS levels were lower than that of MSBM (P<.05). Average daily gain was not affected (P>.20) and, as a result, feed efficiency (F/G) tended to improve (P=.14). Steers fed SIL consumed less DM (P<.05), gained faster (P<.01), and were more efficient (P<.01) than all other treatments. Ruminal fluid was collected by stomach tube from steers (n=90) at -.5, +1, +4, and +7 hours from feeding. Values reported are means across sampling times. Ruminal NH_3N and molar proportions of acetate decreased (P<.05) and propionate increased (P<.05) with increasing CCDS level. Despite significance, no discernable pattern was observed for ruminal fluid pH. The CCDS was an effective protein and energy source in 60% roughage growing diets. Maximum inclusion rate is at least 20% of diet DM.

Key Words: Condensed Corn Distillers Solubles, Growing Diets, Steers

Introduction

The fermentation of corn grain to ethanol produces, in addition to ethanol, distillers grains and a liquid fraction called sweet water or thin stillage. This liquid fraction is often condensed to a syrup with approximately 30 to 50% DM, 10 to 20% fat, and 20 to 30% protein known as condensed corn distillers solubles (CCDS).

Although the feeding of distillers solubles is not a recent development, limited work has been conducted to determine optimum and maximum levels of CCDS as currently produced in the upper Midwest. This study was designed to meet the following objectives: (1) to determine the effects of increasing levels of CCDS on feedlot performance of steer calves fed growing diets and (2) to determine effects on rumen function.

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Materials and Methods

Two hundred crossbred steer calves (initial weight 553 lb) were randomly allotted within breed type to 20 pens (10 steers/pen, 4 pens/treatment) and fed 40% concentrate diets (Table 1) containing either CCDS at 0 (MSBM), 5 (5CCDS), 10 (10CCDS, or 20% (20CCDS) of the diet DM or a predominantly corn silage diet (SIL).

Diets were mixed and fed once daily at 8:30 a.m. Steers were allowed to consume feed ad libitum during the trial. The diets were formulated to contain 11.5% protein, .75% Ca, .64% P, and 1.48% K. Steers received monensin at 24.6 mg/kg of diet DM. Feed ingredients were sampled weekly and stored frozen for later analysis for DM and Kjeldahl N. All steers were fed a common diet during the final 5 days of the 84-day study.

Table 1. Grower trial diet composition (% DM)

Ingredient	MSBM	5CCDS	10CCDS	20CCDS	SIL
Dry rolled corn	25.12	26.94	23.71	17.06	—
Grass hay	30.00	30.00	30.00	30.00	—
Oat hay	30.00	30.00	30.00	30.00	—
Soybean meal	6.16	4.75	3.38	.84	11.87
Molasses	5.00	—	—	—	—
CCDS	—	5.00	10.00	20.00	—
Limestone	.54	.83	1.05	1.50	.18
Dical phosphorus	1.70	1.20	.80	—	1.78
Potassium chloride	.88	.68	.46	—	.45
Trace mineral salt	.50	.50	.50	.50	.50
Premix	.10	.10	.10	.10	.10
Corn silage	—	—	—	—	85.12
Chemical analysis					
DM, %	85.84	78.65	71.86	61.80	55.49
CP, %	10.78	10.70	10.57	10.40	11.57

Initial and final weights were determined after an overnight shrink off feed and water. All steers were vaccinated for IBR, BVD, PI3, BRSV, and black leg and received ivermectin and an estradiol implant. One steer died 37 days into the study due to causes not related to treatment.

Ruminal fluid was collected by stomach tube from nine animals per treatment on day 23 and day 58 of the trial. Samples were collected .5 hours before and 1, 4, and 7 hours after feeding, strained through cheesecloth, analyzed immediately for pH, and then acidified and frozen for later analysis for VFA and NH_3N. Values reported are means across sampling times.

Performance variables were analyzed as a randomized block design using the GLM procedures of SAS. Variables were tested for linear, quadratic, and cubic effects of CCDS level. Treatment means were separated by the PDIFF option of LSMEANS when F was significant. Block represented pen type (confinement vs open, dirt lots). Mean ruminal pH, NH_3N, and VFA concentrations were analyzed as a completely random design using GLM procedures.

Results and Discussion

In the growing trial DMI at higher CCDS levels were lower than that of the MSBM diet ($P<.05$; Table 2). Average daily gain was not affected and, as a result, feed efficiency (F/G) tended to improve with increasing CCDS level ($P=.14$). Steers fed SIL consumed less DM ($P<.05$), gained faster ($P<.01$), and were more efficient ($P<.01$) than all other treatments.

Despite significant differences ($P<.05$) between growing diets (Table 3), there was no discernable pattern in mean ruminal fluid pH. However, ruminal NH_3N and molar proportions of acetate decreased ($P<.05$) and propionate increased ($P<.05$) with increasing CCDS level when averaged across sampling times.

CCDS used in this study was an effective protein and energy source in 60% roughage growing diets. When replacing soybean meal, molasses and corn, CCDS apparently results in similar gain, lower intake, and a trend toward improved feed efficiency.

Table 2. Performance data

Item	MSBM	5CCDS	10CCDS	20CCDS	SIL
DMI, lb/day	16.67[a]	15.94[ab]	15.08[bc]	15.06[bc]	13.89[c]
CPI, lb/day	1.79	1.70	1.59	1.57	1.61
ADG, lb/day	2.09[d]	2.14[d]	2.03[d]	2.09[d]	2.38[e]
F/G	7.94[d]	7.52[d]	7.46[d]	7.25[d]	5.81[e]

[a,b,c]P<.05; [d,e]P<.01.

Table 3. Rumen fermentation data[a]

Item	MSBM	5CCDS	10CCDS	20CCDS	SIL
pH	6.68[de]	6.74[de]	6.62[ef]	6.81[d]	6.54[f]
NH_3N[b]	4.99[e]	3.80[e]	4.71[e]	2.26[d]	4.06[e]
Acetate[c]	64.87[e]	64.20[e]	61.97[d]	61.17[d]	63.61[e]
Propionate[c]	21.22[de]	20.87[d]	21.59[de]	24.15[f]	22.35[e]
Butyrate[c]	10.76[d]	11.55[d]	13.00[e]	11.70[d]	10.74[d]

[a]Means across sampling times.
[b]mg/dl.
[c]Molar percent.
[d,e,f]P<.05.

A COMPARISON OF SINGLE-SOURCE VERSUS COMMINGLED EARLY-WEANED PIGS.

R. C. Thaler[5] and B. Rops[6]

Animal/Range Sciences 9626

Introduction

With the changes occurring in today's swine industry, producers are looking at methods to incorporate the latest technologies like all-in/all-out production, Segregated Early Weaning (SEW), improved genetics, phase- and split-sex feeding, etc. to remain competitive and profitable. One of the most popular technologies is SEW. Since pigs weaned at 10-14 days of age have few, if any, diseases, SEW allows producers to get high health status pigs and tremendous performance. Also, it is relatively easy to incorporate all-in/all-out production, improved genetics, phase-feeding and split-sex feeding into this system.

However, some of these technologies require a certain scale of size to be practical. One way to achieve that size is for individual producers to network together and pool resources to avoid the high costs associated with expansion. Since individual SEW nurseries would be expensive for every operation to build and buyers of SEW pigs are looking for larger groups to finish, it would be a benefit if producers could build a common or larger nursery and pool SEW pigs together to decrease building costs and increase production numbers. Therefore, the objective of this trial was to determine if commingled SEW pigs perform as well as single source SEW pigs.

Materials and Methods

Four hundred seventy-five early-weaned pigs (<14 days of age) of similar genetics were utilized in this trial. Two hundred twenty-five pigs from a single source were placed in the East room and two hundred fifty pigs from 4 different sources were placed in the West room (commingled room). Two of the pens in the West room were filled with pigs from the same herd that provided the pigs for the single source room to provide a means of comparison. There were 25 pigs per pen and all pigs were managed according to standard SEW production practices. All pigs were fed Cargill-Nutrena's SEW diets (4 different diets in 9 weeks).

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The barn was run to maintain strict biosecurity between the two rooms. The door between the two rooms was locked and personnel entered the rooms through the doors on the west and east sides of the barn. Chores were done by one individual, working first in the single source room and then going to the commingled source room to decrease the chance of contamination. Pig weights and feed consumption were recorded weekly.

Unfortunately, during the middle of the trial, both rooms broke with Porcine Reproductive and Respiratory Syndrome (PRRS). It was identified as having come from the single source farm and therefore both rooms were affected. For that reason, the data from this trial was not statistically analyzed. However, raw means are presented to allow for comparison.

Results and Discussion

Average daily gain, feed intake, and feed efficiency for the entire nine week trial are presented in Table 1. There appeared to be no difference between SEW strategies on daily gain, feed intake, and feed efficiency, nor were differences in deathloss reported. From gross observations it appeared that the commingled pigs were less affected than the single source pigs by the disease outbreak. One possible explanation for this observation is that the immune system of the commingled pigs might have been stimulated upon entering the facility and prior to the outbreak of PPRS, thereby providing the pigs more protection. However, this is only speculation for the gross observations, not the performance data.

The theory of commingling SEW pigs to achieve "single source" status still holds potential and efforts are under way to re-run the trial. One of the main points that can be discerned from this trial is how difficult a disease PRRS is to manage and the devastating effects it can have on an operation.

The authors wish to thank Don and Jim Benson (Hurley, SD), Jim and Mike Dailey (Jefferson, SD), and Freeman Feeds for their support of this project.

Table 1. Cumulative Nine-Week Performance Data.

Single Source Room

Pen	Gain	Feed Intake	Feed/Gain
11	.63	1.2	1.91
12	.67	1.3	1.89
13	.61	1.1	1.87
14	.75	1.4	1.87
15	.61	1.2	1.94
16	.58	1.1	1.92
17	.55	1.0	1.77
18	.50	1.0	2.07
19	.44	.9	2.12
Average	.59	1.1	1.92

Commingled Room

Pen	Gain	Feed Intake	Feed/Gain
1	.70	1.4	2.05
2	.65	1.2	1.88
3	.67	1.3	1.89
4	.61	1.2	1.92
5	.66	1.3	1.91
6	.62	1.2	1.91
7	.57	1.1	1.99
8	.59	1.1	1.78
9	.54	1.0	1.81
10	.65	1.2	1.78
Average	.63	1.2	1.89

THE EFFECTS OF ORAL ANTIBIOTIC THERAPY ON PIGLET PRODUCTIVITY AND IMMUNE FUNCTION FOLLOWING CHALLENGE WITH *E. COLI* AND ROTAVIRUS

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Animal/Range Sciences 9627

INTRODUCTION

Early weaning programs have been aimed at the control and elimination of respiratory infections in the young pig. Segregation from their dams at less than 21 days, batch rearing with all-in-all-out by room, building, or site, and proper biosecurity (cleaning, disinfecting and quarantine) are mandatory to implement early weaning programs. Early weaning with all its components gives a tremendous economic advantage to those who use this technology. This technology however does not come without a cost. Enteric infections such as neonatal coccidiosis and post weaning diarrhea problems have not been prevented by early wean programs. Although the Pork Quality Assurance Program has been developed to achieve the highly desirable goal of reduced antibiotic use, there are still occassions when feed and water medications are needed for the prevention and control of enteric infections.

We were interested in the effects of low levels of conventional water and feed grade antibiotic treatments on performance and immunological parameters of the young pig infected with the common enteric pathogens, ***E. coli*** and rotavirus. Previously, we had tested this treatment at both a research facility and a commercial operation and had shown increased production and decreased immunological response in the treated animals. We have established that the use of such a program would be a benefit to those producers who do not have the production facilities that would allow early weaning (7-10 days) and/or multi-site production. However the effect of these oral treatments on minimizing production losses and activation of the immune system following infection with enteric infections has not been established. The purpose of this study was to measure production and immunological parameters in orally medicated and control animals following a post weaning ***E. coli*** and rotavirus challenge.

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MATERIALS AND METHODS

Animal and Management

Farrowing and neonatal pig management - A commercial 130 head sow herd of known health status was chosen for this trial. Pigs were processed at 1 day of age (tails removed, iron dextran injections, needle teeth clipped). The pigs were vaccinated for ***Mycoplasma hyopneumoniae*** at 7-11 days of age and the boars were castrated. Prior to vaccination on day 7-11, a 3 ml blood sample was collected. At day 17-21 (weaning day) the pigs were re-vaccinated with ***M. hyopneumoniae*** and a 10 ml heparinized blood sample were collected from 10 pigs in each group.

Ten sows (ten litters-92 pigs:5 litters/group) were randomly assigned to one of two groups: 1) control and 2) treatment. The treatment regimen consisted of feeding 400 g/ton of Aureomycin[ä] in the gestation-lactation ration for 1 week before and 1 week after farrowing. The baby pigs' water was treated with water soluble Aureomycinä to deliver 10 mg/# body weight beginning day 2 post farrowing through day 9 post farrowing. Auero-Sulmetä soluble was added to the pigs drinking water at rate of 250 mg chlortetracycline/250 mg sulfamethazine per gallon from day 10 post farrowing through day 27-34 post farrowing (10 days postweaning) ASP250ä at a rate of 100 gm Chlortetracycline/100 gm sulfamethazine/50 gm penicillin per ton was used in the creep feed. Control pig diets were managed using the farm's husbandry procedures and all control creep contained 40 grams/ton of Apralanä.

Nursery management - The pigs were weaned at 17-21 days of age and transported 100 miles from Brookings, SD to Beresford, SD to a newly remodeled nursery-finisher isolation facility. The nursery facility contained 2 rooms each room contained 10-6' ft x 16' pens. The 46 treatment and 46 control pigs were each divided into 8 replicates. Eight pens in one room were divided with plywood and plastic coated wire was placed over the plats to prevent injury to the young pigs. Treated pigs were placed in one half and control pigs were placed in the other half of each pen. The treated pigs received Auero-Sulmetä soluble in the drinking water at rate of 250 mg chlortetracycline/250 mg sulfamethazine per gallon for 10 days post weaning (day 27-34 post farrowing). All the pigs received traditional phase I, II & III commercial nursery diets. Diet changes were made at 7 and 21 days post weaning. The treated pigs nursery diet contained ASP250ä at a rate of 100 gm chlortetracycline/100 gm sulfamethazine/50 gm penicillin per ton. Control pigs weaning diets contained 40 grams/ton of Apralan[TM]. All pigs were switched to 20 grams/ton of Tylan 10 for the grower/finisher phase and these diets were standard grow finish diets. The pigs were weighed weekly through day 160. All feed was weighed to obtain feed efficiency data.

Microbiological challenge - Rotavirus (OSU strain) was obtained from Dr. David Benfield, Dept. Vet. Science, South Dakota State University (SDSU). The stock virus had been passed through pigs. The virus was grown on MA 104 cells, harvested and titrated. The tier of the challenge virus was 6.25 X10^9 $TCID_{50}$. The virus was diluted with minimum essential media (MEM) to give each pig a 2 ml challenge dose of 10^7 of $TCID_{50}$ rotavirus p.o.. The 0111 strain ***E. coli*** was grown in broth cultures and diluted to 250 ml with PBS and each pig was given a 2 ml dose p.o. that contained ***10^8 E. coli*** 0111. The pigs were challenged 2 days after arriving at the nursery facility (19-23 days of age).

Clinical indices - Clinical signs (fever and diarrhea) were recorded. The temperature of the same one or two pigs/pen was taken for 15 days. Diarrhea was assessed daily in each pen on a scale of 0-4 (0-firm, formed feces; 1-pasty feces; 2-pudding feces; 3-slightly runny feces; and 4-watery feces) for 29 days.

Microbiological test - A fecal sample was collected using a sterile swab from one pig in each pen on the day of challenge and 3, 10, 16, 24, 28, and 35 days post challenge (PC).
Bacteriology The swabs were streaked by the SDSU Diagnostic Bacteriology Laboratory on differential plates. The number of hemolytic ***E. coli*** were estimated. ***E. coli*** isolates were then typed for O111.
Virology The fecal swabs were then pooled according to treatment groups and the samples examined with an electron microscope for the presence of rotavirus by the SDSU Electron Microscopy Laboratory.
Serology Blood was collected and serum samples were harvested at 7-11 and 53-57 days of age (35 days post challenge) from 10 pigs in each group. Serum samples were tested for ***M. hyopneumoniae*** antibodies using a commercial ***M. hyopneumoniae*** ELISA performed by Oxford Diagnostic Laboratories, Worthington, MN.
Clinical Immunology 10 ml heparinized blood was collected and lymphocytes harvest at 17-21 (weaning day), 23-27 (4 days post challenge), 30-34 (11 days post challenge) and 53-59 days of age (34 days post challenge) from 10 pigs in each group. Mitogen proliferation assays were conducted in the SDSU Clinical Immunology Laboratory. The plant lectins, concanavalin A (Con A) at 1 ug/ml, phytohemagglutinin A (PHA) at 1 ug/ml and pokeweed mitogen (PWM) at 5 ug/ml were used to stimulate isolated peripheral blood lymphocytes. The lymphocytes were cultured for 44 hours and pulsed for 4 hours with tritiated (^3H) thymidine and harvested at 48 hours in a cell collector. The disks were counted in a liquid scintilation counter. All cultures were done in triplicate and the values represent the mean specific incorporation (sample mean-unstimulated cell mean) of the

triplicate samples. Forced antibody production was performed. The assay was standardized with a preparation of porcine IgG (Sigma, St. Louis, MO).

RESULTS

Production Results from the growth trial are presented in Table 1a-e. In the starter phase, the treatment protocol improved daily gain (P<.124) and feed efficiency (P<0.079)(Table 1a). In the grower, finisher, and overall growth phases, performance was not affected by treatment (P>.10)(Tables 1b-d). Ultrasonic measurements of 10th rib backfat thickness and loin eye area at 240 lbs were unaffected by treatment (P>.10)(Table 1e).

Clinical signs The temperatures of the treated pigs were not significantly different from the control group from day 1 to day 15 post challenge (PC)(Figure 1). The temperatures of the treated pigs were in the normal range throughout the trial (Figure 1). From day 6 to day 15, the temperatures of the treated pigs were lower than the control.   The diarrhea scores were similar between control and treatment groups. The diarrhea was biphasic in the control group at 4-5 days PC and at 18-24 days PC. The highest amount of diarrhea occurred at Days 18-22 PC (Figure 2).

Microbiology No rotavirus was identified prior to challenge (Table 2). Rotavirus was identified at Day 3 post challenge in both control and treated pigs. Rotavirus was also identified at Day 10 and Day 16 PC (Table 2) in the control pigs. Hemolytic ***E. coli*** was isolated from 1 treatment pen prior to beginning the study (Table 3). Test are under way to determine the stereotype. Hemolytic ***E. coli*** at moderate levels were isolated at Days 16 and 24 PC. No hemolytic ***E. coli*** was isolated from the control prigs prior to the study. Hemolytic ***E. coli*** was present through out the trial in the control group (Table 3). Stereotyping of the ***E. coli*** established that the challenge was 0111 but subsequent isolations throughout the trial were negative for 0111.

Serology There was no serological response to the ***M. hyopneumoniae*** vaccination in the treated pigs and a very small response (1/10) of the control pigs (Table 4). Three of the control pigs had passive ***M. hyopneumoniae*** titers while none of the treated pigs had passive titers on Day 10.

Clinical immunology T cell mitogen activity, B cell mitogen activity and induced immunoglobulin (Ig) were measured in the treatment and control groups (Figures 3-5). The immunological response with the T cell mitogens with both phytohemagglutinin (PHA) and concanavalin A (ConA) was lower in the treatment group (Figure 3). The ConA response was significantly lower (p<0.05) at 17, 30 and 56 days of age (Figure 3). The B and T cell mitogen pokeweed mitogen (PWM)(Figure 4) and the forced antibody production assays (Figure 5) had a different pattern from the T cell assays. Prior to challenge on day 17, B cell proliferation (Figure 4) and induced antibody production (Figure 5) were similar in both groups. At 23 days of age (4 days post challenge) both parameters were depressed. At 30 days of age, the B cell mitogen activity (Figure 4) and the induced antibody production (Figure 5) were higher in the treatment group. At 56 days of age, the B cell mitogen activity was similar in both groups and the antibody production was higher in the control group.

DISCUSSION

The production results indicated again a early advantage in rate of gain and feed efficiency in the treatment group (Table 1a). However by the end of the trial the two groups were similar in those parameters (Table 1c-d). Data from this trial indicate that the MEW protocol used in this study improves nursery performance, but compensatory performance masks those benefits in the grower and finisher phases. These results may represent what would happen under field conditions following removal from water antibiotic therapy. One of the main design issues is that the control and treatment animals were housed in adjacent pens throughout the trial. The treated pigs could have become infected after the end of the treatment resulting in similar production results at the end of this study. In the future, strict segregation should be used to determine the long term effect of this antibiotic therapy.

Clinical scores were similar for both groups. The initial design called for monitoring temperatures for 14 days. The data indicates that temperatures were on the rise and with the occurrence of diarrhea at 18 days temperatures should be monitored concurrently with diarrhea. The diarrhea scores indicate that the treated pigs were partially protected from the initial diarrheal phase at 4-5 days PC. Duration and severity of the second phase was similar between the two groups. Again the contamination and infection of the treated pigs by the adjacent control pigs following end of antibiotic therapy could have played a factor in the resulting second diarrheal phase. The immune response to diarrheal disease in the control animals was not effective in preventing the second diarrheal phase.

The microbiological data was interesting in this trial. Rotavirus recovery was much lower in the treated pigs. The sensitivity of the electron microscopy detection is 10^5 particles/ml. The decreased rotavirus detection indicates lower replication of rotavirus in the treated pigs. ***E. coli*** detection was also lower with no organism detected 3 days PC indicating that the treatment reduced the load of ***E. coli***. Subsequently the levels of ***E. coli*** recovery during the second diarrheal phase was similar between the two groups. The 0111 stereotype could not be recovered after the initial infection. We have discussed this with Dr. David Francis, a expert in porcine ***E. coli*** and we have no explanation for this phenomena.

The serological data in this experiment was disappointing. There was a single control pig that responded to the ***M. hyopneumoniae*** vaccine. The vaccine used in this trial was a different product from that used in the previous trial. The manufacturer of the vaccine was the same company that performed the ***M.***

hyopneumoniae ELISA test. We have shared this humoral response data with them.

The immunological data was similar to that seen in our two previous studies. There was a decreased T cell response indicating a lower inflammatory response. This decreased inflammatory response has a sparing effect that allows increased growth in the treated pigs. The antibody capacity and production of the treated animals as measured by B cell mitogen activity and forced immunoglobulin should allow them to respond to a challenge.

CONCLUSIONS

These results indicate an increase in daily gain and feed efficiency with pigs treated with an oral antibiotic regiment. The ***E. coli*** -rotavirus challenge model indicated an advantage to the treated pigs with a lower fever response, increased clearance of ***E. coli*** and rotavirus and decreased T-cll activation. The ***E. coli*** and rotavirus and decreased T-cell activation. These decreased physiological and immunological responses and higher pathogen clearance are all factors that could result in the increased production parameters in the treatment group.

Table 1 a. Weaning Performance (Starter Phase Days 17-61, 10-46 lbs.)

	Control	Treatment	p Value
Daily gain, lbs	0.756	0.827	0.124
Daily feed, lbs	1.418	1.440	0.542
Feed/gain	1.900	1.742	0.079

Table 1 b Performance (Grower Phase-Days 62-105, 46-118 lbs.)

	Control	Treatment	p value
Daily gain, lbs	1.647	1.689	0.465
Daily feed, lbs	4.083	4.248	0.258
Feed/gain	2.489	2.511	0.717

Table 1 c. Performance (Finishing Phase Days 106-160, 118-234 lbs)

	Control	Treatment	p value
Daily gain, lbs	2.052	2.026	0.762
Daily feed, lbs	6.356	6.377	0.911
Feed/gain	3.116	3.153	0.595

Table 1d. Overall Performance (Days 17-160, 10-234 lbs)

	Control	Treatment	p Value
Daily gain, lbs	1.529	1.554	0.570
Daily feed, lbs	4.154	4.222	0.435
Feed/gain	2.730	2.717	0.793

Table 1e. Carcass Performance (234 lbs.)

	Control	Treatment	p Value
10th Rib Fat Thickness, in	0.849	0.849	0.999
Loin Eye Area, sq. in.	5.175	5.075	0.405

Table 2. Rotavirus Detection in Pigs

Days Post Challenge

	Day 0	Day 3	Day 10	Day 16	day 24	Day 28	Day 35
Control	neg.	pos	pos	pos	neg.	neg.	neg.
Treated	neg.	pos	neg.	neg.	neg.	neg.	neg.

pos-virus detected in fecal samples

neg. - no virus was detected in fecal samples

Table 3. *E. coli* Detection in Pigs

Days Post Challenge

	Day 0	Day 3	Day 10	Day 16	Day 24	Day 28	Day 35
Control	0	1.1	1.3	1.1	2.3	1.3	0.1
Treated	0.1	0	0.9	1.6	2.0	0	0.4

0 - no hemolytic ***E. coli***

1 - few hemolytic ***E. coli***

2 - moderate hemolytic ***E. coli***

3 - many hemolytic ***E. coli***

Table 4. Serological response (log 10) to *Mycoplasma hyopneumoniae* (number of pigs seropositive/total number of pigs tested).

Days of age	Treatment	Control
Day 10	0 (0/10)	0.77 ± 1.25 (3/10)
Day 56	0 (0/10)	0.32 ± 1.01 (1/10)