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Soil Science Research Report - 1986

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EFFECT OF LONG TERM SEED AND BROADCAST P ON WINTER WHEAT YIELDS

D. H. Sander and G. A. Peterson

Objective: To determine the effect of long term applications of seed and broadcast P on winter wheat grain yield.

Procedure: Study locations were established in 1976 in Hitchcock County (Carter) and in 1978 in Red Willow County. Phosphorus was applied with the seed or broadcast every other year in the wheat-fallow system at each location at rates of 0 to 37.5 lbs P/ac at 7.5 lbs P increments. Broadcast P was incorporated each year with the final tillage. Yields have been reported for each harvest in previous Research Reports. In 1986 after six harvests, grain yields were significantly increased by applied P at the Carter location even though hailed and seed applied P was more effective than broadcast (Table 1). In previous years applied P has not generally increased yield since the soil test for P was medium (17 ppm Bray No. 1, 0-4") when the experiment was established. At the Red Willow County location, grain yields were increased with applied P and seed P was superior to broadcast even after five P applications and five harvests. The superiority of seed applied P apparently is continuing especially at the low application rates, but seems to be superior even at the high application rates. Soil test P was low at the Red Willow location in 1973 (6 ppm Bray No. 1, 0-4"). Soil samples have been taken twice at each location.

Table 1. Effect of long-term seed and broadcast P placement in yields of winter wheat. 1986.

Treatment P rate	Red Willow Co. 78-86-7		Carter[1/] 76-86-0	
	Grain	Straw	Grain	Straw
lbs/ac	bu/ac	lbs/ac	bu/ac	lbs/ac
0	16	2367	23	1700
		Seed Applied		
7.5	25	3079	20	3160
15.0	23	2892	24	3711
22.5	31	3444	21	3320
30.0	28	3373	26	3827
37.5	30	3257	20	3070
Mean	27	3204	22	3418
		Broadcast		
7.5	16	2314	19	3168
15.0	14	2145	18	3053
22.5	19	2661	20	3471
30.0	24	3124	23	3418
37.5	27	3338	19	3115
Mean	20	2714	20	3070
		Analysis of Variance		
Rate	**	**	*	NS
Method	**	**	*	NS
Rate * Method	NS	NS	NS	NS

[1/] Grain yields were reduced by hail.

EFFECT OF METHOD AND TIME OF P APPLICATION ON WINTER WHEAT GRAIN YIELD

D. H. Sander

Objective: To determine the effectiveness of split P application on wheat grain yields and P uptake.

Procedure: The effect of different methods of P application and when those applications were made to wheat were studied at three locations in 1986 (Hitchcock, Gosper, and Saunders Counties). Methods of application included placing P with the seed (Sd), knifing P prior to planting in 30 cm spacings (12 inches) (KF), knifing P in the spring (KS), and combinations of half the P placed with the seed and half knifed in the fall (Sd+KF) and half with the seed and half knifed in the spring (Sd+KS). All methods were studied at 10, 20, and 30 lbs P/ac. One treatment included no P (check). Brule wheat was seeded at a rate 60 lbs/ac in the middle of September.

Results: Wheat grain yields were increased by applied P at all three locations (soil tests showed low available P at all locations), by 25, 15, and 15 bu/ac at the Hitchcock, Gosper, and Saunders County locations respectively. Methods of P application significantly influenced grain yields. Seed application was the most effective method of applying P at all locations. Seed applied P was surprisingly more effective than knife application at each location varying from about 10 bu/a at the Hitchcock location to 8 bu/ac at Gosper County to 6 bu/ac in Saunders County. This difference between performance of seed applied P versus knife P is contrary to previous results which indicate equal effectiveness of these two methods of P application. The spring knife method was generally the poorest method of P application for wheat having no effect on yield at either the Gosper or Saunders County locations. It seemed that the split treatments were generally only about as effective as the amount of P applied with the seed. P analysis for P uptake and head counts are in progress.

Table 1. Effect of method of P application on wheat grain wheat grain yields. 1985.

Method of P Application	P Rate lbs/ac 10	20	30	Mean
	Hitchcock County 86-15, bu/ac			
Seed (Sd)	57	61	65	61
Knife Fall (KF)	47	49	43	46
Knife Spring (KS)	48	54	55	52
Split:Sd+KF	49	57	55	54
Split:Sd+KS	50	58	65	57
Mean	50	56	57	
Dribble (Db)		39		
Split:Sd+Db		53		
No P	38			
	Gosper County 86-17, bu/ac			
Seed (Sd)	51	57	56	55
Knife Fall (KF)	40	41	48	43
Knife Spring (FS)	40	44	38	40
Split:Sd+KF	45	51	51	49
Split:Sd+KS	43	48	51	47
Mean	44	48	49	
Dribble (Db)		40		
Split:Sd+Db		51		
No P	40			
	Saunders County 86-22, bu/ac			
Seed (Sd)	42	42	44	43
Knife Fall (KF)	36	38	35	36
Knife Spring (KS)	26	34	27	29
Split:Sd+KF	36	42	43	40
Split:Sd+KS	34	43	45	41
Mean	35	40	39	
Dribble (Db)		40		
Split:Sd+Db		41		
No P	29			

Analysis of Variance

Source	Hitchcock Co.	Gosper Co.	Saunders Co.
P Rate	.01	.01	.02
Method	.01	.01	.01
P rate*method	NS	NS	NS

BKR Demonstration Farm - Comparison of Lime Sources and Rates in a Corn-Soybean Rotation

Gary W. Hergert and Dennis Bauer

Objectives

1. To evaluate the effect of various lime sources and rates on crop yields on an acid sandy soil.

2. To demonstrate the economics of liming with various lime sources.

Procedure

This experiment was established under a small center pivot near Bassett, Nebraska on a Valentine-Boelus fine sand in 1985. Soil analysis in the spring of 1985 showed a pH of 5.6, 1% organic matter, 34 ppm Bray 1P, 138 ppm K, and 0.8 ppm sulfur. The liming recommendation was for 1000 pounds of ag lime per acre. Four treatments included a check, broadcast and incorporated ag lime, broadcast and incorporated pelleted lime, and row applied pelleted lime at the time of planting. The broadcast pelleted lime rate was selected by spending the same dollar amount/A as the Ag lime cost. Lime was broadcast April 18, 1985 and incorporated by a single disking. Treatments were laid out in replicated strips which ranged in width from 20 to 50 feet wide. Four replications were used. Corn was planted May 7, 1985. No starter was used because of the high soil test level. Anhydrous ammonia was applied June 1 at 128 pounds N per acre. Hail damage on June 11 was estimated at 25% loss based on an estimate by the Federal Crop Insurance Adjuster. Irrigation was based on Agnet irrigation programs and using the check book method, 14.8 inches of water was applied. Four corn rows 200 feet long were combine harvested in the fall and weighed in a weigh wagon. Yields were corrected to 15.5% moisture and are shown in Table 1. Hail damage lowered the yield potential and may have caused the lack of a treatment effect. There was no significant effect although yields were quite good considering the degree of hail damage.

The plot area was sampled by treatment for each rep in the spring of 1986. Results are shown in Table 2. No difference in soil pH for the various treatments was shown and based on the soil tests 3000 pounds of ag lime was recommended. In 1986 the ag lime plot was split. Half received no additional lime while the other half received the 3000 pound ag lime recommendation. The broadcast pelleted lime treatment was also split, half did not receive any additional lime, the other half received a broadcast application of 1250 pounds of pelleted lime per acre. The liming rates in 1985 and 1986 were based on spending the same amount of money for liming treatments. The broadcast lime treatments were incorporated by a single disking. In 1986 125 pounds of pelleted lime was placed with the soybean seed at planting. Soybeans were planted May 16, 1986 and were treated with a seed inoculant. Herbicide was Sonalan and included 20 pounds of N and 15 pounds of sulfur per acre.

There was a significant response to liming in 1986 (Table 3). The ag lime was significantly better than the check and the two broadcast pelleted lime treatments. The row applied pelleted lime performed as well as the higher rates of broadcast pelleted lime. If this method of application works by creating a small zone of higher pH around the seed this may be an economical method for liming. More research is needed to confirm this conjecture.

No additional lime applications will be made to these plots. The pH's will be followed in the spring of the years to determine the influence of treatments on soil pH. Corn will be grown in 1987 and soybeans will be the crop in 1988. Yield results will be taken from the different treatments to follow the residual effects of the treatments applied.

Table 1. Corn grain yields - 1985

Ag lime - 1,000 #/A	118 a
Pelleted lime with seed - 120 #/A	117 a
Pellet lime - 350# - Broadcast	114 a
Check	115 a

cv = 3.9%
Values followed by the same letter are not significantly different.

Table 2. Soil pH for 0-8" depth, spring 1986

	Rep 1	Rep 2	Rep 3	Rep 4	Avg
Pelleted lime, broadcast, 350 lbs/A 1985	5.4	5.3	4.9	4.8	5.1
Ag lime, broadcast, 1000 lbs/A 1985	5.1	5.1	5.1	5.1	5.1
Check	5.3	4.9	5.1	5.1	5.1
Pelleted lime, with the seed, 118 lbs/A	5.2	5.0	5.0	4.9	5.0

Table 3. Soybean yields - 1986

Ag lime 1985 & 1986	51.4 a
Ag lime 1985	47.7 ab
Row - pelleted 1986	47.6 ab
Broadcast - pelleted 1985	46.1 b
Check	45.9 b
Broadcast & pelleted 1985 & 1986	45.4 b

cv = 6.2%

EFFECT OF BAND SPACING ON THE EFFECTIVENESS OF DUAL PLACED N AND P ON CORN YIELD AND P UPTAKE

B. Eghball and D. H. Sander

Objective: To determine the effect of band spacing on the effectiveness of dual-placed N and P on corn yield and P uptake.

Procedure Two experiments were conducted on a Moody sicl in Antelope County and on a Nora sil in Boone County in Nebraska in 1986. The experiment at Boone County was destroyed by hail. Five P application rates of 0, 7.5, 15, 22.5, and 30 kg P ha^{-1} with band spacings of 30, 45, 60, and 75 cm were used. N was applied as NH_3 at 200 kg N ha^{-1}. Both experiments were under center pivot irrigation. Whole plants at the 7 leaf stage and ear leaves were taken for P analysis. Grain yield and total P uptake were determined at harvest.

Results: The results indicate that neither ear leaf P or P uptake at the 7 leaf stage were significantly affected by the P application rate or band spacing (Table 1). There was a significant effect of applied P on grain yield and total P uptake where linear relationships with applied P were observed for both grain yield and total P uptake. No effect of band spacing on the grain yield and total P uptake was observed.

Table 1. Effect of P application rate and band spacing seven leaf, earleaf and total P uptake and grain yield of corn.

Variable	Seven leaf P uptake	Ear leaf P uptake	Total P uptake	Grain yield
	mg P Plant $^{-1}$	mg P leaf^{-1}	kg ha^{-1}	
P Rate kg P ha^{-1}				
0	32.7	17.4	26.7	9815
7.5	35.6	18.0	29.9	9916
15.0	35.9	18.7	31.8	10678
22.5	38.4	19.3	33.5	10419
30	35.1	18.6	32.7	10724
Band spacing (cm)				
30	38.4	19.2	32.5	10310
45	33.5	17.2	30.3	10728
60	34.4	18.5	30.3	10269
75	36.0	18.7	30.6	10385
Replication	NS	NS	NS	NS
Rate (R)	NS	NS	NS	NS
Linear	NS	NS	0.09†	0.04
Quadratic	NS	NS	NS	NS
Band Spacing (BS)	NS	NS	NS	NS
Linear	NS	NS	NS	NS
Quadratic	NS	NS	NS	NS
R*BS	NS	NS	NS	NS

† Actual probability level up to 0.10 level, NS indicate significance level 0.10.

Effect of Broadcast Phosphorus on P Response of Ridge-Planted Corn

Gary W. Hergert

Objectives

1. Determine the broadcast P rate needed to obtain maximum yield of corn on a low phosphorus Cozad silt loam.

2. Determine the effect of annual applications of P on yield response and influence on soil P level.

Procedure

More ridge-till planted corn is being planted every year. Since there is very little tillage in this system one might assume that broadcast phosphorus would be a poor method for correcting phosphorus deficiency. A field at the WCREC has been in continuous no-till corn production for about 20 years. An area in the field was identified with a low phosphorus level (Table 1). A phosphorus recommendation depending upon which soil test is used would be somewhere between 40 to 80 pounds of broadcast phosphorus per acre annually according to our current NebGuide on fertilizer suggestions for corn. The phosphorus level in the sub soil was low but uniform throughout the plot area.

In the spring of 1985 a P rate study was designed as a five by five Latin square. P rates were 0, 25, 50, 75, and 100 pounds of P_2O_5 per acre. Plots were 60 feet long by eight-30 inch rows wide. 0-46-0 was broadcast with 180 pounds of N as ammonium nitrate after corn stalks were chopped. Corn was planted with a four row non-flexible Buffalo till planter. This planter splits the ridge taking off about 5 inches of the ridge and splitting it into the old row covering the chopped corn residue. In 1985 and 1986 the only operation after planting was a ditching the first part of July. In the spring of 1986 the plots were split and half of the plots received an annual application of the P rate.

The data for both years showed that a P rate somewhere between 50 to 75 pounds per acre maximized the yield. Earleaf P in both years correlated well to annual phosphorus application (Table 2). Phosphorus in the grain was determined in 1985. Analyses for 1986 have not been completed yet. Since this is a continuous corn production system the only phosphorus removal is in the grain. An apparent phosphorus use efficiency can be calculated although it may be somewhat risky. The apparent P use efficiency is the P uptake minus the check divided by the phosphorus applied. The values shown in Table 2 are quite high. The research does show that broadcasting in this minimum tillage system with recommended rates of phosphorus was an effective method for correcting phosphorus deficiency. Soil will be analyzed at the end of 4 years of annual P applications, after which time the plot will be treated as a residual P experiment.

Table 1. Soil analysis of Cozad silt loam P rate plot at North Platte - spring 1985.

Rep.	O.M.	pH	Phosphorus 0-8 Bray	0-8 SBC	8-16 Bray	8-16 SBC	16-24 Bray	16-24 SBC	lb NO_3-N/6'
I	1.3	7.7	7.8	6.8	3.6	4.1	4.4	4.3	58
II	1.2	7.7	4.3	5.2	3.9	4.3	3.8	3.6	63
III	1.2	7.6	5.3	5.0	2.6	3.9	3.6	3.6	63
IV	1.3	7.5	5.4	5.0	3.8	3.6	3.4	3.5	78
V	1.3	7.6	6.6	6.1	4.4	3.9	3.0	3.3	51
Avg	1.3	7.6	5.9	5.2	3.7	4.0	3.9	3.7	63

Table 2. Effect of P rate on plant parameters.

P rate	Grain 1985	Grain 1986	Earleaf P 1985	Earleaf P 1986
	bu/A (relative yield)			
Check	145 (78)	173 (79)	0.206	0.193
25	160 (86)	192 (87)	0.226	0.193
25 Annual	-	207 (94)	-	0.209
50	178 (96)	213 (97)	0.247	0.204
50 Annual	-	218 (99)	-	0.299
75	180 (97)	216 (98)	0.257	0.231
75 Annual	-	220 (100)	-	0.240
100	186 (100)	219 (100)	0.259	0.240
100 Annual	-	220 (100)	-	0.253

Additional 1985 Data

P rate	Grain P	P Removal	Apparent P use efficiency
0	0.158	25	-
25	0.170	29	36%
50	0.171	33	36%
75	0.181	35	30%
100	0.187	38	30%

HIGH YIELD CORN - SOYBEAN- WHEAT ROTATION STUDY

W. R. Peterson, D. T. Walters, and R. A. Olson

Objectives: To examine the response of corn yield as a result of being in a corn-soybean-wheat rotation with all crops irrigated as required on a Sharpsburg sicl. To evaluate the energy efficiency of a corn-wheat-soybean rotation and monoculture corn as influenced by nutritional requirements.

Procedure: Plots were established in 1981-82 using a corn-soybean-wheat rotation and continuous corn. Design was such that every crop is produced every year. Nine fertility treatments are applied as the subplot factors. These include a check, three rates of N, two rates of P and K with singular rates of manure, S, Zn, Cu, and B. Highest rates of nitrogen are employed for corn while 1/2 and 1/4 the corn nitrogen rate are applied to wheat and soybeans respectively.

Results: The 1986 growing season proved to be very favorable for corn and soybeans. The resulting yields proved to be excellent as shown in Table 1. Heat and moisture stress was very limited throughout the growing season. Corn plots were irrigated only twice while soybeans received no irrigtion. Growing conditions for wheat were less favorable. Leaf rust was severe and appeared to reduce yield significantly.

Table 1 gives crop yield response to the various treatments. As a result of generally poor wheat yields, wheat response was minimal to fertilizer amendments. The manure treatment gave the highest yield. There was no significant soybean yield response to treatments at the 0.05 level using the Waller Duncan Test.

In 1986, the control treatment produced a very high yield of 181 bu/a for the corn grown in rotation. This compares to 81 bu/a for the check plot for corn grown continuously. Unlike wheat and soybeans, corn required supplemental nitrogen to produce maximum yields. In past years, the manure treatment with some supplemental nitrogen produced top yields. However, in 1986 the manure treatment was not up to previous years performance. This may have been partially due to the fact tht first brood corn borers are attracted to the most advanced corn. The manure treatments were visually ahead in growth stage and appeared to have had the greatest occurrence of shot-hole corn borer feeding.

Table 2 gives the analysis of variance for the comparison of grain yield of rotation corn versus grain yield of continuous corn. Rotation effect was significant at the 0.10 level with average response over all treatments to rotation being 33.1 bu/acre.

For comparative purposes in terms of energy analysis treatments 1, 2, 4, 8 and 9 were selected as representative cases. In terms of energy yield, corn was by far the most productive crop (Table 3). Corn produced more than twice the energy equivalent as did soybeans per acre and approximately six times the energy yield of wheat in 1986. It should be emphasized that there is a major influence of growing season on energy equivalents produced as well as on the efficiency of energy production.

The growing season in 1986 was such that corn and soybeans were favored while wheat yields were limited.

The energy expenditure for production energy yield and efficiency ratios involved in the production of irrigated wheat, soybeans, and corn in rotation and corn grown continuously are given in Tables 4, 5, and 6. The figures of energy expenditure are average values and as such are not influenced by season.

Energy efficiency in response to added fertilizer treatments is limited for wheat and soybeans (Tables 4, 5). Wheat is especially energy efficient for the control treatment. This is partially a growing season effect for wheat as there was little response to treatment in terms of wheat yield in 1986. However, the two year average wheat yield also shows that the control treatment was the most energy efficient. Soybean energy efficiency response to treatment was less variable but the check tended to be as energy efficient as the other treatments.

The energy expenditure and efficiency of corn grown in rotation and continuous corn, both under irritation, is given in Table 6. For continuous corn, efficiency is greatly improved by adding either manure or supplemental nitrogen. This occurred both in 1986 and for the 1985-86 average. For corn grown in rotation, the energy efficiency response to manure or additional nitrogen was less apparent in 1986. Due to a very high check yield, which could be considered abnormally high, the energy efficiency of the check treatment was comparable to the other treatments. When the two year average is examined the trend more closely approximates the trend shown by the continuous corn.

The energy production and efficiency of the corn-soybean-wheat rotation and continuous corn is examined in Table 7. As expected, the total energy produced by the rotation is less than corn grown in monoculture. Corn is a high energy producing crop but also requires considerable energy to produce. Including other crops in rotation with corn reduces total energy production but increases the efficiency of energy use. The result is that energy efficiency for the rotation check treatment is approximately twice the check tretment for continuous corn.

Table 1. Grain yields in high yield rotation experiment, 1986. Mead field lab on Sharpsburg sicl.

Treatment [1/] lb/A	Average grain yields bu/a[2/] Rotation Corn	Soybeans	Wheat	Continuous Corn
1. Control	181 cd	61 a	28 ab	81 c
2. 20T manure[3/]	184 bcd	68 a	36 a	164 b
3. 80+0+0	205 abcd	69 a	24 b	166 b
4. 160+0+0	224 abc	74 a	26 ab	188 ab
5. 160+40+0	208 abcd	62 a	32 ab	200 a
6. 160+40+40	228 ab	63 a	30 ab	187 ab
7. 160+40+30+20S+10Zn +1B+0.5Cu	203 abcd	75 a	28 ab	212 a
8. 320+80+80	245 a	75 a	30 ab	167 b
9 160+40+40+20T manure[3/]	177 d	76 a	27 ab	194 a

1/ Wheat receives one-half the N rate of corn, soybeans one-fourth.
2/ Means followed by the same letter within a column are not significantly different at the 5% level.
3/ 20T manure applied in alternate years.

Table 2. Analysis of variance for the comparison of continuous vs. rotated corn yields, 1986.

Sources	Prob. > F
Rep	0.53
Rotation	0.1021
Rep x R	0.0181
Treatment (T)	0.0001
R x T	0.0002

Table 3. Energy yields of corn, wheat, soybean rotation versus continuous corn, 1986. Mead Field Lab on Sharpsburg sicl.

Treatment	Yield Mcal/ha Rotation Wheat	Soybeans	Corn	Continuous Corn
1	5,852	15,610	40,122	17,955
2	7,525	17,402	40,787	36,352
4	5,435	18,937	49,652	41,672
8	6,272	19,195	54,085	37,017
9	5,645	19,450	39,012	43,002

Table 4. Energy use and efficiency for wheat Mcal/ha

Treatment	1	2	4	8	9
Machinery			360.18		
Gasoline			374.74		
Diesel			519.34		
Electricity			42.43		
Nitrogen	0	0	1300.00	2600.00	1300.00
Phosphorus	0	0	0	272.73	136.36
Potassium	0	0	0	145.46	72.73
Manure	0	1010.10	0	0	1010.10
Seed			12.74		
Herbicide			223.71		
Transportation			41.39		
Total	1574.53	2854.63	2874.53	4592.72	4093.72
Yield (1986)bu/A	28	36	26	30	27
Kcal output/ Kcal input	4.0	3.1	2.0	1.5	1.5
Avg. yield (85-86)	35	51	33	40	46
Kcal output/ Kcal input	5.0	4.4	2.6	2.0	2.5

Table 5. Energy use and efficiency for irrigated soybeans Mcal/ha.

Treatment	1	2	4	8	9
Machinery			210.42		
Gasoline			242.62		
Diesel			4225.25		
Irrigation (12")			278.89		
Nitrogen	0	0	650.00	1300.00	650.00
Phosphorus	0	0	0	272.73	136.36
Potassium	0	0	0	145.46	72.73
Manure	0	1010.10	0	0	1010.10
Herbicide			307.73		
Seed			585.60		
Transportation			38.29		
Total	1574.53	2584.63	6538.80	4592.72	4093.72
Yield 1986	61	68	74	75	76
Kcal output/ Kcal input	2.8	2.7	3.1	2.7	2.7
Avg. yield 85-86	51.5	56.5	56.5	60.5	60.5
Kcal output/ Kcal input	2.4	2.2	2.4	2.2	2.2

Table 6. Energy use and efficiency for irrigated corn Mcal/ha

Treatment	1	2	4	8	9
Machinery			990.00		
Gasoline			267.79		
Natural Gas			16.54		
Electricity			869.81		
Nitrogen	0	0	2600.00	5400.00	2600.00
Phosphorus	0	0	0	272.73	136.36
Potassium	0	0	0	145.46	72.73
Manure	0	1010.10	0	0	1010.10
Seed			504.50		
Irrigation (20")			472.24		
Diesel			7839.59		
Insecticides			439.97		
Herbicides			174.84		
Transportation			49.40		
Total	11,624.68	12,634.78	14,224.68	17,242.87	15,443.87
1986 yield					
Continuous Corn	81	164	188	167	194
Kcal output/ Kcal input	1.5	2.9	2.9	2.1	2.8
Rotated Corn	181	184	224	245	177
Kcal output/ Kcal input	3.5	3.2	3.5	3.1	2.5
Avg. Yield (85-86)					
Continuous Corn	89	159	175	165	183
Kcal output/ Kcal input	1.7	2.8	2.7	2.1	2.6
Rotated Corn	151	183	199	218	190
Kcal output/ Kcal input	2.9	3.2	3.1	2.8	2.7

Table 7. Corn-soybean-wheat rotation energy yield per acre and energy efficiency of corn-soybean-wheat rotation versus continuous corn, 1986.

Treatment	Energy Yield Mcal/yr/ha		Energy Efficiency Mcal produced/Mcal consumed	
	Rotation		Rotation	
	corn-soybean-wheat	cont. corn	corn-soybean-wheat	cont. corn
1	20,527	17,953	3.2	1.5
2	21,905	36,350	3.0	2.9
4	24,675	41,670	3.1	2.9
8	26,518	37,015	2.7	2.1
9	21,370	43,000	2.4	2.8

The Influence of Soil Bulk Density, Soil Water Regime and Fertilization on The Uptake of P and K by Corn.

S. Mu'azu and J. Skopp

Soil compaction is known to have detrimental effects on crop growth and nutrient uptake. There is a need to determine if the effects of compaction can be reduced through modification of the irrigation regime and fertilization.

A growth chamber study was conducted on a loamy sand to determine the influence of soil bulk density and soil water regime and their interaction on the uptake of P and K. Two growth chamber experiments, each involving four levels of soil bulk density, three levels of irrigation frequency with four replications were conducted. The experiments involved factorial arrangements in a complete block design.

The first experiment used soil without added fertilizer. The second experiment utilized the same soil fertilized with phosphorus and nitrogen. The effects of bulk density from both experiments are illustrated in Table 1. The effects of irrigation frequency are given in Table 2. High soil bulk densities decreased corn uptake of P and K by restricting root length and root surface area while increasing the root radius. Uptake of P and K per unit root area were increased at high bulk densities.

Uptake of P increased with increase in irrigation frequency when soil P was moderate but had no effect on P uptake when soil concentration of P was high. The high initial K content of the soil resulted in a nonsignificant influence of irrigation frequency on K uptake. There was no interaction between soil bulk density and irrigation frequency.

These results suggest that soils low in phosphorus and subject to compaction can be managed by increasing the number of irrigations (while keeping the cumulative water applied constant). Alternatively maintaining phosphorus levels high may counteract some effects of compaction. However, these recommendations should be used with caution since they are based on growth chamber studies, not field experiments.

Table 1. Bulk Density Effects.

Parameter	Unfertilized Soil: Bulk Density Level	Unfertilized Soil: Mean*	Fertilized Soil: Mean*
Uptake of P (μmol)	1.4	312. a	298. a
	1.5	318. a	272. a
	1.6	266. b	217. b
	1.7	294. b	185. c
Uptake of K (mmol)	1.4	5.78 a	5.07 a
	1.5	5.79 a	4.58 a
	1.6	5.02 b	3.76 b
	1.7	4.89 b	3.31 b
Uptake of P Per Root Area (μ mol cm^{-2})	1.4	51. c	156. a
	1.5	61. b	184. a
	1.6	58. bc	230. b
	1.7	80. a	240. b
Uptake of K Per Root Area (μ mol cm^{-2})	1.4	95. a	263. a
	1.5	110. ab	312. ab
	1.6	110. b	378. bc
	1.7	133. c	433. c
Shoot P Composition (Percent)	1.4	0.129 a	0.211 a
	1.5	0.138 ab	0.214 a
	1.6	0.132 a	0.217 a
	1.7	0.184 b	0.201 a

* Means with common letter are not significantly different at α = .1 by Tukey's HSD (for same experiment and parameter).

Table 2. Irrigation Frequency Effects.

Parameter	Unfertilized Soil: Irrigation Level (times/day)	Unfertilized Soil: Mean*		Fertilized Soil: Mean*	
Uptake of P (μmol)	.89	315.	b	245.	a
	.71	306.	b	237.	a
	.50	271.	a	245.	a
Shoot K Composition (Percent)	.89	3.113	b	4.496	a
	.71	3.045	b	4.669	a
	.50	3.318	a	4.567	a
Root Dry Matter (g)	.89	3.84	ab	1.257	a
	.71	4.02	b	1.329	a
	.50	3.54	a	1.478	a
Shoot Dry Matter (g)	.89	6.98	a	3.38	a
	.71	7.02	a	3.14	a
	.50	6.23	a	3.10	a

* Means with common letter are not significantly different at $\alpha = .1$ by Tukey's HSD (for same experiment and parameter).

Long Term Effects of N-Serve on Improving Nitrogen Use Efficiency for Furrow Irrigated Corn

Gary W. Hergert

Objective

1. Determine whether there is a long term yield advantage from using annual applications of N-Serve in preplant spring applied ammonia on a furrow irrigated silt loam soil.

2. Determine the effect of N-Serve on corn grain nitrogen removal, apparent nitrogen use efficiency, and soil residual nitrate levels after a 5 year period of time.

Procedure

At a given location for a given year there may or may not be a significant response to N-Serve if the conditions for leaching or denitrification are not severe enough to cause significant differences in nitrogen loss. If the use of N-Serve results in higher carryover of residual nitrate over time, the increased yield at lower nitrogen rates should show a cumulative effect over time if the residual nitrogen accumulation is not lost. This study is designed as a two factor factorial with N rates and N-Serve. Nitrogen rates in 40 lb. increments from 40 to 200 lbs. are used with and without 0.5 lbs. of N-Serve/acre. A check plot receiving no nitrogen was also included. The ammonia applicator is run through the check plots to simulate the tillage effect from applying ammonia in other plots. Five replications were used with the plot size of 70'long by 4-30" rows wide. The soil is a Cozad silt loam which is furrow irrigated. The site had been in continuous ridge-till corn production for at least 15 years before the initiation of this study. Much of the time the area has not received nitrogen fertilizer. The residual nitrate level was low in the spring of 1985 when the study was initiated. The soil analyses are shown in Table 1 as well as nitrate levels for the whole plot area taken by 1 foot increments to the water table. The phosphorus level was low and 80 pounds of phosphorus as 0-46-0 was broadcast in the spring of 1985. The low baseline level of nitrate will serve as a comparison for future samplings of various nitrogen rates to determine nitrate leaching under various treatments. Each replication of the study was sampled to the 12 foot depth. Corn variety Pioneer 3541 was planted May 3, 1985 and on April 30, 1986 BoJac 603 was planted. Grain yields and various plant parameters for 1985 are summarized in Table 2. The only significant factor affecting yields in 1985 was nitrogen rate. The same indication was shown in 1986 (Table 3).

Response variables for grain yield, earleaf nitrogen and grain nitrogen all generally show curvilinear responses to nitrogen applied. The response for grain nitrogen content is fairly linear up to the nitrogen rate that maximized yield (Figure 1).

Since this plot is a continuous corn plot and the only nitrogen removal is in the grain an apparent nitrogen use efficiency can be calculated by subtracting the nitrogen removal in the check from the nitrogen removed for a nitrogen rate divided by the nitrogen rate. These values are calculated in Table 2 and 3. For the 2 year averages nitrogen efficiencies were 63%, 63%, 58%, 52%, and 42% for the N rates from 40 to 200 pounds. For both years the maximum yield was obtained with about 160 pounds of nitrogen/acre. This represents an average apparent nitrogen use efficiency of about 52%. Nitrogen removal in the grain can be plotted against nitrogen rate for the linear portions of the curve. Extrapolation of the line back to the X axis gives a value for the amount of nitrogen from mineralization. Using three nitrogen rates in 1985 shows an apparent mineralization of 75 pounds N/acre. The data from 1986 show a value of about 78 pounds N/acre. Growing conditions both seasons were ideal for good corn production. The soil contains about 1.5% organic matter. These value show that the soil is mineralizing about 50 pounds of nitrogen per percent organic matter. For the 10 years previous to this experiment no nitrogen was used in this area so the mineralization should be near a steady state level.

Table 1. Soil Analysis - 1985

Soil Analysis - Cozad Silt Loam

pH	% O.M.	Bray 1 P	K	Zn	lbs NO_3-N/6'
		ppm	ppm	ppm	
7.9	1.5	4.3	354	2.4	54

	Depth-ft	ppm NO_3-N
NO_3	0- 1	4.3
	1- 2	2.8
	2- 3	2.0
	3- 4	2.2
	4- 5	1.7
	5- 6	1.9
	6- 7	2.1
	7- 8	1.9
	8- 9	1.9
	9-10	2.0
	10-11	1.9
	11-12	2.1

Table 2. Yield results and crop parameters for 1985 N-Serve study.

N-Rate	N-Serve	Bu/A	Grain Moist.	Grain % N	Earleaf % N	Harvest Pop. 1,000's	N Removal #/A
0	-	87	25.2	1.04	1.87	24.9	43
40	-	137	23.7	1.08	2.30	24.3	70
40	+	134	24.3	1.04	2.21	25.1	66
80	-	168	23.2	1.17	2.54	25.7	94
80	+	170	22.2	1.18	2.55	24.2	95
120	-	175	22.3	1.27	2.64	25.3	105
120	+	175	22.3	1.24	2.64	24.5	102
160	-	185	22.3	1.31	2.78	24.9	115
160	+	171	22.1	1.32	2.78	23.8	107
200	-	178	21.8	1.34	2.81	24.6	113
200	+	177	21.7	1.32	2.83	24.0	111

N-Rate	Bu/A	Grain Moist.	Grain % N	Earleaf % N	Harvest Pop.	N Removal #/A	Apparent N Use Efficiency %
0	87	25.2	1.04	1.87	24.9	43	—
40	136	24.0	1.06	2.25	24.7	68	64
80	169	22.7	1.18	2.54	24.9	94	64
120	175	22.3	1.25	2.64	24.9	104	51
160	178	22.2	1.31	2.78	24.4	111	42
200	178	21.7	1.33	2.82	24.3	112	35

N-Serve	Bu/A	Grain Moist.	Grain % N	Earleaf % N	Harvest Pop.	N Removal #/A
With	166	22.5	1.22		24.3	96
Without	169	22.7	1.23		25.0	99

AOV	Bu/A	Grain Moist.	Grain % N	Earleaf % N	Harvest Pop.	N Removal #/A
			PR>F			
N-Rate	.001	.001	.001	.001	.78	.001
N-Serve	.20	.39	.29	.51	.13	.11
Rate * NI	.35	.17	.75	.82	.48	.64
CV	5.4%	3.0%	3.8%	3.9%	5.9%	6.7%

Table 3. Yield results and crop parameters for 1986 N-Serve study.

N-Rate	N-Serve	Bu/A	Grain Moist.	Grain % N	Earleaf % N	Harvest Pop. 1,000's	N Removal #/A
0	-	102	26.9	1.01	1.40	32.8	49
40	-	147	25.5	1.13	1.77	32.8	79
40	+	137	24.8	1.07	1.85	32.6	70
80	-	178	24.5	1.20	2.23	31.9	101
80	+	175	24.4	1.17	2.28	32.7	97
120	-	207	24.1	1.30	2.53	32.7	128
120	+	201	24.8	1.35	2.46	29.8	128
160	-	225	24.4	1.42	2.67	32.9	151
160	+	222	24.0	1.39	2.58	33.3	145
200	-	226	24.0	1.38	2.67	32.2	147
200	+	222	23.3	1.39	2.74	31.9	146

N-Rate	Bu/A	Grain Moist.	Grain % N	Earleaf % N	Harvest Pop.	N Removal #/A	Apparent N Use Efficiency %
0	102	26.9	1.01	1.40	32.8	49	—
40	142	25.2	1.10	1.81	32.7	74	63
80	177	24.5	1.19	2.25	32.3	99	63
120	204	24.4	1.33	2.50	31.3	128	66
160	224	24.2	1.40	2.63	33.1	148	63
200	224	23.6	1.39	2.71	32.1	146	49

N-Serve	Bu/A	Grain Moist.	Grain % N	Earleaf % N	Harvest Pop.	N Removal #/A
With	191	24.2	1.27	2.38	32.0	117
Without	197	24.5	1.29	2.37	32.6	121

AOV	Bu/A	Grain Moist.	Grain % N	Earleaf % N	Harvest Pop.	N Removal #/A
	PR>F					
N-Rate	.001	.03	.001	.001	.36	.001
N-Serve	.15	.34	.47	.31	.10	.81
Rate * NI	.98	.46	.44	.63	.40	.71
CV	5.8%	3.5%	4.9%	5.9%	5.9%	6.2%

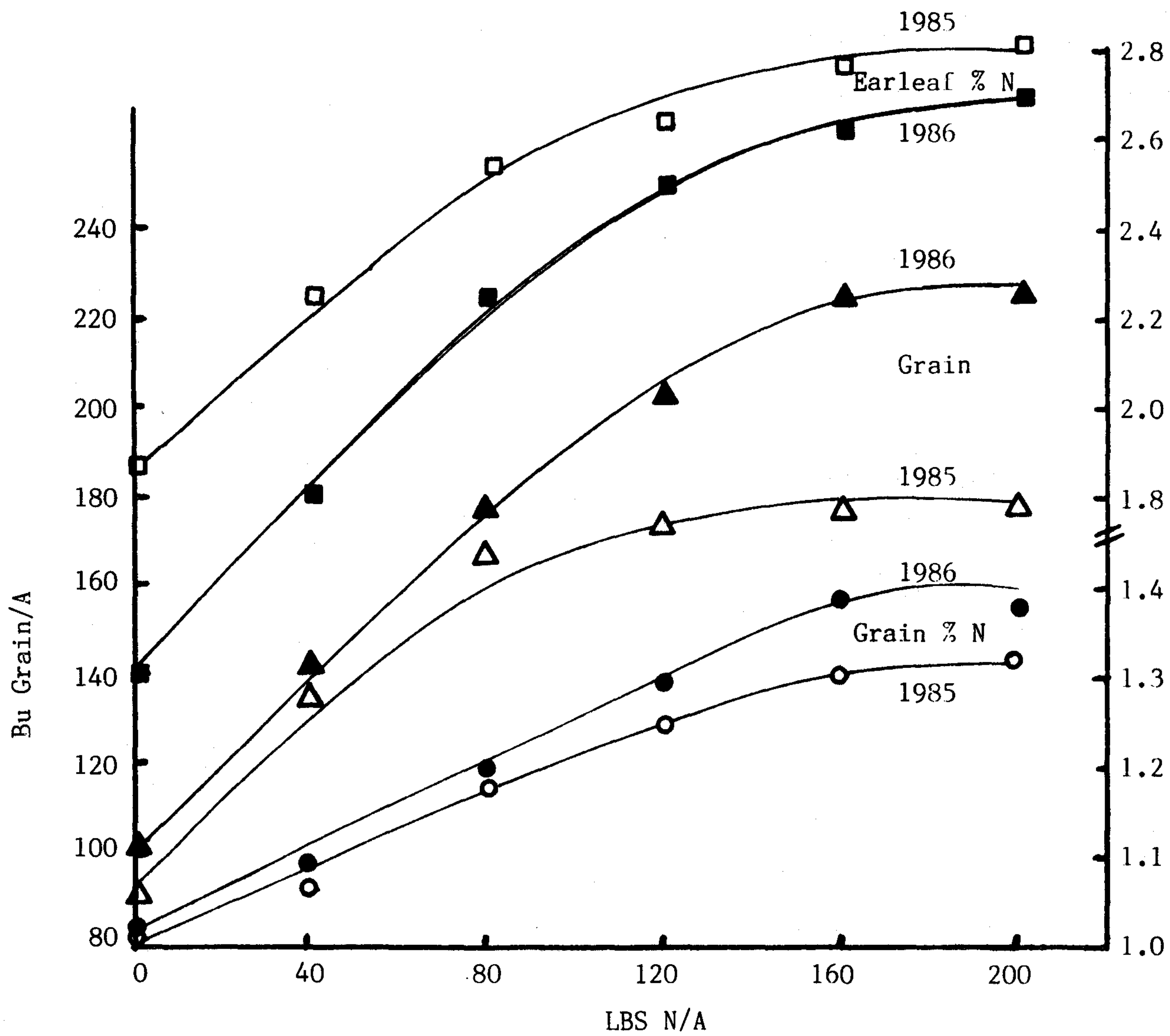

Figure 1. Effect of N rate on plant parameters.

MAXIMIZING FERTILIZER N AND WATER USE EFFICIENCY ON IRRIGATED AND RAINFED CORN

G. Techtmeier, D. H. Sander and R. A. Olson

Objective To determine the combination of N, crop and water management practices for optimizing yield of monoculture corn on Sharpsburg sicl. This was the fifth and final year for the study.

Procedure: The non-irrigated portion of the experiment carried the four N rates of 0, 60, 120, and 180 lbs/a. Two crop row spacings were employed of conventional 30" and one of average 20" spacing with rows 10" apart in beds spaced 30" apart. Corn was planted in two populations of 14,000 and 21,000 plants/a. Nitrogen was applied as NH_4NO_3 either at planting or as a summer sidedressing at a 12-18" growth stage.

The irrigated portion was planted in basins 10' wide by 25' long to a stand of 30,000 plants/a in either conventional 30" or average 20" spacing as with the non-irrigated. Nitrogen as NH_4NO_3 was applied at rates of 0, 80, 160, and 240 lbs/a at three different times, viz: all at planting, all as a sidedressing at 12-18" growth, or split with 1/3 at planting and the remainder in two simulated fertigations. Irrigation water was measured through water meters into the basins in 2" increments approximately weekly or 4" increments with twice the interval, precise timing varying with years as influenced by seasonal precipitation. Goal was to have around 24" moisture supplied for the growing season. Three of the years involved were exceptionally wet during the early and late portions of the growing season such that irrigation practice had little impact on yields in those years.

Corn was hand planted to accommodate the several variables contained in the study. Hybrids employed were Pioneer 3377 and 3475.

Experimental Results: The 5-year average results for the study are presented in Table 1. Applied N more than doubled yield of grain in the irrigated portion of the study with response to something in excess of 160 lbs N/a, but little difference was recorded for time of N application. There was an average 15 bu/a increase for 20" row spacing over 30" spacing. How much benefit derived from the 'bed' planting system with 30" between beds in contrast with uniform 20" spacing cannot be stated from the data obtained. The 8 bu/a better average yield for the lighter more frequent irrigation mode is undoubtedly related to N use efficiency by the crop with the heavier infrequent rate contributing to accentuated leaching and volatilization losses of N.

Yield in the non-irrigated portion peaked with 120 lbs N/a applied, again with little difference for time of N application. The lack of benefit for sidedressing in both irrigated and non-irrigated systems is probably the result of very dry weather conditions during early summer in three of the years that prevented fertilizer N movement into the crop rooting zone in time for effective crop utilization. The modified 20" row spacing averaged 8 bu/a better than conventional 30" spacing, and the 21,000 plant population exceeded 14,000 population by 6 bu/a. Of interest is the fact that the optimum combination of 120 lb N/a x 20" row spacing x 21,000 plants/a afforded yields in excess of 180 bu/a in the non-irrigated portion during 1986, some 20 bu/a better than the best combination of 160 N x 20" rows x sidedress N x light frequent watering on the irrigated portion.

Details of water use efficiency by the crop under the varied management systems remain to be calculated.

Table 1. Nitrogen x water x crop management study on corn, 1982-86.

N rate		Row Spacing		N Time		Irrigation Rate/ Timing	
				Irrigated			
	bu/a		bu/a		bu/a		bu/a
0	72	30"	153	PL	163	Lo	164
80	147	20"	168	SD	163	Hi	156
160	168			Sp	165		
240	174						
				Non-irrigated			
						Plant Pop.	
0	90	30"	133	P1	137	14,000	134
60	127	20"	141	Sd	138	21,000	140
120	143						
180	144						

Irrigation: Lo = light, frequent; Hi = heavier, less frequent to same seasonal total.

Row spacing: 30" = conventional; 20" = 10" rows on beds 30" apart.

PHOSPHORUS PLACEMENT FOR IRRIGATED CORN

R. B. Ferguson

Objective: To evaluate four phosphorus fertilizer placement methods for irrigated corn:

- BR - broadcast and incorporated with a rotary tiller
- ST - starter, 2X2 placement
- KN - 19 cm on either side of the row
- BI - surface band, rotary tiller incorporated

These four methods were compared at four rates of phosphate application - 10, 20, 40 and 80 kg P_2O_5 ha^{-1}.

Location: Clay Co., Hastings silt loam soil.
Nuckolls Co., Hastings silt loam soil.

Procedures

Treatments were applied and corn planted at the Clay county site on May 6, 1986. The BR and BI treatments were applied, the entire study area tilled with a rotary tiller to a depth of 8 cm, and the site planted. The location of the fertilizer bands from the BI treatment were marked prior to planting with flags in the alleys. The planter was aligned with these marks to insure that the planted row fell on the fertilizer band. Starter treatments were applied in the appropriate plots at planting in a band 7 cm to the side and 5 cm below the seed. The KN treatments were applied after planting with two knives per row, 19 cm from the row. Due to the looseness of the soil following the rotary tillage operation, the knifing operation tended to throw soil over the planted row unless the applicator was driven quite slowly.

Treatments were applied and corn planted at the Nuckolls county site on May 7, 1986. Because of the problems encountered at the Clay county location with covering the row with the KN treatments, at the Nuckolls county site the KN treatments were applied prior to tillage. The knife depth was approximately 12 cm at both locations, below the depth of tillage, so the tillage operation did not disrupt the bands from the KN treatment. The locations of the knives were marked with flags in the alleys, both to align the planter and to locate the band for soil sampling during the season. Otherwise, treatments were applied at the Nuckolls county location in the same manner as in Clay county.

Other cultural practices, such as nitrogen fertilizer application, herbicide application, cultivation and irrigation were performed by the farmer in the same manner as the rest of the field. Nitrogen was applied preplant as anhydrous ammonia in Clay county, as UAN solution through the center-pivot in Nuckolls county. The Clay county site was cultivated once, the Nuckolls county site was in a field of no-till corn. Both sites had weed control by hand within the study area.

Plant tissue samples were collected at two times for both locations; at approximately the 8 leaf stage (6/16/86 in Clay Co., 6/17/86 in Nuckolls Co.), and at silking (7/15/86 in Clay Co., 7/17/86 in Nuckolls Co.).

Harvest was conducted with a two-row plot combine, harvesting the center two rows of the four-row plots. Harvest was 10/17/86 at the Clay county location, 11/6/86 in Nuckolls county. Plots weights were taken on the combine, and a grain sample was retained for moisture determination and analysis for nitrogen and phosphorus content.

Results and Discussion

Results of soil samples taken from the immediate plot areas prior to treatment application are given in Table 1. These results indicate that the soil test results from the farmers samples were not representative of the plot area - errors were made in sample analysis or in soil sampling or both. In both cases, the soil test taken by the farmer indicated a much lower Bray-1 level of P than did the sampling prior to treatment application. If this information had been available earlier, it is doubtful that these locations would have been used for the study, especially the Clay county location. At the soil test levels found in the surface layer at both locations, we would expect no response to fertilizer phosphorus, and that was the case.

Table 1. Bray-1 P levels of study locations, 1986.

	Clay Co.	Nuckolls Co.
	----- ppm -----	
Farmer test	5	7
UNL 0-15 cm	54	31
UNL 15-30 cm	24	5
UNL 30-45 cm	10	3

Results from the analysis of data combined from both locations is given in Table 2. Grain yield was influenced very little by phosphorus fertilization, with the unfertilized check yielding 136.1 bu A^{-1} and the highest yielding treatment making 144.5 bu A^{-1}.

Results of the data combined from both locations and analyzed by P_2O_5 application rate and placement method are given in Table 3. Grain yield was not significantly influenced by application rate. There was a trend towards increased tissue P levels at the higher application rates and with the KN and ST placement methods at the first sampling date, but these differences disappeared at the second tissue sampling date. There were significant differences between the two locations for practically all parameters. Average grain yield in Clay county was 128.9 bu A^{-1}, while the mean grain yield in Nuckolls county was 145.0 bu A^{-1}. Two factors contributed to these differences; in Clay county, there was a lower plant population, due partially to the covering of the planted row with the knives in the KN treatment. Also, moisture stress was noted late in the season at the Clay county location.

Data analyzed by P_2O_5 application rate and placement method for each location separately are presented in Tables 4 and 5. In Clay county, no significant effect of fertilizer application rate was found on any variable (Table 4). There was a trend towards higher yields with the surface application methods (BR and BI). There was also a trend towards a reduced stand with the KN treatment - an artifact of the additional soil thrown by the knives covering the planted row. The plants in the KN plots emerged later and appeared more stressed early in the season, which may have slightly reduced yields.

There is also a trend towards increasing tissue P levels with the subsurface application methods (KN and ST) at the first sampling date. These differences did not exist at the second sampling date.

In Nuckolls county,increasing P application rates had no effect on grain yield, but did increase tissue P levels at the first sampling date (Table 5). The 80 kg ha^{-1} rate also increased tissue P concentrations at the second sampling date. No significant effects of placement method were noted in Nuckolls county.

Table 2. Combined analysis, by treatment, 1986.

Trt.	P_2O_5 Rate	Appl. Method	Yield	Stand	Moisture	N-1	N-2	P-1	P-2
	kg ha^{-1}		Bu A^{-1}	40 ft			%		
1	--	--	136.1	63.1	19.2	3.89	2.85	0.289	0.268
2	10	BR	138.1	60.0	19.2	3.85	2.87	0.292	0.272
3	20	BR	141.6	62.1	19.6	3.84	2.83	0.291	0.274
4	40	BR	137.3	63.3	19.2	3.85	2.88	0.292	0.264
5	80	BR	134.7	61.0	19.0	4.09	2.87	0.317	0.260
6	10	KN	136.5	58.3	19.4	3.97	2.93	0.314	0.217
7	20	KN	135.5	60.9	19.3	3.95	2.78	0.309	0.258
8	40	KN	140.7	60.3	19.5	3.98	2.81	0.316	0.262
9	80	KN	133.0	58.1	19.3	4.07	2.80	0.326	0.273
10	10	ST	132.8	59.8	19.0	3.89	2.79	0.287	0.263
11	20	ST	134.6	63.8	19.4	4.01	2.81	0.313	0.263
12	40	ST	136.2	57.6	19.3	3.91	2.59	0.315	0.263
13	80	ST	136.2	64.9	18.7	3.82	2.83	0.314	0.272
14	10	BI	139.7	59.1	18.9	4.01	2.84	0.305	0.270
15	20	BI	138.3	62.6	19.1	3.76	2.73	0.290	0.259
16	40	BI	136.2	59.8	19.0	3.68	2.82	0.283	0.256
17	80	BI	144.5	62.6	19.1	3.97	2.84	0.309	0.268
LSD (0.05)			9.8	4.0	1.0	0.22	0.21	0.027	NS
PR > F			0.771	0.004	0.002	0.037	0.520	0.019	0.376
C.V.			7.20	6.63	2.11	5.78	7.55	8.91	5.99

Table 3. Combined analysis for both locations, by P rate and placement method.

P_2O_5 Rate	Yield	Stand	Moisture	N-1	N-2	P-1	P-2
kg ha^{-1}	Bu A^{-1}	40 ft.	%				
10	136.7 a	59.3 b	19.1 ab	3.93 ab	2.86 a	0.299 b	0.269 a
20	137.4 a	62.4 a	19.3 a	3.89 ab	2.79 a	0.301 b	0.264 a
40	137.6 a	60.2 ab	19.3 a	3.85 b	2.77 a	0.302 b	0.261 a
80	137.2 a	61.8 a	19.0 b	3.99 a	2.83 a	0.317 a	0.268 a
Pr > F	0.956	0.014	0.032	0.124	0.381	0.024	0.137
Placement Method							
BR	137.9 a	61.7 a	19.1 b	3.92 ab	2.86 a	0.300 b	0.268 a
BI	139.7 a	61.0 ab	19.0 b	3.86 b	2.81 a	0.297 b	0.263 a
ST	134.9 a	61.3 ab	19.2 ab	3.90 ab	2.76 a	0.305 ab	0.265 a
KN	136.5 a	59.5 a	19.4 a	3.99 a	2.83 a	0.316 a	0.266 a
Pr > F	0.314	0.076	0.011	0.134	0.368	0.018	0.661
Location							
Clay	128.9 b	57.0 b	17.4 b	3.85 b	3.10 a	0.303 a	0.284 a
Nuckolls	145.0 a	64.6 a	20.9 a	3.98 a	2.53 b	0.305 a	0.247 b
Pr > F	0.0001	0.0001	0.0001	0.003	0.0001	0.691	0.0001
C.V.	7.28	6.67	2.12	5.99	7.69	8.45	6.05

Treatment means followed by the same letter are not significantly different at 5% level.

Table 4. Analysis by P rate and placement method, Clay Co.

P_2O_5 Rate	Yield	Stand	Moisture	N-1	N-2	P-1	P-2
kg ha^{-1}	Bu A^{-1}	40 ft.	%				
10	128.8 a	55.9 a	17.4 a	3.88 a	3.14 a	0.300 a	0.291 a
20	131.4 a	58.4 a	17.4 a	3.83 a	3.12 a	0.301 a	0.284 a
40	127.4 a	55.9 a	17.4 a	3.77 a	3.05 a	0.297 a	0.282 a
80	128.0 a	58.1 a	17.3 a	3.93 a	3.09 a	0.316 a	0.278 a
Pr > F	0.601	0.181	0.751	0.482	0.762	0.289	0.171
Placement Method							
BR	132.4 a	57.6 a	17.2 b	3.82 a	3.17 a	0.290 b	0.285 a
BI	131.4 ab	57.6 a	17.3 b	3.80 a	3.13 ab	0.299 ab	0.287 a
ST	126.8 ab	57.4 a	17.4 b	3.80 a	2.97 b	0.304 ab	0.279 a
KN	124.9 b	55.6 a	17.6 a	3.99 a	3.12 ab	0.321 a	0.285 a
Pr > F	0.056	0.606	0.004	0.226	0.158	0.041	0.567
C.V.	6.60	7.12	2.03	7.67	8.28	10.10	5.67

Table 5. Analysis by P rate and placement method, Nuckolls Co.

P_2O_5 Rate	Yield	Stand	Moisture	N-1	N-2	P-1	P-2
kg ha^{-1}	Bu A^{-1}	40 ft.	%				
10	143.6 a	62.5 b	20.8 bc	3.99 a	2.57 a	0.298 b	0.247 b
20	143.0 a	66.1 a	21.0 ab	3.95 a	2.46 b	0.300 b	0.243 b
40	147.8 a	64.5 ab	21.2 a	3.94 a	2.50 ab	0.306 ab	0.240 b
80	145.8 a	65.2 ab	20.6 c	4.05 a	2.58 a	0.317 a	0.258 a
Pr > F	0.608	0.086	0.002	0.160	0.040	0.040	0.002
Placement Method							
BR	143.1 a	65.6 a	20.9 a	4.01 a	2.54 a	0.310 a	0.252 a
BI	147.5 a	64.5 a	20.8 a	3.92 a	2.49 a	0.294 b	0.240 b
ST	142.9 a	65.3 a	21.0 a	3.99 a	2.55 a	0.306 ab	0.251 a
KN	146.7 a	62.8 a	21.0 a	4.00 a	2.54 a	0.311 a	0.247 ab
Pr > F	0.542	0.200	0.187	0.248	0.598	0.079	0.062
C.V.	7.69	6.17	1.90	3.77	5.33	6.42	5.30

Residual Effects of Growing Corn After Fertilizing With Different Soil Test Recommendations.

D. H. Sander, G. H. Hergert, and C. Shapiro

Objective: To determine the residual effects of long term fertilizer applications based on fertilizer recommendations from five different soil test laboratories.

Procedure: Long term soil test comparison studies were initiated in Nebraska beginning in 1973 and 1974 at four locations (West Central, South Central, and the Northeast Research and Extension Centers, and the Agricultural Research and Development Center at Mead, NE. These studies involved sending a soil sample each year (1973 and 1974 thru 1985) from plots assigned to each of five soil test laboratories in 1973 and 1974 for fertilizer recommendations. The recommended fertilizer was broadcast, incorporated by disking and corn grown at each location for yield. All corn was irrigated except at the Northeast location. Grain yields were reported in various Agronomy Department Reports from 1973 thru 1984. Residual corn and soybean yields were obtained from the South Central location beginning in 1979. In 1986, the Northeast, West Central and Mead locations were soil sampled and soil tests determined by the UNL laboratory. UNL fertilizer recommendations were applied and corn grown to determine the residual effect of past fertilizer applications. Plots were split at the West Central and Northeast locations and N applied to half the plot and no N applied to the other half. The residual nitrate level was used at each location as a basis for the recommended nitrogen rate to apply.

Results: Soil test results and corn grain yields after 12 and 13 years of applying the recommended fertilizer from the different laboratories are shown in Table 1, 2 and 3 for the different locations. Soil analysis shows that the high level of phosphorus and zinc applied to the plots over time as recommended by the laboratories is reflected in the higher residual soil test values found in 1986 (see Agronomy Department Report No. 49-1984). While several laboratories also recommended considerable potassium, potassium fertilization did not seem to affect soil test potassium levels. Residual nitrogen analysis should reflect primarily the nitrogen rates applied in 1985.

All residual nitrate levels were relatively high at the West Central location (Table 1). Without applied nitrogen average yield was 180 bu/a. Yields without nitrogen were lowest following UNL recommendations which generally reflects lower nitrogen recommendations from UNL (160 lbs N/A recommended in 1985). Applied nitrogen increased yield an average of 20 bu/A. Even with high residual nitrate, laboratory B corn yield may have been low since no nitrogen was applied. However, yields where no nitrogen was applied seemed to accurately reflect the residual nitrate levels.

At the Northeast location, residual nitrates were low at all plots except for laboratory A, which did not receive a nitrogen recommendation. Where nitrogen was applied (Labs B, C, D, and UNL) yields were increased. Phosphorus was recommended and applied to laboratory C and UNL plots. The soils in these plots received less phosphorus fertilizer over the period

1974-85, which is reflected in the lower soil test values for phosphorus. While corn yields are somewhat variable, there is no apparent evidence that past fertilizer treatments influenced yields.

At the Mead location, laboratory B had a significantly higher corn yield than all other laboratories except laboratory D, which was higher than laboratories A and C. It is not apparent why corn yield from laboratory B was high since other laboratories in the group have comparable fertilizer recommendation histories. No difference in grain moisture was observed.

Table 1a. Soil test results after 12 years (1974-85) of growing irrigated corn and applying fertilizers recommended by five soil test laboratories.[1/] West Central Research and Extension Center, North Platte, NE. 1986.

Measurement	Laboratory (1974-85) A	B	C	D	UNL
pH	6.8	6.6	6.6	6.8	7.1
OM, %	1.7	1.7	1.7	1.7	1.8
Bray-P, ppm	39	37	28	35	18
Bicarb-P, ppm	22	21	18	23	13
Potassium, ppm	501	518	484	500	378
DTPA-An, ppm	1.5	2.7	3.1	1.3	1.7
Cl Zn Index	6.1	9.2	10.9	5.7	6.8
NO_3-N 0-8", ppm	4.4	5.5	10.4	6.3	6.3
NO_3- 0-24", ppm	6.3	11.5	13.2	10.4	7.0
NO_3- 24-48", ppm	9.7	24.7	8.5	12.8	7.1
NO_3-N lbs/6ft	139	308	187	196	124

[1/] All analysis by UNL

Table 1b. UNL suggested fertilizer program for 1986 (170 bu/A yield goal).[2/]

	lbs per acre				
Nitrogen (N)	100	0	50	40	100
Phosphorus (P_2O_5)	0	0	0	0	0
Potassium (K_2O)	0	0	0	0	0
Zinc (Zn)	0	0	0	0	0

[2/] All recommendations are based on UNL soil analysis in Table 1a.

Table 2a. Soil test results after 12 years (1974-85) of growing dryland corn and applying fertilizers recommended by five soil test laboratories.[1] Northeast Research and Extension Center, Concord, NE. 1986.

	Laboratory (1974-85)				
Measurement	A	B	C	D	UNL
Organic Matter, %	2.8	2.9	2.7	2.7	2.6
pH	6.0	5.7	5.6	5.7	5.9
pH (buffer)	6.6	6.5	6.5	6.6	6.6
Phosphorus, ppm	22	21	12	23	13
Potassium, ppm	273	260	251	251	263
Nitrate-N (0-8), ppm	31.6	6.5	2.5	4.5	6.4
Nitrate-N (8-24), ppm	1.3	3	1.1	1.5	2.7
Nitrate-N, #/6 ft.	136	50	18	29	47

[1]/All analysis by UNL

Table 2b. UNL suggested fertilizer program for 1986 (100 bu/A yield goal).[2]

	lbs per acre				
Nitrogen (N)	0	100	130	120	100
Phosphorus (P_2O_5)	0	0	40	0	40
Potassium (K_2O)	0	0	0	0	0
Lime	4000	5000	5000	4000	4000

[2]/All recommendations are based on UNL soil analysis in Table 2a.

Table 2c. Corn grain yields (bu/A) following 12 years of applying fertilizers according to recommendations from five soil test laboratories with UNL recommendations in 1986.

Recommended N and P	92	130	99	127	114
No N	104	111	87	107	104

Table 3a. Soil test results after 13 years (1973-83) of growing irrigated corn and applying fertilizers recommended by five soil test laboratories.[1/] Agric. Res. and Dev. Center at Mead, NE. 1986.

	Laboratory (1973-85)				
Measurement	A	B	C	D	UNL
OM, %	2.3	2.2	2.3	2.3	2.4
pH	5.5	5.6	5.9	5.9	6.1
pH (buffer)	6.5	6.6	6.6	6.6	6.6
B&K P No. 1, ppm	60	47	20	36	26
Potassium, ppm	383	341	310	325	333
NO_3-N, #/6 ft	77	57	48	57	59

[1/] Analysis all by UNL

Table 3b. UNL suggested fertilizer program for 1986, (170 bu/A yield goal).[2/]

	lbs per acre				
Nitrogen (N)	150	170	180	170	170
Phosphorus (P_2O_5)	0	0	0	0	0
Potassium (K_2O)	0	0	0	0	0
Lime	5000	4000	4000	4000	4000

[2/] All recommendations are UNL based on soil analysis in Table 3a.

Table 3c. Corn grain yields and grain moisture in 1986 following 13 years of applying fertilizers recommended by five soil test laboratories with UNL recommendations in 1986.

Grain yield, bu/A	174c[1/]	225a	168c	206ab	186bc
Grain moisture, %	18.7a	18.1a	18.7a	18.7a	19.4a

[1/] Means followed by the same letter are not statistically different at the 0.05 level of probability.

TILLAGE, ROTATION AND N RATE EFFECTS ON DRYLAND CORN PRODUCTION AND NITROGEN UPTAKE IN NORTHEASTERN NEBRASKA.

D. T. Walters and C. A. Shapiro

Objective: To determine the effects of tillage on corn yield and N use efficiency when grown in rotation with soybeans or continuously with or without a hairy vetch cover crop.

Procedures: Three corn crop sequences continuous corn (CC), corn-soybean (CB) and continuous corn with a hairy vetch cover crop (CCV) were established in 1985 under three tillage systems (spring disk, spring plow and no-till) at the Northeast Research and Extension Center, Concord, NE. Five N rates (0, 40, 80, 120 and 160 kg N/ha) within each tillage x cropping sequence were applied annually as broadcast NH_4NO_3 prior to tillage in the spring. This experiment was designed as a split-split plot RCB with tillage as main plots (100' x 210'), rotations as subplots (100' x 35') and N rates as sub-sub plots (20' x 35'). Soil type is a Kennebec silt loam (Cumulic Hapludoll).

Corn (Pioneer 3475) was planted on May 8 at 44,000 plants/ha in 30" rows. Counter was applied to all corn for rootworm control. Century 84 soybeans were planted on June 3. Weeds were chemically controlled on all plots with the addition of two cultivations in the disk and spring plow treatments. Grain and stover were hand harvested at physiological maturity on October 6.

Madison hairy vetch (Vicia villosa) was planted in the previous years corn on October 21, 1985 with a Hi-boy tractor equipped with four ground driven insecticide boxes modified to deliver the vetch seed between the corn rows. Vetch was surface broadcast in this manner at 27 kg seed/ha. Dry conditions in 1985 following vetch planting and a cool, wet fall resulted in little to no vetch ground cover over winter. Vetch germinated in the spring of 1986 approximately one week prior to tillage, therefore, little or no vetch biomass was incorporated. Vetch was again seeded in August 4, 1986 and a thick stand of vetch resulted. Yields and N uptake data for the CCV treatment in 1986 do not reflect the influence of vetch but only that of the vetch planting operation.

Results: Corn yields were very good in 1986 with near ideal weather conditions. Temperatures were moderate and rainfall was adequate and timely. An analysis of variance for selected variables is presented in Table 1.

Corn following soybeans averaged 1.56 Mg grain/ha greater than either CC or CCV (Table 2). Yields were maximized at the 120 kg N rate for both disk and spring plow treatments, however, highest grain production was achieved at the 160 kg N rate under no-till. Examination of the tillage x N rate interaction shows a quadratic N rate response for both disk and spring plow treatments and a linear response under no-till. The grain yield response to rotation with soybeans under no-till was superior to the same rotation under spring plowing. This is in part due to improved plant population and standability of the crop under no-till. High winds following cultivation in the disk and spring plow plots resulted in some downed stalks. This may have been a result of crown root damage during cultivation. Grain yields at the 0 N rate were approximately 2.4 Mg/ha or 68% higher for corn following soybeans regardless of tillage.

Neither crop sequence or tillage had a great effect on grain N concentration. However, grain N concentrations at the low N rates were significantly higher for the CB treatment as reflected in the rotation x NR interaction (Table 1).

Fertilizer N use efficiency as measured by the ratio:

$$\frac{\text{grain N removed (fertilized-check)}}{\text{fertilizer N rate}}$$

was 62, 12 and 35% at the 40 kg N rate for the disk, spring plow and no-till treatments respectively. Poor efficiency was recorded for corn following soybeans at the 40 kg N rate (5%) whereas the CC and CCV treatments had 58 and 50% fertilizer N use efficiency at this N rate respectively. Fertilizer N use efficiency declined at N rates exceeding 40 kg/ha. Significant N mineralization under spring plowing was reflected in both higher grain yields and N concentrations than disk or no-till at the 0 kg N rate.

Plant population increased linearly as a function of N rate. Plant population was significantly greater under no-till when corn followed soybeans. Difficulty was encountered in penetrating the soil with the planter in heavy corn residue.

Stover yield reflects the quantity of crop residue left for erosion protection (Table 3). The results in Table 3 indicate an increase in stover yield up to the 80 kg N rate. Stover yields were also significantly increased following soybeans when compared to the CC or CCV rotations especially under no-till. Stover N concentrations were highest following soybeans and increased linearly with N rate to the 120 kg N rate under disk and no-till treatments and to the 160 kg rate under spring plow. Stover N concentrations were consistently higher following soybeans at all N rates. Nitrogen returned in corn residue averaged 15.5 kg/ha more for the CB rotation when compared to CC or CCV sequences. Tillage had little effect on stover N removal.

In summary, corn in rotation with soybean yielded 1.25 times more grain than continuous corn. Grain yield on the CB rotation at the 0 kg N rate surpassed even the highest yielding CC treatments. Tillage influenced grain production and stover yield by an apparent stimulation of N mineralization under plowed conditions and improved plant populations under no-till. The influence of vetch as a cover crop could not be evaluated in 1986, however, a successful seeding in late 1986 should provide us with this information in the 1987 season.

Table 1. Analysis of variance for selected variables, tillage x rotation x N rate, Concord, NE, 1986.

Source	df	Grain Yield	Gr. N (%)	Grain N removed	Popula-tion	Stover Yield	Stover N (%)	Stover N Removed
		Prob. > F						
Till	2	.57	.19	.58	.02	.08	.37	.32
Rotation	2	.001	.10	.001	.11	.001	.001	.001
CBvsCC+CCV	1	.001	.10	.001	.07	.001	.001	.001
CCvsCCV	1	.61	.49	.38	.86	.58	.001	.06
Till * Rot	4	.23	.30	.03	.05	.04	.25	.03
NR	4	.001	.001	.001	.06	.001	.001	.001
NR lin	1	.001	.001	.001	.004	.001	.001	.001
NR quad	1	.01	.001	.001	.82	.006	.47	.02
Till x NR	8	.04	.08	.01	.70	.56	.59	.80
Rot x NR	8	.1	.02	.01	.63	.54	.08	.30
TillxRotxNR	16	.41	.57	.55	.53	.31	.94	.27

Table 2. Main effect and 2 way interaction means for corn grain yield, N, grain N removal and population in 1986.

Source		Grain Yield*	Grain N	Grain N Removal	Population
		Mg/ha (bu/A)	%	kg/ha	1000/ha
Tillage					
Disk		6.66(126)	1.54	103	35.4
Sp. plow		6.65(125)	1.59	106	36.3
No-till		6.92(131)	1.55	108	38.8
Rotation					
Corn/Soy (CB)		7.78(147)	1.58	123	37.8
Cont. Corn (CC)		6.28(118)	1.56	98	36.3
Cont. Corn w/vetch (CCV)		6.17(116)	1.54	96	36.4
N-Rate (kg/ha)					
0		6.02(114)	1.46	89	35.3
40		6.74(127)	1.54	104	36.1
80		6.76(128)	1.59	107	37.2
120		7.14(135)	1.63	116	37.2
160		7.04(133)	1.59	112	38.3
Till x N rate					
Disk	0	5.70(108)	1.45	83	34.4
	40	7.00(132)	1.55	108	35.3
	80	6.64(125)	1.53	102	36.6
	120	7.00(132)	1.64	115	35.5
	140	6.94(131)	1.53	106	35.2
Sp. Plow	0	6.38(120)	1.51	97	34.6
	40	6.49(123)	1.58	102	35.7
	80	6.79(128)	1.62	110	37.1
	120	7.06(133)	1.64	115	36.4
	160	6.51(123)	1.62	105	37.8
No till	0	5.99(113)	1.44	88	36.8
	40	6.74(127)	1.50	102	37.3
	80	6.86(129)	1.61	110	38.0
	120	7.36(139)	1.59	117	39.8
	160	7.67(145)	1.60	123	42.0
Till x Rotation					
Disk	CB	7.57(143)	1.56	118	34.7
	CC	6.30(119)	1.56	98	35.6
	CCV	6.10(115)	1.51	93	35.9
Sp. Plow	CB	7.40(140)	1.60	118	37.1
	CC	6.31(119)	1.58	100	36.3
	CCV	6.23(117)	1.60	99	35.6
No till	CB	8.38(158)	1.59	134	41.8
	CC	6.22(117)	1.53	96	36.9
	CCV	6.17(116)	1.52	95	37.7
Rotation x N rate					
CB	0	7.61(144)	1.55	118	36.0
	40	7.64(144)	1.56	120	37.5
	80	7.78(147)	1.60	125	39.6
	120	8.15(154)	1.62	132	38.7
	160	7.73(146)	1.58	122	37.3
CC	0	5.17(97)	1.44	75	35.2
	40	6.36(120)	1.54	98	35.2
	80	6.33(120)	1.60	101	35.3
	120	6.64(125)	1.60	106	36.4
	160	6.90(130)	1.60	110	39.3
CCV	0	5.28(100)	1.41	75	34.6
	40	6.23(118)	1.52	95	35.7
	80	6.18(117)	1.55	96	36.8
	120	6.64(125)	1.65	109	36.6
	160	6.50(123)	1.58	103	38.4

*Grain yield as Mg/ha is for dry matter yield, bu/A adjusted to 15.5% moisture

Table 3. Main Effect and 2 way interaction means for stover yield, N and stover N removal in 1986.

Source		Stover Yield	N	Stover N Removal
		Mg/ha	%	kg/ha
Tillage				
Disk		4.94	.85	42
Sp. plow		5.13	.87	45
No-till		5.24	.83	44
Rotation				
CB		5.71	.95	54
CC		4.83	.83	40
CCV		4.76	.77	37
N Rate				
0		4.66	.72	34
40		4.98	.79	40
80		5.33	.85	46
120		5.27	.93	49
160		5.26	.96	51
Till x N Rate				
Disk	0	4.41	.73	32
	40	4.82	.81	39
	80	4.99	.86	43
	120	5.18	.93	48
	160	5.28	.94	49
Sp. plow	0	4.89	.73	36
	40	5.09	.79	40
	80	5.36	.84	45
	120	5.22	.93	49
	160	5.09	1.04	53
No-till	0	4.69	.69	33
	40	5.04	.77	40
	80	5.63	.85	49
	120	5.42	.91	50
	160	5.42	.92	50
Till x Rotation				
Disk	CB	5.29	.93	49
	CC	4.79	.86	42
	CCV	4.72	.76	36
Sp. plow	CB	5.65	.95	54
	CC	4.87	.82	40
	CCV	4.87	.83	40
No-till	CB	6.19	.95	59
	CC	4.83	.80	39
	CCV	4.70	.73	34
Rotation x N Rate				
CB	0	5.37	.82	43
	40	5.53	.92	51
	80	5.87	.98	58
	120	6.10	.97	59
	160	5.67	1.04	59
CC	0	4.33	.67	29
	40	4.62	.72	33
	80	5.17	.85	44
	120	4.87	.92	45
	160	5.16	.97	50
CCV	0	4.27	.66	28
	40	4.80	.72	35
	80	4.94	.72	35
	120	4.85	.88	43
	160	4.95	.88	43

SOYBEAN VARIETY EVALUATION ON HIGH pH SOIL - 1986 *

E. J. Penas, R. W. Elmore, R. S. Moomaw and G. W. Hergert

Objectives:

1. Evaluate approximately 50 soybean varieties each year to determine their performance under the soil conditions of high pH (7.5 and higher) found in the Platte Valley and similar soils.

2. Evaluate the influence of an iron chelate on chlorosis score and seed yield on about 20 varieties that have shown some tolerance to the soil conditions of the Platte Valley. Two tester varieties will also be included; Century, which has some tolerance and Nebsoy, which has no tolerance to these soils.

3. Determine what soil characteristics contribute to chlorosis in soybeans.

Procedure:

Forty-nine soybean varieties were planted at two sites (Colfax and Madison Counties) and forty-seven varieties were planted at two sites (Dawson and Merrick Counties). At each site, plots were replicated six times except Dawson County where seven replications were planted.

Eighteen varieties were planted with and without EDDHA iron chelate placed in the seed furrow using four pounds of material in 20 gallons of water per acre. One site was with the variety trial in Colfax County and the other site was in Dodge County.

Each plot was two rows wide (30 inch rows) by 20 feet long except the plots where iron was applied. These were four row plots; two rows each with and without iron.

Each plot was visually rated for green color (1 = normal green color to 5 = extreme chlorosis and 6 = dead plants) eight weeks after planting. Seed yields were harvested from four locations. The sight in Merrick County was not harvested because of extreme soil variability and weeds. Two replications in Dodge County were discarded because of flood water damage.

Experimental Results:

Variety Evaluation Study

Seed yields were harvested from three sites. The Madison County site was not similar to the Colfax and Dawson County sites; thus, only two

* This research was supported in part by a grant from the Nebraska Soybean Development, Utilization and Marketing Board.

sites are included in the summary in Table 1. Even these two sites are different in terms of seed yield level and degree of chlorosis and this resulted in a site by variety interaction; however, varieties are different even when averaged across these two locations. Yields range from 9 to 45 bushels per acre.

Thirty-three varieties are in the top group in terms of seed yield (32-45 bushels per acre). Of these, six varieties are in the test for the first time. The others in the top group have been in the test for two or more years. Century, the standard variety used since the beginning of these studies, was not in the top group; however, it again yielded significantly higher than Nebsoy, the tester variety being used.

The soybean plants were visually scored for chlorosis at eight weeks after planting. Degree of chlorosis was severe at Colfax County and moderate at Dawson County. This difference in sites resulted in a site by variety interaction; however, varieties are different in terms of chlorosis score across the two sites. These data are shown in Table 2. Twenty-five varieties were in the top group (2.2 - 3.0) and all but two of these are in the top group in terms of seed yield.

Seed yield is negatively correlated to chlorosis score. This relationship is illustrated in Figure 1. As the degree of chlorosis increases (an increasing chlorosis score), seed yields are decreased.

Colfax County. Chlorosis was severe at this site. Chlorosis scores by variety are shown in Table 3. Twenty-five varieties are in the top group (2.3 - 3.6). Seed yields by variety are given in Table 4. Thirty-three varieties are in the top group (23 to 39 bushels per acre) All varieties that were in the top group in terms of chlorosis score are in the top group in terms of seed yield. The strong relationship between chlorosis score and seed yield is illustrated in Figure 2.

Dawson County. Chlorosis was moderate in this field. Chlorosis scores by variety are shown in Table 5. Twenty-four varieties are in the top group (1.8 - 2.5). Seed yields by varieties are listed in Table 6. Nineteen varieties are in the top group (45 to 52 bushels per acre) in terms of seed yield and all but three are in the top group in terms of chlorosis score. The relationship of seed yield to chlorosis score is illustrated in Figure 3.

Madison County. Chlorosis was slight at this site. Table 7 lists the varieties according to clorosis score. Slightly over one half of the varieties rank in the top group (1.2 - 1.8). Three varieties in this top group were in the bottom group at Colfax County where chlorosis was severe. Table 8 shows the seed yields by variety. Twenty varieties ranked in the top group (48 to 57 bushels per acre) and two of these were in the bottom group at Colfax County. Seven varieties in the top group in Madison County were in the bottom half in both Colfax and Dawson Counties. Because of this lack of similarity of this site with the other two sites, data from Madison County are not included in the over-sites summary. It is doubtful that varieties were separated according to their tolerance to high soil pH at this site; however, Figure 3 shows that the seed yield of varieties was related to chlorosis score at this site in Madison County.

Variety X Iron Chelate Study

Seed yields were harvested from two sites. Chlorosis was severe at both locations. Seed yields from these two sites are shown in Table 9. Without iron, all varieties except Mead and Nebsoy were in the top group in terms of seed yield. This was expected since the top fifteen varieties were all in the top group over a three year period of testing (1983-85). The application of four pounds of Iron EDDHA placed with the seed at planting resulted in a seventeen bushels per acre seed yield increase. Response ranged from 3 to 30 bushels per acre, depending on variety. Twelve varieties were in the top group where EDDHA was applied. These data indicate that the application of EDDHA was economical for most varieties except Nebsoy.

Table 10 shows the chlorosis score of each variety without and with EDDHA. Iron EDDHA improved the color of all varieties as illustrated by a change in score by 1.3 units. Mead and Nebsoy were the only two varieties not in the top group without EDDHA; whereas, only Nebsoy was different than the rest where EDDHA was applied.

Colfax County. Table 11 shows the chlorosis score eight weeks after planting for 18 varieties at Colfax County without and with EDDHA. Fourteen varieties are in the top group where no EDDHA was applied. The application of EDDHA improved the chlorosis score 1.2 units and all varieties were in the top group except Nebsoy.

Table 12 shows the seed yield for 18 varieties grown without and with EDDHA. All varieties except Century, Nebsoy and Mead are in the top group when grown without EDDHA. The application of EDDHA increased seed yield by an average of 14 bushels per acre; however, not all varieties responded the same. Century and Mead, which were not in the top group without EDDHA, responded markedly and are in the top group when EDDHA was applied. Hoegemeyer 205 and McCubbin Taylor did not respond well and are not in the top group. Nebsoy, the tester variety, did poorly under both conditions.

Dodge County. Table 13 gives the chlorosis score eight weeks after planting for 18 varieties at Dodge County without and with EDDHA. Fifteen varieties are in the top group in terms of chlorosis score when grown without EDDHA. The application of EDDHA resulted in less chlorosis (1.2 units); however, only thirteen varieties remained in the top group.

The application of EDDHA increased seed yield sixteen bushels per acre (Table 14). Without EDDHA, fourteen varieties were in the top group in terms of seed yield. With EDDHA, the same varieties plus S Brand S44A were in the top group. All varieties, except Nebsoy respond well to EDDHA applied with the seed.

Table 1. 1986 SOYBEAN CHLOROSIS COLFAX AND DAWSON COUNTIES
SEED YIELD

ANALYSIS OF VARIANCE

SOURCE	DF	SS	MS	F	
SITE	1	46195.106	46195.106	589.69	***
VARIETY	46	25836.110	561.655	3.40	***
BLOCK(SITE)	11	22754.236	2068.567	26.41	***
SITE*VARIETY	46	7587.917	164.955	2.11	***
ERROR	497	38934.244	78.339		
TOTAL	601	142593.785			

EXPERIMENTAL MEAN IS 33.9 C.V. = 26.1%

DUNCAN'S MULTIPLE RANGE TEST (5% PROTECTION LEVEL)
MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

BRAND	ENTRY	MEAN	RANGES OF INSIG. CHANGE
-----	BSR 101	44.6	A
Fontanelle	4646	42.7	A B
Horizon	H29	42.4	A B
Asgrow	A2187	41.9	A B C
Golden Harvest	H1276	41.5	A B C D
NC+	2D90+	41.2	A B C D E
McCubbin	Troy	40.4	A B C D E
S Brand	S46D	38.9	A B C D E F
Latham	1010	38.7	A B C D E F
Jacques	J105	38.4	A B C D E F
McCubbin	Taylor	38.3	A B C D E F
Stine	2050+	37.8	A B C D E F G
Dekalb-Pfizer Gen.	CX283	37.6	A B C D E F G
Jacobsen	799	37.4	A B C D E F G
Hoegemeyer	200	37.4	A B C D E F G
Northrup King	W003747	37 1	A B C D E F G
Asgrow	A3427	36.7	A B C D E F G
S Brand	S47B	36.6	A B C D E F G
Ohlde	2193	36.3	A B C D E F G
MSR	Royal	35.9	A B C D E F G
Jacques	J231	35.7	A B C D E F G
Golden Harvest	H1285	35.7	A B C D E F G
-----	Lakota	35.3	A B C D E F G
Hoegemeyer	205	35.0	A B C D E F G
Jacques	J103	35.0	A B C D E F G
Fontanelle	4545	34.9	A B C D E F G
Profiseed	1350	34.8	A B C D E F G
S Brand	S44A	34.3	A B C D E F G
Superior	SPB308	33.2	A B C D E F G
Stine	2330	33.0	A B C D E F G
-----	Weber	32.9	A B C D E F G
Stine	2920	32.7	A B C D E F G
Horizon	H25	32.4	A B C D E F G
Profiseed	1152	31.8	B C D E F G H
-----	Mead	31.8	B C D E F G H
-----	Century 84	29.7	C D E F G H
Pioneer	9292	29.7	C D E F G H
Golden Harvest	H1233	29.5	C D E F G H
Northrup King	S30-31	29.3	C D E F G H
Northrup King	S23-03	29.1	D E F G H
Latham	650	29.1	D E F G H
Superior	EX250	28.8	E F G H
Dekalb-Pfizer Gen.	CX264	27.5	F G H I
Pioneer	9271	25.6	G H I
MSR	X5557	19.9	H I J
Ohlde	3000	16.6	I J
-----	Nebsoy	9.3	J

Table 2. 1986 SOYBEAN CHLOROSIS COLFAX AND DAWSON COUNTIES
THIRD CHLOROSIS SCORE

ANALYSIS OF VARIANCE

SOURCE	DF	SS	MS	F	
SITE	1	137.996	137.996	273.65	***
VARIETY	46	209.869	4.562	5.75	***
SITE*VARIETY	46	36.473	0.793	1.57	**
BLOCK(SITE)	11	165.210	15.019	29.78	***
ERROR	503	253.653	0.504		
TOTAL	607	809.472			

EXPERIMENTAL MEAN IS 3.15 C.V. = 22.6%

DUNCAN'S MULTIPLE RANGE TEST (5% PROTECTION LEVEL)
MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

BRAND	ENTRY	MEAN	RANGES OF INSIG. CHANGE
Asgrow	A2187	2.2	A
-----	BSR 101	2.3	A B
Hoegemeyer	200	2.5	A B C
NC+	2D90+	2.6	A B C D
Profiseed	1152	2.7	A B C D
Fontanelle	4646	2.7	A B C D
Jacques	J231	2.7	A B C D
S Brand	S46D	2.7	A B C D
Golden Harvest	H1276	2.7	A B C D
Horizon	H29	2.7	A B C D
Jacques	J105	2.8	A B C D E
Jacobsen	799	2.8	A B C D E
Jacques	J103	2.8	A B C D E
Latham	1010	2.8	A B C D E
McCubbin	Taylor	2.8	A B C D E
-----	Lakota	2.8	A B C D E
McCubbin	Troy	2.9	A B C D E
Ohlde	2193	2.9	A B C D E
Stine	2330	2.9	A B C D E
S Brand	S44A	2.9	A B C D E
Northrup King	S23-03	3.0	A B C D E
Profiseed	1350	3.0	A B C D E
S Brand	S47B	3.0	A B C D E
Dekalb-Pfizer Gen.	CX283	3.0	A B C D E
MSR	Royal	3.0	A B C D E
Superior	EX250	3.1	B C D E
-----	Weber	3.1	B C D E
Fontanelle	4545	3.1	B C D E
Stine	2050+	3.2	C D E
-----	Century 84	3.2	C D E
Horizon	H25	3.2	C D E
Golden Harvest	H1285	3.2	C D E
Hoegemeyer	205	3.2	C D E
Northrup King	W003747	3.2	C D E
Latham	650	3.3	C D E F
Asgrow	A3427	3.3	C D E F
-----	Mead	3.3	C D E F
Stine	2920	3.4	D E F
Dekalb-Pfizer Gen.	CX264	3.5	D E F
Golden Harvest	H1233	3.5	D E F
Superior	SPB308	3.5	D E F
Pioneer	9292	3.6	E F G
Northrup King	S30-31	4.1	F G H
Pioneer	9271	4.3	G H I
MSR	X5557	4.6	H I
Ohlde	3000	5.0	I
-----	Nebsoy	5.0	I

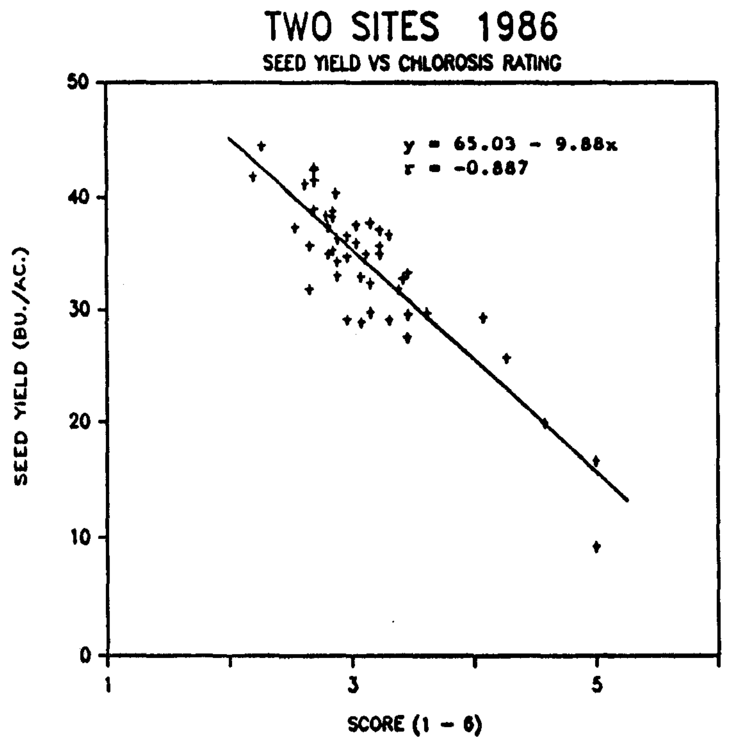

Figure 1. Relationships of Chlorosis Ratings taken at Eight Weeks and Seed Yield at Two Sites, 1986.

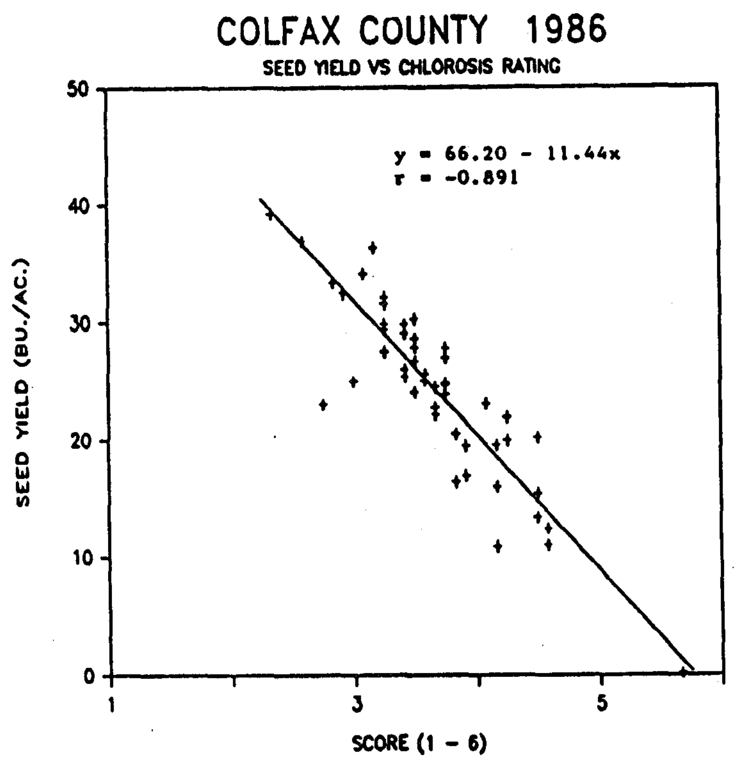

Figure 2. Relationships of Chlorosis Ratings taken at Eight Weeks and Seed Yield at Colfax County, 1986.

Table 3. 1986 SOYBEAN CHLOROSIS COLFAX COUNTY
EIGHT WEEK CHLOROSIS RATINGS

ANALYSIS OF VARIANCE

SOURCE	DF	SS	MS	F	
VARIETY	48	100.940	2.103	2.60	***
BLOCK	5	158.612	31.722	39.29	***
ERROR	236	190.554	0.811		
TOTAL	289	450.611			

EXPERIMENTAL MEAN IS 3.66 C.V. = 24.6 %

DUNCAN'S MULTIPLE RANGE TEST (5% PROTECTION LEVEL)
MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

BRAND	ENTRY	MEAN	RANGES OF INSIG. CHANGE
-----	BSR 101	2.3	A
Asgrow	A2187	2.7	A B
Profiseed	1152	2.8	A B C
Hoegemeyer	200	2.8	A B C D
NC+	2D90+	2.9	A B C D E
-----	Amsoy 71	3.0	A B C D E F
Golden Harvest	H1276	3.1	A B C D E F
Latham	1010	3.2	A B C D E F
Stine	2330	3.3	A B C D E F G
Profiseed	1350	3.3	A B C D E F G
-----	Lakota	3.3	A B C D E F G
Horizon	H29	3.3	A B C D E F G
Fontanelle	4646	3.3	A B C D E F G
S Brand	S46D	3.3	A B C D E F G
S Brand	S44A	3.4	A B C D E F G H
Jacques	J103	3.4	A B C D E F G H
Ohlde	2193	3.4	A B C D E F G H
McCubbin	Taylor	3.4	A B C D E F G H
Jacques	J105	3.5	A B C D E F G H
McCubbin	Troy	3.5	A B C D E F G H
Stine	2050+	3.5	A B C D E F G H
Jacques	J231	3.5	A B C D E F G H
MSR	Royal	3.5	A B C D E F G H
Jacobsen	799	3.6	A B C D E F G H
Fontanelle	4545	3.6	A B C D E F G H
Horizon	H25	3.7	B C D E F G H
Stine	2920	3.7	B C D E F G H
Golden Harvest	H1285	3.7	B C D E F G H
-----	Amcor	3.8	B C D E F G H
-----	Weber	3.8	B C D E F G H
Dekalb-Pfizer Gen.	CX283	3.8	B C D E F G H
S Brand	S47B	3.8	B C D E F G H
Hoegemeyer	205	3.8	B C D E F G H
Latham	650	3.8	B C D E F G H
Northrup King	S23-03	3.8	B C D E F G H
Superior	EX250	3.9	C D E F G H
Asgrow	A3427	3.9	C D E F G H
Northrup King	WO03747	4.1	D E F G H
-----	Century 84	4.2	E F G H
-----	Mead	4.2	E F G H
Pioneer	9292	4.2	E F G H
Superior	SPB308	4.3	F G H
Golden Harvest	H1233	4.3	F G H
Pioneer	9271	4.5	G H I
Northrup King	S30-31	4.5	G H I
Dekalb-Pfizer Gen.	CX264	4.5	G H I
-----	Nebsoy	4.6	H I
MSR	X5557	4.6	H I
Ohlde	3000	5.7	I

Table 4. 1986 SOYBEAN CHLOROSIS COLFAX COUNTY
SEED YIELD

ANALYSIS OF VARIANCE

SOURCE	DF	SS	MS	F	
VARIETY	48	15397.768	320.787	2.46	***
BLOCK	5	21805.702	4361.140	33.46	***
ERROR	230	29980.216	130.349		
TOTAL	283	67380.435			

EXPERIMENTAL MEAN IS 24.3 C.V. = 47.0%

DUNCAN'S MULTIPLE RANGE TEST (5% PROTECTION LEVEL)
MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

BRAND	ENTRY	MEAN	RANGES OF INSIG. CHANGE
-----	BSR 101	39.2	A
Asgrow	A2187	36.9	A B
Latham	1010	36.3	A B C
Golden Harvest	H1276	34.1	A B C
Hoegemeyer	200	33.3	A B C D
NC+	2D90+	32.4	A B C D E
Fontanelle	4646	32.1	A B C D E
Horizon	H29	31.6	A B C D E
Stine	2050+	30.3	A B C D E F
-----	Lakota	29.8	A B C D E F
S Brand	S44A	29.7	A B C D E F
S Brand	S46D	29.4	A B C D E F
Jacques	J103	29.0	A B C D E F G
McCubbin	Troy	28.6	A B C D E F G
MSR	Royal	27.9	A B C D E F G
-----	Amcor	27.8	A B C D E F G
Profiseed	1350	27.6	A B C D E F G H
Stine	2330	27.5	A B C D E F G H
Hoegemeyer	205	27.0	A B C D E F G H
Jacques	J105	26.7	A B C D E F G H
Ohlde	2193	25.9	A B C D E F G H
Fontanelle	4545	25.6	A B C D E F G H
McCubbin	Taylor	25.4	A B C D E F G H
-----	Amsoy 71	25.0	A B C D E F G H
Jacobsen	799	25.0	A B C D E F G H
S Brand	S47B	24.8	A B C D E F G H
-----	Weber	24.6	A B C D E F G H
Golden Harvest	H1285	24.5	A B C D E F G H
Jacques	J231	24.1	A B C D E F G H
Dekalb-Pfizer Gen.	CX283	23.9	A B C D E F G H
Northrup King	W003747	23 0	A B C D E F G H
Profiseed	1152	23.0	A B C D E F G H
Stine	2920	22.8	A B C D E F G H
Horizon	H25	22.1	B C D E F G H
Superior	SPB308	21.9	B C D E F G H
Latham	650	20.5	B C D E F G H
Pioneer	9271	20.2	B C D E F G H
Golden Harvest	H1233	19.9	C D E F G H
Pioneer	9292	19.5	C D E F G H
Asgrow	A3427	19.4	C D E F G H
Superior	EX250	16.9	D E F G H
Northrup King	S23-03	16.5	D E F G H
-----	Century 84	16.0	E F G H
Northrup King	S30-31	15.5	E F G H
Dekalb-pfizer Gen.	CX264	13.4	F G H I
MSR	X5557	12.4	G H I
-----	Nebsoy	11.0	H I
-----	Mead	10.9	H I
Ohlde	3000	0.2	I

Table 5. 1986 SOYBEAN CHLOROSIS DAWSON COUNTY
EIGHT WEEK CHLOROSIS RATINGS

ANALYSIS OF VARIANCE

SOURCE	DF	SS	MS	F	
VARIETY	46	151.830	3.300	12.62	***
BLOCK	6	9.391	1.565	5.98	***
ERROR	276	72.181	0.262		
TOTAL	328	233.391			

EXPERIMENTAL MEAN IS 2.71 C.V. = 18.9%

DUNCAN'S MULTIPLE RANGE TEST (5% PROTECTION LEVEL)
MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

BRAND	ENTRY	MEAN	RANGES OF INSIG. CHANGE
Asgrow	A2187	1.8	A
Jacques	J231	1.9	A B
Fontanelle	4646	2.1	A B C
Jacobsen	799	2.1	A B C
S Brand	S46D	2.2	A B C D
Horizon	H29	2.2	A B C D
Northrup King	S23-03	2.2	A B C D
-----	BSR 101	2.2	A B C D
-----	Century 84	2.3	A B C D
Hoegemeyer	200	2.3	A B C D
Jacques	J103	2.3	A B C D
S Brand	S47B	2.3	A B C D
Jacques	J105	2.3	A B C D
Golden Harvest	H1276	2.4	A B C D
Superior	EX250	2.4	A B C D
McCubbin	Taylor	2.4	A B C D
NC+	2D90+	2.4	A B C D
Dekalb-Pfizer Gen.	CX283	2.4	A B C D
McCubbin	Troy	2.4	A B C D
Ohlde	2193	2.4	A B C D
S Brand	S44A	2.4	A B C D
Northrup King	WO03747	2.5	A B C D E
-----	Weber	2.5	A B C D E
-----	Lakota	2.5	A B C D E
Latham	1010	2.6	B C D E F
Profiseed	1152	2.6	B C D E F
Stine	2330	2.6	B C D E F
MSR	Royal	2.7	C D E F
-----	Mead	2.7	C D E F
Dekalb-Pfizer Gen.	CX264	2.7	C D E F
Fontanelle	4545	2.7	C D E F
Profiseed	1350	2.7	C D E F
Horizon	H25	2.7	C D E F
Asgrow	A3427	2.8	C D E F
Golden Harvest	H1233	2.8	C D E F
Superior	SPB308	2.8	C D E F
Hoegemeyer	205	2.8	C D E F
Golden Harvest	H1285	2.9	D E F
Latham	650	2.9	D E F
Stine	2050+	2.9	D E F
Pioneer	9292	3.1	E F
Stine	2920	3.2	F G
Northrup King	S30-31	3.7	G H
Pioneer	9271	4.1	H I
Ohlde	3000	4.4	I
MSR	X5557	4.6	I
-----	Nebsoy	5.4	J

Table 6. 1986 SOYBEAN CHLOROSIS DAWSON COUNTY
SEED YIELD

ANALYSIS OF VARIANCE

SOURCE	DF	SS	MS	F	
VARIETY	46	18017.984	391.395	10.15	***
BLOCK	6	996.649	166.108	4.30	***
ERROR	275	10614.781	38.599		
TOTAL	327	29633.159			

EXPERIMENTAL MEAN IS 42.2 C.V. = 14.7%

DUNCAN'S MULTIPLE RANGE TEST (5% PROTECTION LEVEL)
MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

BRAND	ENTRY	MEAN	RANGES OF INSIG. CHANGE
Fontanelle	4646	51.8	A
Horizon	H29	51.8	A
Asgrow	A3427	51.5	A
-----	BSR 101	49.6	A B
Dekalb-Pfizer Gen.	CX283	49.3	A B C
McCubbin	Taylor	49.3	A B C
NC+	2D90+	49.2	A B C
Northrup King	W003747	49.1	A B C
Jacobsen	799	48.1	A B C D
-----	Mead	47.5	A B C D E
McCubbin	Troy	47.1	A B C D E
S Brand	S46D	47.1	A B C D E
S Brand	S47B	47.0	A B C D E
Golden Harvest	H1276	46.7	A B C D E
Jacques	J105	46.7	A B C D E
Asgrow	A2187	46.1	A B C D E F
Jacques	J231	45.8	A B C D E F G
Golden Harvest	H1285	45.3	A B C D E F G
Ohlde	2193	45.2	A B C D E F G
Stine	2050+	43.4	B C D E F G H
Superior	SPB308	43.4	B C D E F G H
MSR	Royal	43.3	B C D E F G H
Fontanelle	4545	42.9	B C D E F G H
Hoegemeyer	205	42.0	B C D E F G H
Latham	1010	41.8	B C D E F G H
Horizon	H25	41.6	B C D E F G H
-----	Century 84	41.5	B C D E F G H
Stine	2920	41.2	C D E F G H
Northrup King	S30-31	41.2	C D E F G H
Profiseed	1350	40.9	D E F G H
Hoegemeyer	200	40.8	D E F G H
Jacques	J103	40.4	D E F G H
-----	Weber	40.2	D E F G H
Northrup King	S23-03	40.1	D E F G H
Profiseed	1152	40.0	D E F G H
-----	Lakota	40.0	D E F G H
Superior	EX250	39.3	E F G H
S Brand	S44A	39.2	E F G H
Pioneer	9292	38.4	F G H
Golden Harvest	H1233	38.2	F G H
Dekalb-Pfizer Gen.	CX264	37.8	G H
Stine	2330	37.7	G H
Latham	650	36.9	H I
Ohlde	3000	30.6	I J
Pioneer	9271	30.5	I J
MSR	X5557	26.6	J
-----	Nebsoy	8.1	K

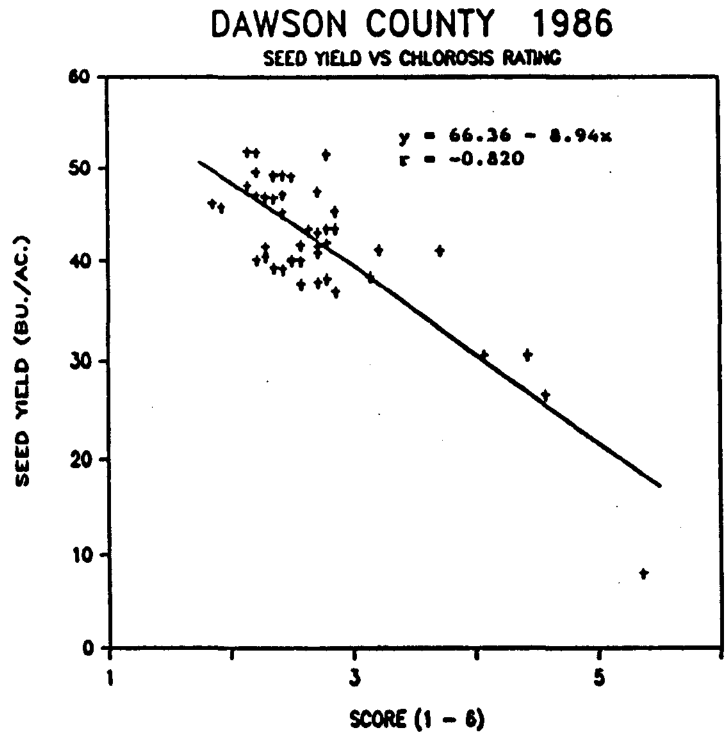

Figure 3. Relationships of Chlorosis Ratings taken at Eight Weeks and Seed Yield at Dawson County, 1986.

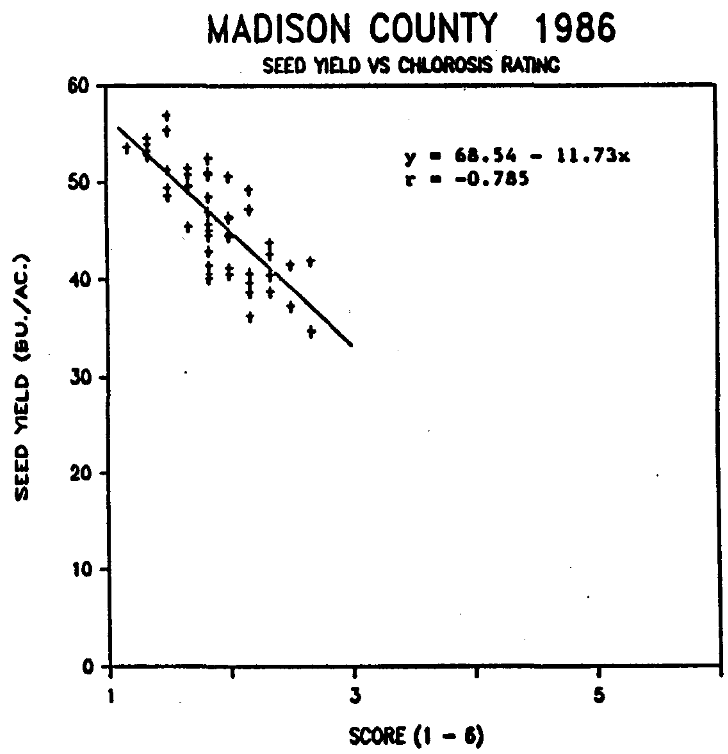

Figure 4. Relationships of Chlorosis Ratings taken at Eight Weeks and Seed Yield at Madison County, 1986.

Table 7. 1986 SOYBEAN CHLOROSIS MADISON COUNTY
EIGHT WEEK CHLOROSIS RATING

ANALYSIS OF VARIANCE

SOURCE	DF	SS	MS	F	
VARIETY	48	36.605	0.763	2.48	***
BLOCK	5	16.571	3.314	10.78	***
ERROR	240	73.762	0.307		
TOTAL	293	126.939			

EXPERIMENTAL MEAN IS 1.90 C.V. = 29.2%

DUNCAN'S MULTIPLE RANGE TEST (5% PROTECTION LEVEL)
MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

BRAND	ENTRY	MEAN	RANGES OF INSIG. CHANGE
Northrup King	S23-03	1.2	A
-----	Century 84	1.3	A B
Asgrow	A3427	1.3	A B
S Brand	S46D	1.3	A B
Asgrow	A2187	1.3	A B
Fontanelle	4646	1.5	A B C
-----	BSR 101	1.5	A B C
Stine	2920	1.5	A B C
MSR	X5557	1.5	A B C
Northrup King	W003747	1.5	A B C
-----	Lakota	1.7	A B C D
Jacques	J231	1.7	A B C D
Jacques	J105	1.7	A B C D
Horizon	H29	1.7	A B C D
Jacobsen	799	1.7	A B C D
Fontanelle	4545	1.8	A B C D E
-----	Weber	1.8	A B C D E
Northrup King	S30-31	1.8	A B C D E
Latham	1010	1.8	A B C D E
Horizon	H25	1.8	A B C D E
Dekalb-Pfizer Gen.	CX264	1.8	A B C D E
McCubbin	Troy	1.8	A B C D E
Pioneer	9292	1.8	A B C D E
Latham	650	1.8	A B C D E
Golden Harvest	H1276	1.8	A B C D E
Stine	2330	1.8	A B C D E
McCubbin	Taylor	1.8	A B C D E
Superior	SPB308	2.0	B C D E F
Jacques	J103	2.0	B C D E F
-----	Nebsoy	2.0	B C D E F
Dekalb-Pfizer Gen.	CX283	2.0	B C D E F
Hoegemeyer	200	2.0	B C D E F
S Brand	S44A	2.0	B C D E F
S Brand	S47B	2.0	B C D E F
Ohlde	3000	2.0	B C D E F
MSR	Royal	2.2	C D E F
-----	Mead	2.2	C D E F
Pioneer	9271	2.2	C D E F
Profiseed	1350	2.2	C D E F
-----	Amsoy 71	2.2	C D E F
Profiseed	1152	2.2	C D E F
Stine	2050+	2.3	D E F
-----	Amcor	2.3	D E F
NC+	2D90+	2.3	D E F
Golden Harvest	H1285	2.3	D E F
Superior	EX250	2.5	E F
Golden Harvest	H1233	2.5	E F
Ohlde	2193	2.7	F
Hoegemeyer	205	2.7	F

Table 8. 1986 SOYBEAN CHLOROSIS MADISON COUNTY
SEED YIELD

ANALYSIS OF VARIANCE

SOURCE	DF	SS	MS	F	
VARIETY	48	8697.258	181.193	4.99	***
BLOCK	5	6327.211	1265.442	34.82	***
ERROR	239	8685.504	36.341		
TOTAL	292	23803.951			

EXPERIMENTAL MEAN IS 46.1 C.V. = 13.1%

DUNCAN'S MULTIPLE RANGE TEST (5% PROTECTION LEVEL)
MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

BRAND	ENTRY	MEAN	RANGES OF INSIG. CHANGE
Northrup King	W003747	56.9	A
MSR	X5557	55.3	A B
-----	Century 84	54.6	A B C
S Brand	S46D	54.0	A B C D
Northrup King	S23-03	53.6	A B C D E
Asgrow	A3427	53.2	A B C D E F
Asgrow	A2187	52.9	A B C D E F G
McCubbin	Troy	52.5	A B C D E F G
Jacobsen	799	51.5	A B C D E F G H
Fontanelle	4646	51.3	A B C D E F G H
Northrup King	S30-31	51.0	A B C D E F G H I
Pioneer	9292	50.8	A B C D E F G H I
Horizon	H29	50.8	A B C D E F G H I
Ohlde	3000	50.6	A B C D E F G H I
Jacques	J105	49.8	A B C D E F G H I J
Jacques	J231	49.6	A B C D E F G H I J
-----	BSR 101	49.4	A B C D E F G H I J
Pioneer	9271	49.3	A B C D E F G H I J
Stine	2920	48.6	A B C D E F G H I J K
Golden Harvest	H1276	48.5	A B C D E F G H I J K
-----	Mead	47.2	B C D E F G H I J K L
Fontanelle	4545	47.0	B C D E F G H I J K L
Jacques	J103	46.5	C D E F G H I J K L
Dek-Pfizer Gen.	CX283	46.3	C D E F G H I J K L
Latham	1010	45.7	D E F G H I J K L M
-----	Lakota	45.4	D E F G H I J K L M
McCubbin	Taylor	45.0	E F G H I J K L M
S Brand	S44A	44.7	F G H I J K L M N
-----	Weber	44.6	G H I J K L M N
Superior	SPB308	44.5	G H I J K L M N
S Brand	S47B	44.4	G H I J K L M N
NC+	2D90+	43.8	H I J K L M N
Latham	650	43.0	H I J K L M N O
Stine	2050+	42.6	I J K L M N O
Ohlde	2193	41.9	J K L M N O
Golden Harvest	H1233	41.5	J K L M N O
Horizon	H25	41.4	J K L M N O
-----	Nebsoy	41.2	J K L M N O
Profiseed	1350	40.6	K L M N O
Stine	2330	40.6	K L M N O
Hoegemeyer	200	40.5	K L M N O
Golden Harvest	H1285	40.4	K L M N O
Dek-Pfizer Gen.	CX264	40.2	K L M N O
MSR	Royal	39.6	L M N O
-----	Amcor	38.7	L M N O
Profiseed	1152	38.6	L M N O
Superior	EX250	37.2	M N O
-----	Amsoy 71	36.2	N O
Hoegemeyer	205	34.8	O

Table 9. 1986 SOYBEAN CHLOROSIS COLFAX AND DODGE COUNTIES
VARIETY X FE EDDHA CHELATE
SEED YIELD

ANALYSIS OF VARIANCE

SOURCE	DF	SS	MS	F	
SITE	1	131.508	131.508	1.35	n.s.
BLOCK (SITE)	7	11327.998	1610.285	13.89	***
VARIETY	17	13749.106	808.595	6.94	***
VARIETY* SITE	17	2462.985	144.882	1.24	n.s.
VARIETY*BLOCK(SITE) E(a)	119	13863.382	116.499	1.20	n.s.
IRON	1	22371.177	22371.177	230.34	***
IRON*SITE	1	825.807	825.807	8.50	***
VARIETY*IRON	17	2385.360	152.080	1.48	n.s.
VARIETY*IRON*SITE E(b)	17	1612.535	94.855	0.98	n.s.
RESIDUAL	122	11848.679	97.120		
TOTAL	319	80263.334			

EXPERIMENTAL MEAN IS 32.5 C.V. = 30.3%

DUNCAN'S MULTIPLE RANGE TEST (5% PROTECTION LEVEL)
MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

BRAND	ENTRY	W/O IRON		W/IRON		INCREASE W/IRON
S Brand	S46D	31.7	A	46.0	A B C	14.3
NC+	2D90+	31.2	A	46.3	A B C	15.1
Hoegemeyer	200	30.6	A	43.0	A B C D	12.4
Jacques	J103	29.7	A	49.6	A	19.9
Fontanelle	4545	28.2	A	42.8	A B C D	14.6
McCubbin	Taylor	28.1	A	37.4	C D	9.3
Stine	2050+	25.2	A	43.4	A B C D	18.2
Hoegemeyer	205	24.7	A	35.9	D	11.2
S Brand	S44A	24.5	A	43.5	A B C C	19.0
Stine	2920	24.1	A B	44.9	A B C D	20.8
Superior	SPB308	23.6	A B	47.7	A B	24.1
Dekalb-Pfizer Gen.	CX283	23.1	A B	42.4	A B C D	19.3
S Brand	S47B	23.0	A B	38.4	B C D	15.4
Golden Harvest	H1285	22.8	A B	45.3	A B C D	22.5
MSR	Royal	21.8	A B	36.9	C D	15.1
-----	Century 84	21.4	A B	37.5	C D	16.1
-----	Mead	12.2	B C	42.3	A B C D	30.1
-----	Nebsoy	7.5	C	10.9	E	3.4
		----		----		----
MEAN		24.1		40.8		16.7

Table 10. 1986 SOYBEAN CHLOROSIS COLFAX AND DODGE COUNTIES
VARIETY X FE EDDHA CHELATE
EIGHT WEEK CHLOROSIS RATINGS

ANALYSIS OF VARIANCE

SOURCE	DF	SS	MS	F	
SITE	1	1.222	1.522	2.97	*
BLOCK (SITE)	7	107.914	15.416	18.08	***
VARIETY	17	57.454	3.380	3.96	***
VARIETY* SITE	17	9.282	0.546	0.64	n.s.
VARIETY*BLOCK(SITE) E(a)	119	101.482	0.853	2.07	***
IRON	1	123.709	123.709	300.30	***
IRON*SITE	1	0.457	0.457	1.11	n.s.
VARIETY*IRON	17	4.282	0.252	0.45	n.s.
VARIETY*IRON*SITE E(b)	17	9.476	0.557	1.35	n.s.
RESIDUAL	123	50.671	0.412		
TOTAL	320	480.888			

EXPERIMENTAL MEAN IS 2.98 C.V. = 21.5%

DUNCAN'S MULTIPLE RANGE TEST (5% PROTECTION LEVEL)
MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

BRAND	ENTRY	W/O IRON		W/IRON		CHANGE W/IRON
Hoegemeyer	200	3.0	A	2.1	A	0.9
NC+	2D90+	3.1	A	1.9	A	1.2
S Brand	S46D	3.2	A	1.8	A	1.4
McCubbin	Taylor	3.2	A B	2.1	A	1.1
Jacques	J103	3.3	A B	2.3	A	1.0
Fontanelle	4545	3.4	A B	1.9	A	1.5
Stine	2920	3.6	A B	2.2	A	1.4
S Brand	S44A	3.6	A B	2.3	A	1.3
Stine	2050+	3.6	A B	2.3	A	1.3
Golden Harvest	H1285	3.7	A B	2.2	A	1.5
Dekalb-Pfizer Gen.	CX283	3.7	A B	2.0	A	1.7
Hoegemeyer	205	3.7	A B	2.5	A	1.2
Superior	SPB308	3.8	A B	2.3	A	1.5
S Brand	S47B	3.8	A B	2.4	A	1.4
MSR	Royal	3.8	A B	2.6	A	1.2
-----	Century 84	3.9	A B	2.7	A	1.2
-----	Mead	4.2	B C	2.4	A	1.8
-----	Nebsoy	4.8	C	4.0	B	0.8
		---		---		---
MEAN		3.6		2.3		1.3

Table 11. 1986 SOYBEAN CHLOROSIS COLFAX COUNTY
VARIETY X FE EDDHA CHELATE
EIGHT WEEK CHLOROSIS RATINGS

ANALYSIS OF VARIANCE

SOURCE		DF	SS	MS	F	
VARIETY		17	34.532	2.031	1.95	**
BLOCK		5	103.187	20.637	19.83	***
VARIETY*BLOCK	E(a)	85	88.459	1.041	2.12	***
IRON		1	80.088	80.088	162.97	***
VARIETY*IRON		17	9.774	0.575	1.17	n.s.
RESIDUAL	E(b)	87	42.754	0.491		
TOTAL		212	363.608			

EXPERIMENTAL MEAN IS 3.03 C.V. = 23.2%

DUNCAN'S MULTIPLE RANGE TEST (5% PROTECTION LEVEL)
MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

BRAND	ENTRY	W/O IRON		W/IRON		CHANGE W/IRON
Hoegemeyer	200	2.8	A	2.3	A	0.5
NC+	2D90+	2.9	A B	2.1	A	0.8
S Brand	S46D	3.3	A B C	1.9	A	1.4
McCubbin	Taylor	3.4	A B C D	2.5	A	0.9
Jacques	J103	3.4	A B C D	2.1	A	1.3
S Brand	S44A	3.4	A B C D	2.3	A	1.1
MSR	Royal	3.5	A B C D	2.5	A	1.0
Stine	2050+	3.5	A B C D	2.7	A	0.8
Fontanelle	4545	3.6	A B C D	2.2	A	1.4
Stine	2920	3.7	A B C D	2.3	A	1.4
Golden Harvest	H1285	3.7	A B C D	2.0	A	1.7
Dekalb-Pfizer Gen.	CX283	3.8	A B C D	1.9	A	1.9
S Brand	S47B	3.8	A B C D	2.3	A	1.5
Hoegemeyer	205	3.8	A B C D	2.7	A	1.1
-----	Century 84	4.2	B C D	2.7	A	1.5
-----	Mead	4.2	B C D	2.5	A	1.7
Superior	SPB308	4.3	C D	2.5	A	1.8
-----	Nebsoy	4.6	D	4.1	B	0.5
		---		---		---
MEAN		3.6		2.4		1.2

Table 12. 1986 SOYBEAN CHLOROSIS COLFAX COUNTY
VARIETY X FE EDDHA CHELATE
SEED YIELD

ANALYSIS OF VARIANCE

SOURCE		DF	SS	MS	F	
VARIETY		17	8204.486	482.617	3.39	***
BLOCK		5	11137.660	2227.532	15.64	***
VARIETY*BLOCK	E(a)	83	11821.109	142.423	1.38	*
IRON		1	10424.703	10424.703	98.04	***
VARIETY*IRON		17	3108.748	182.868	1.77	**
RESIDUAL	E(b)	84	8696.167	103.526		
TOTAL		207	52750.652			

EXPERIMENTAL MEAN IS 32.0 C.V. = 31.8%

DUNCAN'S MULTIPLE RANGE TEST (5% PROTECTION LEVEL)
MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

BRAND	ENTRY	W/O IRON		W/IRON		INCREASE W/IRON
Hoegemeyer	200	33.3	A	40.0	A B C	6.7
NC+	2D90+	32.4	A	44.4	A B C	12.0
Stine	2050+	30.3	A B	38.9	A B C	8.6
S Brand	S44A	29.7	A B	44.9	A B C	15.2
S Brand	S46D	29.4	A B	44.6	A B C	15.2
Jacques	J103	29.0	A B	49.0	A	20.0
MSR	Royal	27.9	A B	37.2	A B C	9.3
Hoegemeyer	205	27.0	A B	32.4	B C	5.4
Fontanelle	4545	25.6	A B C	39.9	A B C	14.3
McCubbin	Taylor	25.4	A B C	30.9	C	5.5
S Brand	S47B	24.8	A B C	35.6	A B C	10.8
Golden Harvest	H1285	24.5	A B C	44.0	A B C	19.5
Dekalb-Pfizer Gen.	CX283	23.9	A B C	41.4	A B C	17.5
Stine	2920	22.8	A B C	43.6	A B C	20.8
Superior	SPB308	21.8	A B C	45.3	A B	23.5
-----	Century 84	16.9	B C	36.0	A B C	19.9
-----	Nebsoy	11.0	C	11.7	D	0.7
-----	Mead	10.9	C	41.9	A B C	31.0
		----		----		----
MEAN		24.8		39.2		14.4

Table 13. 1986 SOYBEAN CHLOROSIS DODGE COUNTY
VARIETY X FE EDDHA CHELATE
EIGHT WEEK CHLOROSIS RATINGS

ANALYSIS OF VARIANCE

SOURCE		DF	SS	MS	F	
VARIETY		17	43.134	2.537	6.46	***
BLOCK		3	10.866	3.622	9.22	***
VARIETY*BLOCK	E(a)	51	21.040	0.413	1.04	n.s.
IRON		1	46.127	46.127	122.06	***
VARIETY*IRON		17	3.842	0.226	0.60	n.s.
RESIDUAL	E(b)	54	20.406	0.378		
TOTAL		143	144.415			

EXPERIMENTAL MEAN IS 2.77   C.V. = 22.2%

DUNCAN'S MULTIPLE RANGE TEST (5% PROTECTION LEVEL)
MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

BRAND	ENTRY	W/O IRON		W/IRON		CHANGE W/IRON
Superior	SPB308	2.6	A	2.1	A B C	0.5
S Brand	S46D	2.8	A	1.6	A	1.2
Jacques	J103	2.8	A	2.5	B C	0.3
McCubbin	Taylor	2.9	A B	1.6	A	1.3
NC+	2D90+	3.0	A B C	1.6	A	1.4
Hoegemeyer	200	3.0	A B C	1.8	A B	1.2
Fontanelle	4545	3.0	A B C	1.8	A B C	1.2
Stine	2920	3.0	A B C	2.1	A B	0.9
Stine	2050+	3.3	A B C	1.6	A	1.7
-----	Century 84	3.4	A B C	2.4	A B C	1.0
Dekalb-Pfizer Gen.	CX283	3.4	A B C	2.1	A B C	1.3
S Brand	S44A	3.5	A B C	2.1	A B C	1.4
S Brand	S47B	3.5	A B C	2.4	A B C	1.1
Hoegemeyer	205	3.5	A B C	2.1	A B C	1.4
Golden Harvest	H1285	3.5	A B C	2.6	C	0.9
MSR	Royal	3.9	B C	2.8	C	1.1
-----	Mead	4.0	C	2.6	C	1.4
-----	Nebsoy	5.3	D	3.9	D	1.4
		---		---		---
MEAN		3.3		2.2		1.2

Table 14. 1986 SOYBEAN CHLOROSIS DODGE COUNTY
VARIETY X FE EDDHA CHELATE
SEED YIELD

ANALYSIS OF VARIANCE

SOURCE		DF	SS	MS	F	
VARIETY		17	9754.829	13.647	10.82	***
BLOCK		3	676.382	225.461	4.25	***
VARIETY*BLOCK	E(a)	51	2705.116	53.042	0.45	n.s.
IRON		1	9843.960	9843.960	83.16	***
VARIETY*IRON		17	714.813	42.048	0.36	n.s.
RESIDUAL	E(b)	54	6392.477	118.379		
TOTAL		143	30087.576			

EXPERIMENTAL MEAN IS 34.5 C.V. = 31.6%

DUNCAN'S MULTIPLE RANGE TEST (5% PROTECTION LEVEL)
MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

BRAND	ENTRY	W/O IRON		W/IRON		INCREASE W/IRON
S Brand	S46D	38.0	A	48.3	A	10.3
Jacques	J103	35.5	A B	48.8	A	13.3
Fontanelle	4545	34.7	A B C	45.9	A B	11.2
McCubbin	Taylor	33.6	A B C	46.7	A B	13.1
NC+	2D90+	33.2	A B C	48.1	A	14.9
Superior	SPB308	30.8	A B C D	46.8	A B	16.0
Stine	2920	30.6	A B C D	45.3	A B	14.7
Hoegemeyer	200	30.4	A B C D	48.0	A	17.6
-----	Century 84	29.5	A B C D	41.6	A B C	12.1
Dekalb-Pfizer Gen.	CX283	25.9	A B C D	44.5	A B	18.6
S Brand	S47B	24.7	A B C D	43.6	A B C	18.9
Golden Harvest	H1285	23.3	A B C D	43.4	A B C	20.1
Hoegemeyer	205	22.5	A B C D	42.2	A B C	19.7
Stine	2050+	22.4	A B C D	47.9	A	25.5
S Brand	S44A	19.7	B C D	41.9	A B C	22.2
-----	Mead	18.5	C D	39.7	B C	21.2
MSR	Royal	16.4	D	36.0	C	19.6
-----	Nebsoy	1.8	E	10.3	D	8.5
		----		----		----
MEAN		26.2		42.7		16.5

EFFECT OF N FERTILIZER RATE AND NITRIFICATION INHIBITOR ON N UPTAKE AND LEAF CHLOROPHYLL CONTENT OF SEVERAL CORN HYBRIDS

Richard Ferguson, Gary Hergert, and James Schepers

OBJECTIVES

A study was initiated at the University of Nebraska, South Central Experiment Station at Clay Center as part of the Burlington Northern Foundation Water Quality Project to:

1. Evaluate corn hybrid response to amount and form of plant available N.
2. Determine if leaf N or chlorophyll content could be used as an indicator of plant N status and a guide for fertigation.

PROCEDURES

A large part of this research project deals with the effect of various tillage, pesticide and water management practices on leaching and potential ground water contamination. A nitrification inhibitor was used to delay nitrification of sidedress applied anhydrous ammonia fertilizer. Leaf samples were collected shortly before and after anthesis for chlorophyll determination and N content. Surface soil samples were also collected at these times to evaluate amount and form of plant available N. Threatments for the fertilizer N management study were as follows:

Tillage	(conventional and no-till)
N Rate	(0, 75, 150, and 300 kg N/ha)
Hybrids	(P3377, P3475, P3551, plus FS854)
Nitrification Inhibitor	(with and without) **NS** and **NO NS**, respectively

RESULTS AND DISCUSSION

The crop was planted on May 7 and fertilizer was applied approximately 20-cm deep on June 16. Soil samples were collected in 15-cm increments (**D1**, **D2** and **D3**) to a depth of 45 cm over the fertilizer band on July 9 (**T1**) and July 29 (**T2**)from the conventionally tilled plots (anthesis occurred between July 16 and 20). Leaf punch samples were also collected from the same plots on each sampling date. Soil cores to a depth of 1.8 m were collected in the spring of 1986 and will be taken again in the spring of 1987. Several cores in the area were taken to 15 m in the fall of 1985 to document previous accumulations of nitrate in the profile.

Yields were not different due to the tillage treatments, however nitrification inhibitor did statistically increase yields (Figure 1). These increased yields due to nitrification inhibitor largely occurred at the 150 and 300 kg/ha N rates where yield reductions were typical without nitrification inhibitor. The preliminary conclusion is that excessive amounts of N between 30 and 60 days after emergence may be antagonistic in terms of plant metabolism. Another possible explanation is that the ammonium-to-nitrate ratio is higher later in the growing season where nitrification inhibitor was applied. One can not discount the later, however the fact that maximum yields were obtained with 75 kg N/ha suggests that the excess N hypothesis can not be ignored.

Soil sampling during the season showed that the nitrification inhibitor reduced the amount of plant available nitrogen for a period after application, but made more available near silking time (Figure 2). The initial reduction (July 9) in plant available N (nitrate- plus ammonium-N) where nitrification inhibitor was applied compared to no nitrification inhibitor treatments was apparently due to microbial immobilization followed by subsequent mineralization by July 29.

Leaf chlorophyll content was positively correlated with yield for all 4 hybrids used in 1986, and based on the literature, the same should hold for leaf N content (Figure 3). For a given hybrid, the major changes in chlorophyll content occur between 0 and 75 kg N/ha. A similar trend was found for grain yield with a decrease in yield at the 300 kg/ha N rate for the three Pioneer hybrids. It is worth noting the apparent increase in yield of P3475 at all fertilizer rates with the addition of nitrification inhibitor. It also seems the nitrification inhibitor minimized the yield decline for P3377 and P3551 at the 300 kg/ha N rate.

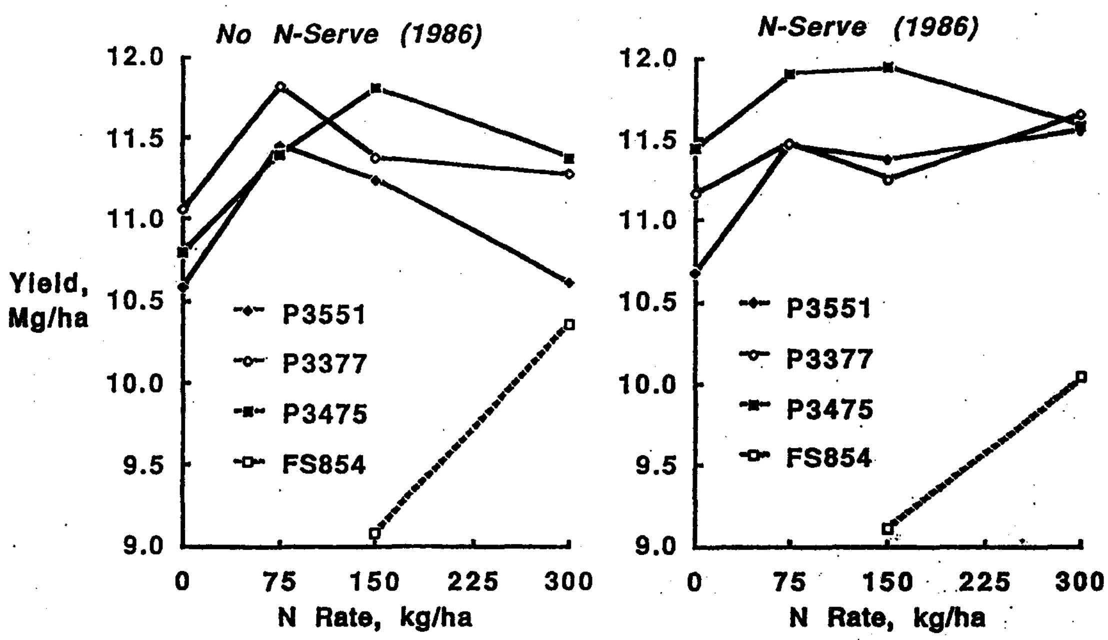

Figure 1. Effect of N rate and nitrification inhibitor on yields of 4 corn hybrids.

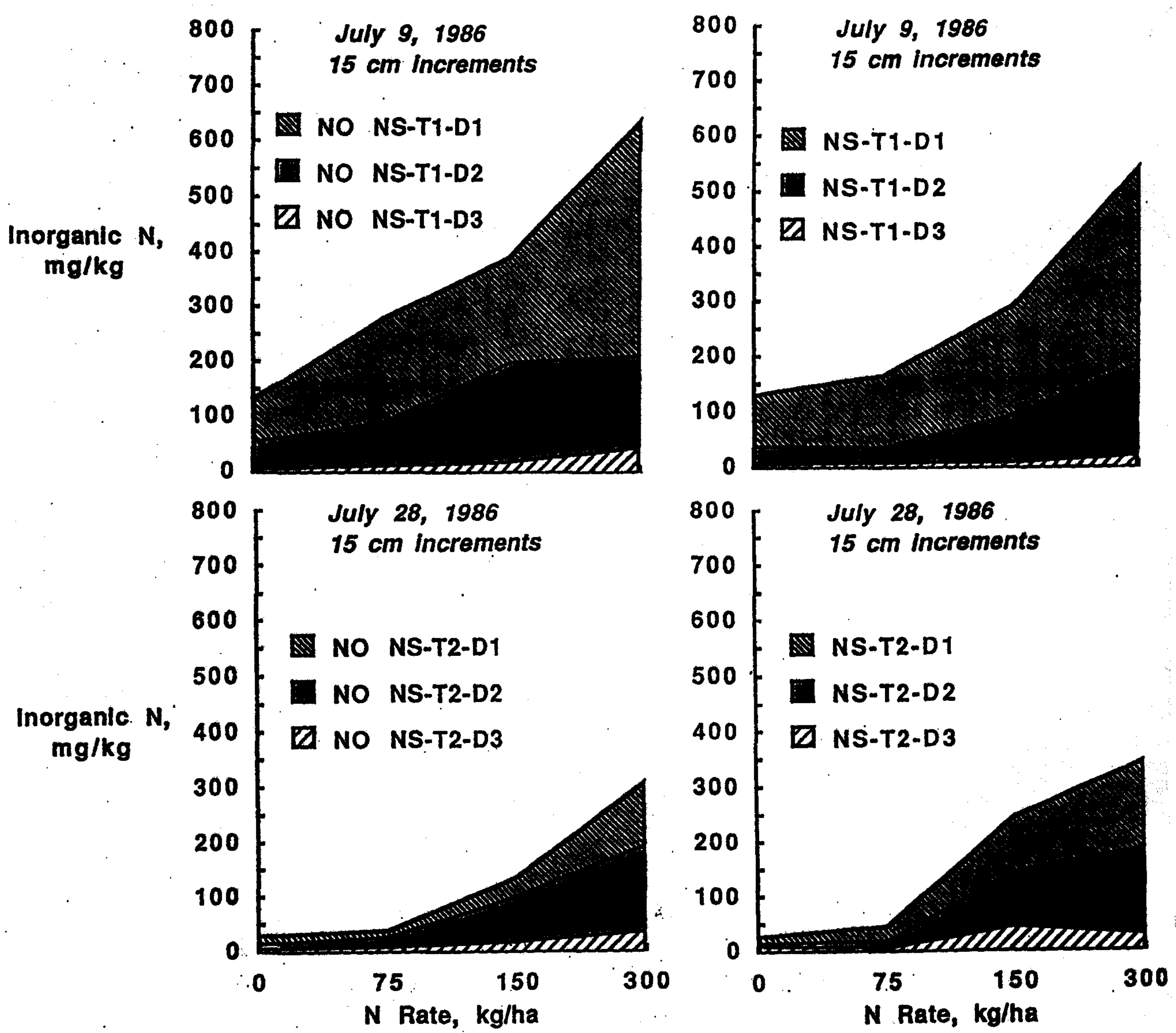

Figure 2. Effect of N rate and nitrification inhibitor on soil inorganic N content.

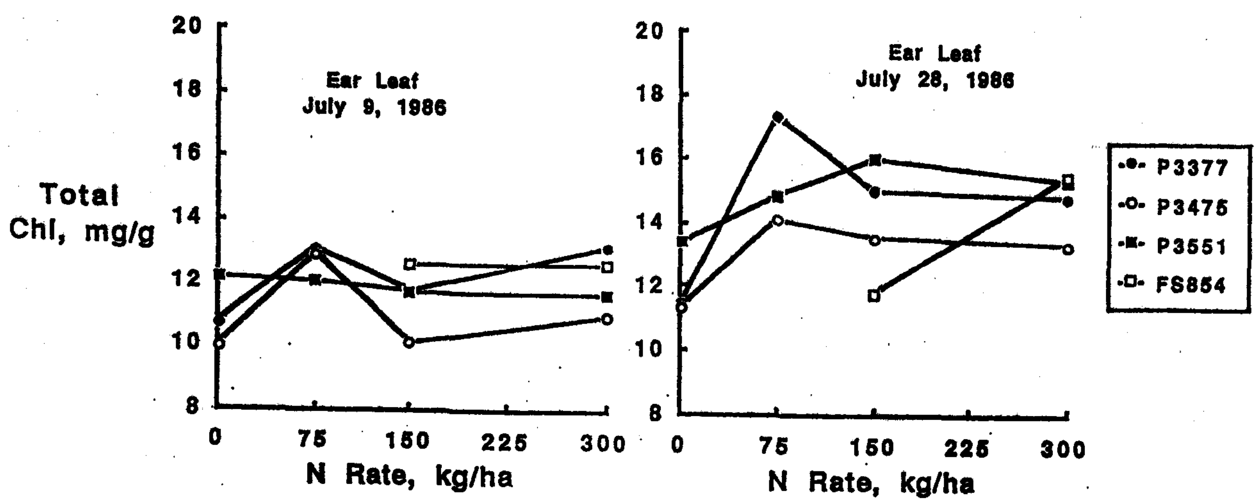

Figure 3. Effect of N and nitrification inhibitor on ear leaf chlorophyll content.

EFFECT OF P APPLICATION RATE AND BAND SPACING ON THE MOVEMENT OF P FROM THE INJECTED BAND IN THREE SOILS

B. Eghball and D. H. Sander

Objective: To determine the movement of applied P fertilizer from the injected band in the soil.

Procedure: An experiment was conducted in the field at the University of Nebraska Field Laboratory at Mead in 1986. Three soils were used (Coly sil, Nora sil and Sharpsburg sicl). Coly and Nora soils were brought from Sherman and Boone counties in Nebraska. The top 30 cm of Sharpsburg soil at Mead was removed and two wooden rectangular prisms 30 cm deep, 210 cm long and 60 cm wide were placed in the removed area directly on the Sharpsburg soil. The prisms were filled with Coly and Nora soils. The Sharpsburg soil was used in place. P fertilizer solution as ammonium polyphosphate tagged with ^{32}P with a specific activity of 592 x 10^5 becquerel g P^{-1} was injected into the soil 5 cm deep. The bands were 10 cm long marked by two wire flags at the beginning and end of each band. Ninety days after application the bands were cut vertically above the treated soil and 96 cm^3 samples were taken from a rectangular prism 12 cm long, 80 cm wide and 1 cm deep from each band. The samples were analyzed for ^{32}P activity using a Geiger-Muller tube.

Results: The results indicate that P fertilizer moves outward from the injected area in all directions to produce a rough shaped cylinder. The diameter of the cylinder is significantly affected by the P application rate (Table 1). The greater the P rate the greater the diameter of the cylinder. The P movement was significantly affected by the band spacing (Table 1). The wider the band spacing the greater the P movement because more fertilizer P is placed in the bands of wider spacings. There was a significant interaction between the P rate and band spacing in Coly soil. Figure 1 shows at 15 kg P ha^{-1} an increase in band spacing did not significantly affect the P fertilizer movement, but at 30 kg P ha^{-1}, P fertilizer movement (cylinder diameter) increased as the band spacing increased. The high pH of this soil probably caused greater interaction of applied P with soil constituents and subsequently resulted in greater fixation of fertilizer P than in the other two soils. A high concentration of P in the band appears to be needed to overcome soil-P fixation before P movement occurs.

Table 1. Effect of P application rate and band spacing on the movement of P from the injected band after 90 days.

P rate Kg ha^{-1}	Band spacing cm	Diameter of band† (cm) Soil Coly sil	Nora sil	Sharpsburg sicl
15	30	4.11	4.16	3.74
15	45	5.00	5.06	4.48
15	60	5.08	5.97	5.28
15	75	5.24	6.09	5.74
30	30	5.08	5.97	5.28
30	45	5.30	6.42	6.26
30	60	6.33	7.32	6.14
30	75	7.13	8.15	7.45
pH (1:1 soil water)		7.7	7.0	6.6
Bulk density Mg m^{3}		1.09	1.09	1.35
Bray and Kurtz #1 P, mg kg^{-1}		33.3	18.7	18.7
Rate		0.01‡	0.01	0.01
Band spacing		0.01	0.01	0.01
Rate*Band Spacing		0.04	NS	NS

† Diameter of band after 90 days from application.
‡ Actual probability level up to 0.05 level, NS indicate significance 0.05.

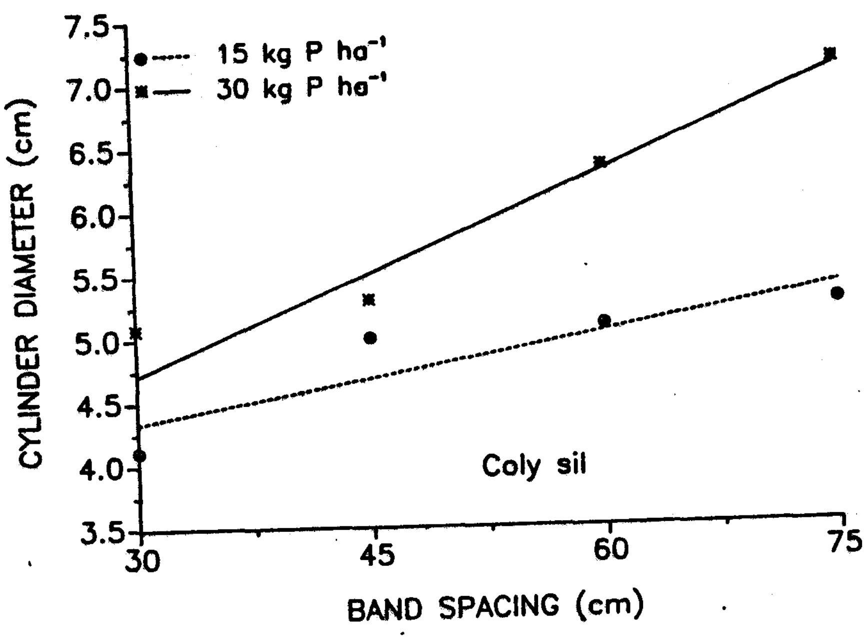

Fig. 1. Effect of band spacing on the movement of P from the injected band at two P rates.

Table 1. Effect of P application rate and band spacing on the movement of P from the injected band after 90 days.

P rate Kg ha^{-1}	Band spacing cm	Diameter of band† (cm) Soil Coly sil	Nora sil	Sharpsburg sicl
15	30	4.11	4.16	3.74
15	45	5.00	5.06	4.48
15	60	5.08	5.97	5.28
15	75	5.24	6.09	5.74
30	30	5.08	5.97	5.28
30	45	5.30	6.42	6.26
30	60	6.33	7.32	6.14
30	75	7.13	8.15	7.45
pH (1:1 soil water)		7.7	7.0	6.6
Bulk density Mg m^{-3}		1.09	1.09	1.35
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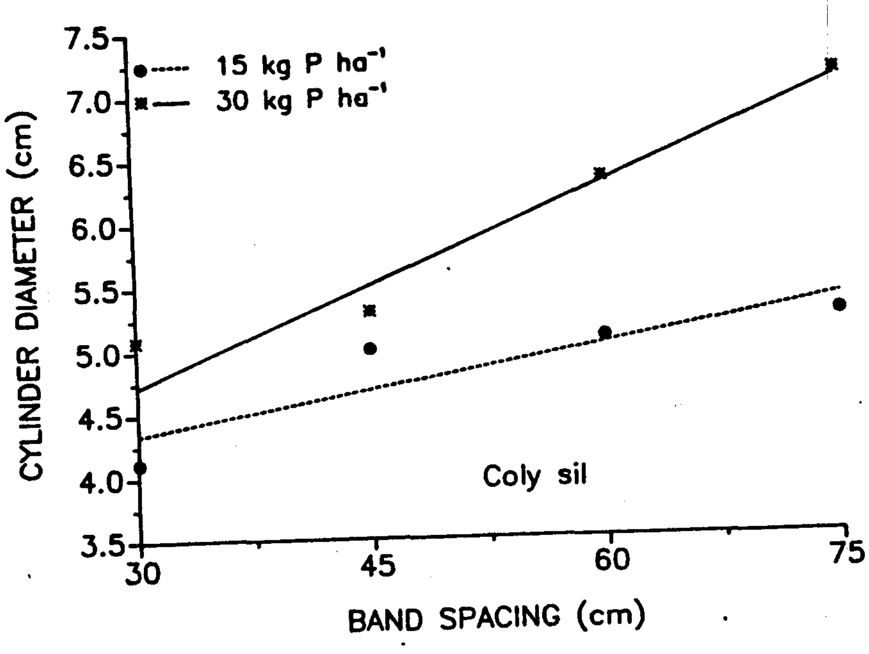


Fig. 1. Effect of band spacing on the movement of P from the injected band at two P rates.

Effect of Time and Source of Nitrogen for Increased Efficiency of Applied Nitrogen

R. J. Fiedler and D. H. Sander

Objectives: To determine (1) the optimum time of applying nitrogen to maximize wheat quality and yield in a wheat-fallow-wheat cropping system, and (2) to study the movement of NO_3-N and NH_4^+-N from different N sources and associated yield performance.

Procedure: Five field studies were conducted on soils selected for low residual nitrate during two cropping sequences (1982-84 and 1983-85). Four studies were located on Keith silt loam on Hitchcock County (84-30, 84-35, 85-45, and 85-50) and one study on a Rosebud silt loam in Perkins County. Treatments consisted of four sources of nitrogen (anhydrous ammonia-AA, ammonium nitrate-AN, urea-ammonium nitrate-UAN, and calcium nitrate-CN) at three rates of application (0, 40 and 80 kg N ha^{-1}). Treatments were applied four times--after harvest, spring, prior to seeding and as spring topdressing. Soil samples were collected from each treatment to a depth of five feet before jointing, at anthesis, and after harvest for NO_3^- and NH_4^+ analysis. Soil water was also determined for each treatment at these soil sampling times. Wheat was cut at anthesis and maturity for determination of yield and N content.

Preliminary Results: While statistical analysis is not completed, Table 1 shows the analysis of variance for grain yields. Applied N increased grain yields at all locations ranging from 330 kg ha^{-1} at location 84-30 to 1320 kg ha^{-1} at location 85-50. Yields were apparently maximized by the highest N rate of 80 kg ha^{-1} only at the Perkins County location (84-40)(Table 2). The time of N application significantly affected N fertilizer performance at all locations (Table 1 and Table 3). At three of the four locations spring topdressing resulted in the highest wheat grain yield and N uptake of the application times studied. Of the three times N was applied during fallow, there were no consistant trends for one time to be superior, when averaged across sources. Even when N was applied after harvest in August (beginning of the fallow period), it was surprisingly effective compared to later application times. Soil nitrate levels at the first sampling tended to be higher when N application was delayed until applied as a spring topdressing. Delaying application during fallow had little effect on soil nitrate content. Of the four N sources studied, AA tended to produce the highest and UAN the lowest grain yield and nitrogen uptake (Table 4). However, N souces affected grain yields differently depending on when it was applied. Table 5 shows the time by source interaction means for those locations where the interaction was significant for grain yield. Ammonia seemed to be a superior N source at location 84-35 compared to other sources at all fallow application times. This trend was apparent at the other two locations but only where N was applied in August prior to seeding. All N sources tended to increase grain yields equally when topdressed although AA produced the lowest yields of all sources when topdressed at two of the three locations where there was a significant source by time of application interaction. The overall superiority of AA as an N source for wheat at all three locations was primarily because of its superiority when applied in August prior to seeding. The study indicates no advantage of applying N earlier in the fallow period to allow nitrogen to move deeper into the root zone with precipitation accumulation during fallow. Soil moisture data and soil nitrate and ammonium content remain to be completely evaluated. Topdressing N with any N source or applying AA in August prior to seeding appeared to be the best way to apply N to winter wheat. Applying AA in August prior to seeding was especially effective and produced the highest yields or equal to the highest of any other N source or time of N application studied.

Table 1. Analysis of variance on winter wheat grain yields for five locations in southwest Nebraska.

Source of	Locations				
Variance	84-30	84-35	84-40	85-45	85-50
Time (T)	.05	.01	.01	.01	.01
Source (S)	NS	.02	NS	.01	.01
Rate (R)	.10	.02	.05	.01	.01
T * S	NS	.02	NS	.01	.01
T * R	NS	NS	NS	NS	NS
S * R	NS	NS	NS	.01	NS
T * S * R	NS	NS	NS	NS	NS

Table 2. Effect of rate of nitrogen application on winter wheat yield, N content and soil N levels in Southwest Nebraska. 1983-85

Rate of N Application	Grain Yield	Grain Protein	Anthesis N	Total N	Soil NO_3-N	Soil NH_4^+-N	Total[2] Soil N
	Mg ha^{-1}	%	------------	------------	kg ha^{-1}	------------	------------
				Hitchcock Co. 84-30			
0	3.36	11.2	58.2	79.8	49.3	122.9	172.2
40	3.51	10.5	76.6	79.6	68.2	166.0	234.2
80	3.69	11.4	79.9	91.6	81.5	208.8	290.3
				Hitchcock Co. 84-35			
0	2.24	10.1	36.9	47.0	33.5	170.8	204.3
40	2.70	11.5	58.7	65.3	35.7	225.3	261.0
80	3.00	12.2	75.1	78.8	46.8	206.9	253.7
				Perkins Co. 84-40			
0	2.96	10.6	84.0	69.3	53.4	93.0	146.4
40	3.31	12.4	75.9	92.0	112.7	175.2	287.9
80	3.35	13.4	90.7	101.8	94.5	277.6	372.1
				Hitchcock Co. 85-45			
0	3.25	8.9	45.8	64.0	39.5	89.2	128.7
40	4.03	8.7	72.9	80.5	49.6	126.9	176.5
80	4.41	9.3	97.9	97.3	55.8	127.8	183.6
				Hitchcock Co. 85-50			
0	2.95	8.7	43.1	55.6	21.0	92.4	113.4
40	3.66	8.9	66.0	71.1	20.5	79.6	100.1
80	4.27	9.3	88.8	89.7	26.3	86.5	112.8

[2] Represents the first of three soil sampling times.

Table 3. Effect of time of nitrogen application on winter wheat yield, N content and soil N levels in a wheat fallow-wheat cropping system in Southwest Nebraska. 1984 and 85.

Time of N Application[1]	Grain Yield	Grain Protein	Anthesis %	Total N	Soil NO_3-N	Soil NH_4^+-N	Total[1] Soil N
	$Mg\ ha^{-1}$	%	----------	----------	kg ha^{-1}	----------	----------
				Hitchcock Co. 85-45			
After harvest	4.13	8.9	83.7	84.6	43.4	107.4	150.8
Spring	4.03	8.8	75.1	81.7	54.2	125.6	179.8
Before seeding	4.24	9.0	89.7	91.4	48.6	129.1	177.7
Spring Topdressing	4.50	9.3	93.0	98.7	64.6	147.4	212.0
				Hitchcock Co. 85-50			
After harvest	3.92	8.8	71.7	81.0	25.2	83.5	108.7
Spring	3.80	9.1	73.9	75.0	14.4	83.7	98.1
Before seeding	3.83	9.0	77.6	76.1	23.7	80.0	103.7
Spring topdressing	4.33	9.5	86.5	90.6	30.7	85.1	115.8
				Hitchcock Co. 84-30			
After harvest	3.40	10.0	72.5	71.9	65.2	265.7	330.9
Spring	3.51	10.8	75.4	81.4	83.1	156.9	240.0
Before seeding	3.66	11.1	71.9	88.3	73.8	155.9	229.7
Spring topdressing	3.78	11.5	85.1	97.4	--	--	--
				Hitchcock Co. 84-35			
After harvest	2.95	11.4	77.4	72.4	44.4	200.3	244.7
Spring	1.99	13.0	67.1	55.9	38.1	211.0	249.1
Before seeding	3.18	11.5	68.6	79.2	40.5	237.3	277.8
Spring topdressing	3.09	11.7	55.8	77.8	--	--	--
				Perkins Co. 84-40			
After harvest	3.33	11.5	74.0	84.6	66.4	163.9	230.3
Spring	3.34	13.1	88.3	99.0	118.8	205.5	324.3
Before seeding	3.17	13.2	75.9	94.5	127.8	312.0	439.8
Spring topdressing	3.49	13.8	95.9	109.9	--	--	-

[1] After harvest, spring, and before seeding applications are during fallow.
[2] Represents the first of three soil sampling times.

Table 4. Effect of source of nitrogen application on winter wheat yield, N content and soil N levels in Southwest Nebraska. 1983-85.

Source of N Application	Grain Yield	Grain Protein	Anthesis N	Total N	Soil NO_3-N	Soil NH_4^+-N	Total[2] Soil N
	$Mg\ ha^{-1}$	%			$kg\ ha^{-1}$		
				Hitchcock Co. 84-30			
AA	3.75	11.5	84.5	96.5	71.4	160.0	231.4
CN	3.59	10.6	71.7	79.9	79.9	185.2	265.1
AN	2.53	10.7	77.4	81.9	69.3	229.5	298.8
UAN	3.50	11.0	70.0	82.8	80.7	162.9	243.6
				Hitchcock Co. 84-35			
AA	2.99	12.3	77.4	79.7	41.6	285.7	327.3
CN	2.81	12.0	67.1	71.5	31.6	211.3	243.9
AN	2.99	11.8	68.6	76.1	46.9	205.3	252.2
UAN	2.58	11.4	55.8	61.8	45.3	157.6	202.9
				Perkins Co. 84-40			
AA	3.41	14.0	88.6	108.0	119.0	328.0	447.0
CN	3.34	12.7	85.2	95.4	127.7	215.4	343.1
AN	3.22	12.9	84.2	95.7	80.0	167.3	247.3
UAN	3.34	12.0	72.9	88.1	86.6	185.7	272.3
				Hitchcock Co. 85-45			
AA	4.30	9.2	93.5	94.1	45.7	122.8	168.5
CN	4.34	9.1	76.1	92.1	62.8	118.6	181.4
AN	4.17	8.9	90.1	85.6	52.1	138.6	190.7
UAN	4.08	8.9	82.0	84.1	50.1	129.5	179.5
				Hitchcock Co. 85-50			
AA	4.21	9.3	85.2	88.2	26.9	97.5	124.4
CN	4.04	9.2	76.5	82.6	22.1	83.3	105.4
AN	3.74	9.1	75.6	74.7	26.3	68.2	94.5
UAN	3.89	8.9	72.3	76.2	17.7	83.3	101.0

[2] Represents the first of three soil sampling times.

Table 5. Effect of time and source of nitrogen application on winter wheat yield, N content, and soil N levels in a wheat-fallow-wheat cropping system in southwest Nebraska. 1983-85.

Time of N Application	Source of N Application	Grain Yield	Grain Protein	Anthesis N	Total N	Soil NO_3-N	Soil NH_4^+-N	Total Soil N[2/]
		Mg ha^{-1}	%	kg ha^{-1}				
				Hitchcock Co. 84-35				
After harvest	AA	3.25	11.7	65.5	80.2	43.5	209.8	253.3
	CN	2.85	11.1	52.9	67.0	40.4	266.4	306.8
	AN	2.80	11.5	81.4	69.9	48.1	143.5	191.6
	UAN	--	--	--	--	--	--	--
Spring	AA	2.52	13.2	64.6	74.0	45.6	338.5	384.1
	CN	1.66	13.2	59.0	45.9	23.3	142.8	166.1
	AN	2.09	12.9	49.8	58.9	49.4	188.8	238.2
	UAN	1.72	12.8	48.5	46.2	38.0	166.4	204.4
Before seeding	AA	3.46	12.3	123.1	93.1	32.8	320.3	353.1
	CN	3.14	11.5	89.6	77.0	31.0	224.7	255.7
	AN	3.33	11.6	75.0	83.1	41.8	345.5	387.3
	UAN	2.84	10.7	48.7	65.8	50.8	151.1	201.9
Spring topdressing	AA	2.75	12.1	69.8	69.4	--	--	--
	CN	3.21	12.1	64.0	85.4	--	--	--
	AN	3.34	11.7	61.9	83.5	--	--	--
	UAN	3.08	10.8	66.6	71.5	--	--	--
				Hitchcock Co. 85-45				
After Harvest	AA	4.22	8.9	90.4	86.1	36.0	96.1	132.1
	CN	4.34	9.4	74.7	95.9	54.7	120.4	175.1
	AN	3.97	8.6	95.0	78.0	43.1	95.4	137.5
	UAN	3.97	8.6	74.8	78.2	39.7	117.6	157.3
Spring	AA	4.00	8.6	82.7	81.4	54.2	113.4	167.6
	CN	4.16	8.8	76.8	84.3	53.7	131.5	185.2
	AN	4.23	9.0	68.2	86.1	51.8	139.1	190.9
	UAN	3.75	8.9	72.9	75.3	57.0	118.3	175.3
Before seeding	AA	4.60	9.7	116.7	111.6	48.5	129.0	177.5
	CN	4.29	8.8	76.8	88.3	40.2	113.0	153.2
	AN	3.95	8.7	84.8	79.8	51.2	148.6	200.3
	UAN	4.13	8.8	80.5	85.7	54.0	125.9	179.9
Spring topdressing	AA	4.39	9.4	84.1	97.4	44.3	152.9	197.2
	CN	4.57	9.2	76.1	99.9	102.7	109.3	212.0
	AN	4.60	9.2	112.1	100.5	61.8	171.2	233.0
	UAN	4.47	9.2	99.5	97.3	49.4	156.3	205.7
				Hitchcock Co. 85-50				
After harvest	AA	4.00	9.2	77.6	81.4	20.2	79.8	100.0
	CN	4.25	9.4	66.5	89.8	28.7	98.5	127.2
	AN	3.78	9.6	82.6	80.8	38.3	91.2	129.5
	UAN	3.61	8.9	59.9	70.6	9.8	58.4	68.2
Spring	AA	3.93	9.2	74.7	79.7	18.2	94.8	113.0
	CN	3.91	9.3	73.9	80.7	22.0	93.4	115.4
	AN	3.54	9.0	83.9	69.3	17.1	61.9	79.0
	UAN	3.79	8.7	63.1	69.8	0.3	84.8	95.1
Before seeding	AA	4.57	9.3	96.7	99.4	32.5	95.7	128.2
	CN	3.70	8.8	75.7	70.8	11.5	71.4	82.9
	AN	3.44	8.5	56.4	64.5	29.4	55.1	84.5
	UAN	3.63	8.7	81.6	69.8	21.4	97.8	119.2
Spring topdressing	AA	4.35	9.3	91.7	92.8	36.6	119.7	156.3
	CN	4.29	9.3	90.1	89.0	27.5	65.6	93.1
	AN	4.21	9.3	79.4	85.1	20.6	64.4	85.0
	UAN	4.48	9.3	84.6	96.5	37.4	85.9	123.3

2/ Represents the first of three soil sampling times.

EVALUATION OF THE INFLUENCE OF STARTER FERTILIZER ON CORN AND GRAIN SORGHUM

E. J. Penas, R. A. Wiese, & R. B. Ferguson

Objective:

Determine the influence of farmer-applied starter fertilizer on plant emergence, early plant growth, grain yield, grain moisture at harvest and final plant populations of corn and grain sorghum.

Procedure:

Cooperating farmers were selected that use starter fertilizer on their row crops. They were asked to leave five strips without starter fertilizer that were each approximately 150 feet in length. Strips were alternated with strips with starter fertilizer (each one-planter width). Thus, each no-starter strip was bordered on both sides with starter fertilizer. Measurements were made on ten pairs of two-row plots. Information was obtained from each farmer to determine the analysis and rate of fertilizer used. In all cases, the fertilizer contained N and P. In some cases, K, S and Zn were also included. County agents collected most of the data prior to harvest. Soil temperature was determined at planting time and again two weeks after planting. Separate soil samples (0-6 inches deep) were collected from each of the no-starter strips. Plant counts per 40 feet of row were taken in the starter and no starter rows in each of the ten pairs of plots. Plant height measurements were taken 30-40 days after planting. Grain yields for corn were determined by harvesting two 25-foot lengths of row in each of the ten pairs of comparisons (two 15-foot rows for grain sorghum). Grain moisture was determined at harvest time.

Experimental Results:

Information was collected from sixteen corn trials and three grain sorghum trials. Data are summarized in Table 1. Locations are listed in order of increasing soil phosphorus. For the corn sites, phosphorus ranged from 7 to 156 ppm phosphorus. For grain sorghum, the range was 8 to 26 ppm phosphorus.

Corn Experiments. Early growth measurements were obtained at nine locations, and at seven of these, there was a significant increase in early growth as a result of applied starter fertilizer. This growth response appears to be independent of soil phosphorus level. Grain yields were high in 1986 with a range of yields from 100 bushels per acre at a site in Washington County to 176 bushels per acre at a site in Boone County. Average yield for the sixteen sites was 152 bushels per acre. Seven sites were irrigated (162 bushels per acre average yield) and nine sites were non-irrigated (145 bushels per acre average yield).

Even though significant increases in early growth were observed at seven sites, grain yield was not influenced by starter fertilizer at any of these sites. Grain yield was increased at three sites. Two of these were low phosphorus sites (7 and 10 ppm P) and one was a high phoshorus soil (39 ppm P). This high P site was the one with low grain yields.

Grain moisture at harvest was reduced by starter fertilizer at five sites and all of these had soil phosphorus levels in the low range (6-15 ppm P). Moisture reduction, though significant, was slight (1% or less). Starter fertilizer increased grain moisture slightly at three sites (0.7 to 0.9%) and these sites had phosphorus levels of 20 ppm P or higher.

Grain Sorghum Experiments. Starter fertilizer increased the early growth of grain sorghum at one site where measurements were taken; however, there was no effect of starter fertilizer on grain yield or grain moisture at any of the three sites. Yields were high at all sites with a range in yield of 91 to 96 bushels per acre.

Table 1. Influence of starter fertilizer applied by producers on early growth, grain yield and grain moisture of corn and grain sorghum, 1986.

Location	Soil P, ppm	Early Growth, % Increase	Grain Yield, bu/ac Increase	Grain Moisture, % Change
		Corn		
Boone (Stuhr)	7	5	17*	0.0
Franklin (Bislow)	10	-	25*	-0.7*
Saunders (Kucera)	10	21*	5	-1.0*
Saunders (Sladky)	13	17*	-7	0.5
Saline (Wilkens)	13	-	0	-0.5*
Dodge (Parr)	13	32*	-2	-0.7*
Dodge (Poppe)	14	24*	-2	-0.5*
Burt (Chamberlain)	18	1	2	-0.1
Gage (Bartling)	18	-	0	0.0
Saline (Hanson)	20	-	7	1.0*
Saunders (Kremlacek)	30	15*	1	0.0
Boone (Briese)	36	7*	-8	0.1
Washington (Moss)	39	-	12*	0.9*
Hamilton (Parpart)	42	28*	-2	-0.2
Washington (Schjodt)	43	-	4	0.7*
Douglas (Magee)	156	-	1	0.0
		Grain Sorghum		
Saunders (Tvrdy)	8	11*	-2	-0.7
Saunders (Moravec)	19	3	-1	0.2
Gage (Wollenburg)	26	-	0	0.3

*Significant effect from starter fertilizer (P = .10)

Long Term N Rate Study at North Platte

Gary W. Hergert and Philip H. Grabouski

Objective

Determine N rate required to produce maximum yield on a Cozad silt loam soil.

Procedure

As a part of the Soil Test Lab Comparison Study which was initiated at North Platte in 1974 a N Rate Study with N rates of 0, 100, 200, and 300 pounds of N per acre was designed with the study. The area has been in continuous corn since 1974. Since 1982 nitrogen analysis on the grain has been done to determine the N removal from this continuous corn production system. Yields through 1980 were reported in the 1980 Soil Science Research Report. In addition that year soil samples were taken from the surface to the water table (12 feet) in the spring from each treatment over reps. Nitrate content was shown for all plots.

Using the nitrogen removal in the grain provides a method for determining apparent nitrogen use efficiency and also for determining long rate mineralization potential of this soil. The term "apparent" must be stressed because in a long term study such as this there are influences especially after 13 years of continuous corn production. Continuous corn production on this soil and the nitrogen fertilization has influenced both the pH and the soil organic matter level (Table 1).

The yield data showed that the 100 pound annual nitrogen rate comes very close to maximizing the yield. Results from the UNL plot in the Soil Test Lab Comparison Study that has had an adjusted N rate based on residual nitrogen since 1978 has shown that the maximum yield has been attained with about a yearly average of 125 pounds of N per acre.

The apparent nitrogen use efficiency was near 50% at the N rate to obtain maximum yield. The nitrogen applied to this plot was applied at planting as broadcast ammonium nitrate. Later application time probably would have enhanced the nitrogen use efficiency especially of the lower rate. The 200 pound N rate is very typical of farmer practice in this area and probably reflects the current nitrogen use efficiency that is attained on the farm.

The average N removal in the check plot over the last 5 years is 60 pounds of N per acre. The organic matter content of 1.5% translates into an apparent mineralization of about 40 pounds of N per percent organic matter. If this value is used for the other N rate plots a slightly lower apparent nitrogen use efficiency is shown than in Table 2. For the 100 pound N rate the value is 44% for 200 pounds of N 25% and for 300 pounds of N 19%.

Since Allison wrote The Enigma of Soil Nitrogen Balance Sheets in 1955 we still have a long way to go in understanding what is happening to all the N we apply.

Table 1. Soil analyses of Grabouski long term N rate study for spring 1986.

N Rate	Check		100		200		300	
Rep	% O.M.	pH	% O.M.	pH	% O.M.	pH	% O.M.	pH
I	1.31	7.7	1.74	6.9	1.82	6.5	1.71	6.2
II	1.55	7.6	1.47	7.4	1.79	6.4	1.84	5.8
III	1.55	7.4	1.71	6.8	1.63	6.6	1.79	6.4
IV	1.55	7.4	1.48	7.2	1.66	6.7	1.63	6.1
Avg	1.49	7.5	1.60	7.1	1.73	6.6	1.74	6.1

Table 2. Yields and N removal from N rate study.

	lbs N/A				Grain N uptake			
N Rate	0	100	200	300	0	100	200	300
Year	bu/A				lbs/A			
1982	126	171	162	158	68	100	100	107
1983	92	145	159	164	49	88	102	110
1984	109	176	196	197	55	107	131	134
1985	116	180	184	185	63	115	130	133
1986	121	206	211	219	62	128	134	149
Average	112	176	182	185	60	108	119	127
Relative yield	61%	95%	98%	100%	-	-	-	-
Apparent N use efficiency	-	-	-	-	-	48%	30%	22%

Nitrogen and Irrigation Management Demonstration Project

Gary W. Hergert. Norman L. Klocke, and Phil Menke

Objective

Determine whether the use of deep sampling for residual nitrate and improved irrigation management based on irrigation scheduling can help cut production costs and nitrogen leaching for furrow irrigated corn in the Platte Valley.

Procedure

Much of the irrigated corn in the Platte Valley is on fine textured soils that has a water table anywhere from 3 to 10 feet below the soil surface. Deep sampling for residual nitrate can help improve nitrogen fertilizer management especially when coupled with improved irrigation management. A furrow irrigated Hord silt loam on the Clarence Stearns farm was selected for this study. The row length was 1640 feet. Corn variety Sakota 680 was planted April 18. Soil samples from the area indicated a water table at about 5 feet. In the top 44 inches of surface soil about 80 pounds of nitrate nitrogen was available (Table 1). A replicated nitrogen rate strip study was used with the following treatments: (1) a check which was to receive no nitrogen, (2) a nitrogen rate based on the residual nitrate value, and (3) a nitrogen rate based on standard farmer practice. The N rate based on residual nitrate for a yield goal of 150 bushel corn was 120 pounds of nitrogen per acre.

The farmer normally applies about 180 pounds of nitrogen per acre. The field received sidedressed ammonia on June 13, 1986. Several attempts were made to calibrate the NH_3 application to attain the desired N rates. After setting the rates, however, and applying all of the strips in the field it was found that a higher nitrogen rate was applied. The lower nitrogen rate actually received 175 pounds of N per acre and the higher nitrogen rate received about 240 pounds of nitrogen per acre. After applying the N we learned that the farmer had already applied 30 pounds of nitrogen as nitrogen solution with the herbicide. This gave nitrogen rates of 30, 200 and 270 pounds of nitrogen per acre.

The irrigation management for the field was monitored but no changes were made in the cooperator's normal practices. The field was irrigated in 12 hour sets with a well that delivered 900 gallons of water per minute. Twenty out of forty rows (every-other row) were irrigated in one set. As a result the pump delivered an average of 6.4 inches of water to the field during each irrigation. With seven irrigations at approximately 10 day intervals, the pump delivered 44.8 inches of water to the field over the season. Assuming that 30% of the pumped water was runoff, 31.4 inches of the irrigation water stayed on the field.

During June 12 through September 10, 1986, data from research plots at WCREC (within 5 miles of the Stearns field) showed that fully irrigated corn used 22.4 inches of water for evapotransporation (ET) and received 6.5 inches of rainfall. This information suggests that 15.5 inches of water leached below the root zone in the Stearns field during the growing season. The amount of leaching was derived from the following: Leaching = Gross Irrigation + Rainfall - Runoff - ET (15.5 in = 44.8 in + 6.5 in - 13.4 in - 22.4 in).

The relationship between gross irrigation (water delivered to the field) and net irrigation (water used by the crop) for the Stearns field was typical of surface irrigation using gated pipe and no reuse pit. Half of the pumped water was lost due to runoff or leaching. In this case the relatively flat slope of the field and the fixed duration (12 hours) and fixed frequency of irrigation (every 10 days) limit possibilities for improving irrigation efficiency. The first way to improve irrigation efficiency would be to vary the frequency of irrigation based on the need for water in the crop root zone. Over the season one or two irrigations may be eliminated. The efficiency of individual irrigations would not improve, but the seasonal efficiency would improve.

On October 29 the plots area was harvested. Six rows were combined out of each strip through the length of the field, dumped into a weigh wagon, sampled for moisture and weighed. The data are shown in Table 2. The check plot yielded about 100 bushels per acre. The addition of 200 pounds of N increased the yield averaged across the strips to 145 bushels per acre. The extremely high nitrogen rate actually decreased yields compared to the 200 pound N rate. The data do show that the residual nitrate level and the mineralization from this soil can sustain a fairly good yield. The nitrogen response, however, was not as great as expected. Soil analysis (Table 1) showed that the phosphorus level was somewhat low for optimum production. This may have influenced the yield potential. The over-irrigation may also have contributed to lower yield. The yield level shows, however, that a much lower nitrogen rate could have been used to attain the yield goal if water management were improved. The yield goal was 150 bushels per acre and the actual yield represented about 96% of the yield goal.

During December, 1986 the check plots and the high nitrogen rate plots were sampled in a grid pattern on all reps. Four holes per strip were taken to assess the variability in nitrate through the field. There was a definite gradient in nitrate levels from the upper end of the field to the lower end of the field (Table 3). More residual nitrogen was left in the higher nitrogen rate although a considerable amount was leached. The highest amount of carry-over nitrogen was at the lower end of the field. The upper end of the field indicated that most of the nitrogen had been leached because the check and the high nitrogen rate were essentially the same.

Plotting of the data (Figure 1) dramatically shows the influence of the irrigation water management. The data indicate that we still have a long way to go in improving irrigation management to make better use of applied nitrogen fertilizer.

Table 1. Soil analysis of Clarence Sterns Field.

	pH	% O.M.	Bray P	NO_3 0-8"	NO_3 8-24"	NO_3 24-44"	Total
NW	6.6	1.7	8	7	6	5	60
NE	7.0	2.7	20	10	7	6	88
SW	6.5	1.4	16	6	7	6	84
SE	6.5	1.3	11	7	7	7	84
Average	6.7	1.5	14	5	7	6	79

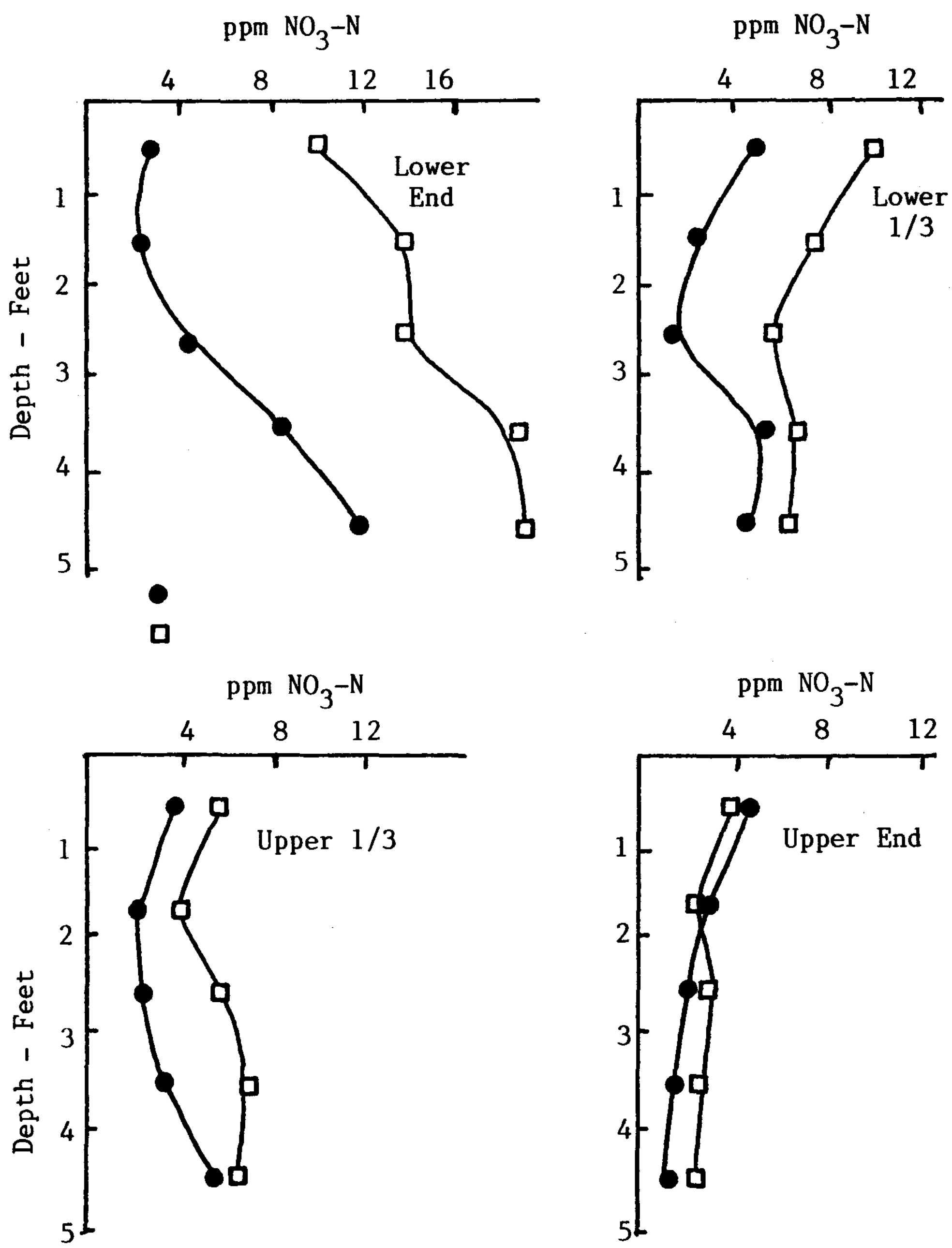
Table 2. Grain yields (#2 corn) and moisture.

N rate	Check	200	270	Check	200	270
	bu/A			% Grain moisture		
Rep I	80	146	135	17.6	17.3	17.3
Rep II	107	132	135	19.0	18.2	18.7
Rep III	99	159	140	18.3	18.3	18.3
Rep IV	120	143	139	18.4	18.0	17.5
Average	101	145	137	18.3	18.0	18.0

Table 3. Soil NO_3 levels - Stearns field - December 1986.

	Lower		Mid-Low		Mid-Upper		Upper	
N rate	0	270	0	270	0	270	0	270
	ppm NO_3-N							
0-1	2.6	9.6	4.7	10.1	4.1	5.9	4.9	3.8
1-2	2.3	14.5	2.4	7.3	2.5	4.1	2.7	2.5
2-3	4.1	14.3	1.4	5.4	2.6	6.2	2.1	2.7
3-4	8.5	16.8	5.4	6.5	3.4	6.9	1.5	3.7
4-5	11.1	16.9	4.2	5.9	4.9	5.7	1.3	3.3
lbs/5'	103	260	65	127	63	104	45	58

Figure 1. Nitrate distribution for Stearns N demonstration plot.



Nitrogen Fertilization of Smooth Brome

R. B. Ferguson

Objective: To evaluate the long-term effects of nitrogen fertilizer rate, source and application method on the yield and nitrogen use efficiency of smooth brome.

Location: The U.S. Meat Animal Research Center, adjacent to the South Central Research and Extension Center farm, Clay Center.

Procedures: Three nitrogen fertilizer rates (50, 100 and 150 lb N/A) were applied with three nitrogen sources (ammonium nitrate (AN), urea, and UAN solution). The UAN solution was applied by two methods, broadcast (BR) and knifed in (KN) on 15 inch centers. Two checks were included, an untreated check and a knife-treated check. The study site is located on a Crete silt loam soil.

Experimental results: Treatments were applied relatively late (April 11). There were also residual effects of manure patches which resulted in uneven growth across the plots, and relatively large C.V. values for the study. The knife treatments had obviously less growth than broadcast treatments at the same N rate. This difference carried through to harvest (Table 1). A possible reason for the poor performance of the knife treatments may be root immobilization of the applied N with little translocation to above ground growth. This study will be continued for several years, with the addition in 1987 of a surface band application of UAN solution.

Table 1. Comparison of nitrogen rates, sources and application methods for smooth brome, Clay Center, NE.

Trt.	N Rate lb/A	N Source	Method	Forage Yield lb/A @ 12.5% H_2O	Forage Percent N	Percent Apparent N Recovery
1	Check	-----	-----	4920	1.17	-----
2	Kn Check	-----	-----	3657	1.41	-----
3	50	AN	BR	8804	1.38	-----
4	100	AN	BR	10315	1.49	-----
5	150	AN	BR	11499	1.86	-----
6	50	UREA	BR	6637	1.40	-----
7	100	UREA	BR	9337	1.41	-----
8	150	UREA	BR	9194	1.71	-----
9	50	UAN	BR	7731	1.33	-----
10	100	UAN	BR	8765	1.60	-----
11	150	UAN	BR	10542	1.67	-----
12	50	UAN	KN	3883	1.54	-----
13	100	UAN	KN	6308	1.55	-----
14	150	UAN	KN	5242	2.05	-----
		LSD (0.05)		2154	0.28	
		F VALUE		5.61	2.68	
		C.V.		28.2	18.1	

Mean Values

		Forage Yield	Forage Percent N	Percent Apparent N Recovery
<u>N Rate</u> (BR)				
50		7724 b	1.37 b	98.4 a
100		9472 a	1.50 b	86.8 a
150		10412 a	1.74 a	87.8 a
	PR > F	0.012	0.013	0.704
	C.V.	22.5	18.9	41.1
<u>N Source</u> (BR)				
AN		10206 a	1.58 a	113.1 a
UAN		9013 a	1.53 a	87.3 ab
UREA		8389 a	1.50 a	72.6 b
	PR > F	0.111	0.836	0.040
	C.V.	22.5	18.9	41.1
<u>Method</u> (UAN)				
BR		9013 a	1.53 a	87.3 a
KN		5145 b	1.71 a	30.6 b
	PR > F	0.0007	0.134	0.0066
	C.V.	32.6	17.6	76.2

A Cropping Systems Approach to Soil and Water Conservation

G. W. Hergert, N. L. Klocke, P. T. Nordquist, G. A. Wicks, and R. T. Clark

Objectives

1. Determine the yield potential and net returns of corn, wheat, sorghum and soybeans in different crop rotations.

2. Compare the irrigation water use efficiencies of the various crops in the different rotations.

3. Evaluate sorghum and soybean varieties to maximize yield while maintaining harvest timing necessary for wheat planting.

The overall objective is to test the feasibility of producing corn, wheat, soybeans, and sorghum which receive no irrigation (continuous dryland), limited irrigation (6 inches), and full irrigation in a 19 inch annual rainfall zone.

Four crop rotations used in this study are winter wheat-corn-soybeans, winter wheat-corn-sorghum, winter wheat-sorghum, and continuous corn. These rotations were established on the limited irrigated block in 1981. The dryland block was established in 1982 and the fully irrigated block was established in 1984. Each crop of each rotation is present each year and all treatments are replicated four times. Whole plots are divided to evaluate varieties or other cultural practices. Limited irrigation management has been coupled with season-long water conservation techniques from the ecofallow system.

All crops are planted using conventional planters modified to plant in no-tillage. Row applied fertilizer to supplies a small amount of nitrogen and phosphorus based on soil tests at planting. Nitrogen is broadcast for corn and sorghum in the spring using ammonium nitrate. N rate is based on residual nitrate levels in the soil. Winter wheat receives a spring top-dressing of nitrogen as ammonium nitrate with the N rate determined by a soil test. For winter wheat going into past soybean plots, plots are split and receive either 0, 30 or 60 pounds of N per acre.

Preplant irrigation for the wheat generally is applied to the maturing soybeans or sorghum. This allows for sufficient soil drying before the soybean or sorghum harvest but provides good soil moisture at planting time of the winter wheat which follows soybean or sorghum harvest by only 2 or 3 days. The remaining irrigations are applied the following spring depending upon rainfall. Irrigations for wheat are applied during preboot and heading. During the last 5 years the total of 6 inches of water for the limited irrigate was used only 3 years. During other years rainfall was sufficient and irrigation was unnecessary. The same general procedure is followed for the fully irrigated wheat except in drier years more spring irrigation is applied and the irrigation begins at about the joint stage.

The limited irrigated corn usually is not irrigated until tassel or silk emergence. Stored soil moisture is usually sufficient to allow crop development without too much stress during the vegetative phase. Irrigations of 1.5 to 2 inches are applied at silk emergence and then at approximately 2 week intervals with the final irrigation occurring during the grain fill period.

Fully irrigated corn is irrigated based on evaporative demand. Limited irrigated soybeans receive their first irrigation in the early pod elongation period. Irrigation amount is 1.5 to 2 inches timed at 2 week intervals. For the limited irrigated sorghum the first irrigation is at the boot stage and it proceeds at 2 week intervals. Fully irrigated soybeans and sorghum are provided water to meet evaporative demand.

Research Results - Crop Yields

Yields for the dryland and limited irrigation treatments have been collected for 4 and 5 years, respectively (See Table 1). To simplify presentation, data have been averaged over varieties. The average yearly rainfall four of the five crop moisture years (Sept. 1 to Aug. 31) was about 1 inch above the long term average of 19.3 inches per year at North Platte. During 1985 precipitation was 3 inches below normal, however in this exceptionally dry year there was not a crop failure on the dryland crops.

Because of the high pH (7.5) of this Cozad silt loam, herbicide selection and use is a challenge. Two out of five years there has been damage or loss of the soybean crop due to herbicide (Sencor) damage. Where soybeans survived the yields were very good and weed control was excellent. Soybeans in the wheat-soybean rotation were killed in 1983; whereas, soybeans in the wheat-corn-soybean rotation were killed in 1986. If a given crop is lost due to herbicide damage it may or may not have an influence on the following crop. The dryland winter wheat yields in 1984 following the wheat-soybean rotation were not affected by the lack of the soybean crop in 1983. Winter wheat yields in the same wheat-soybean rotation under limited irrigation showed a higher yield than the plots where the soybeans were present before the wheat crop.

To date no significant rotation effects have been shown on either the winter wheat or the soybean yields. A significant rotation effect was apparent for the corn. The dryland continuous corn had less available moisture than the corn in wheat-corn-soybean rotation. Standing wheat stubble had a better opportunity to accumulate moisture during the late fall and winter than the continuous corn stubble. Even in an above average precipitation year (1985) corn following wheat had greater early growth. Although the yields of the dryland continuous corn were quite good considering this limited rainfall area they did not match those of corn in the wheat-corn-soybean rotation. The limited irrigated corn showed the same beneficial rotation effect.

Irrigated corn has the highest water use among the crops. No rotation effects have been shown for the fully irrigated corn because the rotations have been established only 3 years. The fully irrigated corn received 13.6 inches of irrigation in 1985 and 15.7 inches in 1986 (Table 2). The production levels attained for the various crops in the different rotations are encouraging because they indicate that management of this no-tillage cropping rotation can produce high yields.

The wheat yields have been somewhat lower than might be expected but winter wheat is planted following soybeans or sorghum about the first of October. Winter wheat is normally planted during the middle to the 20th of September in this area. The 2 week delay may reduce yield potential. This is one limitation of the crop rotations. The advantage of the system, however, is the additional moisture storage for crops following the winter wheat and the soil conservation aspect of maintaining the standing stubble.

Irrigation Water Use Efficiency

For purposes of this discussion, irrigation water use efficiency (IWUE) was defined as follows:

$$\text{IWUE (Limited Irr.)} = \frac{\text{Limited Irrigation Yield - Dryland Yield}}{\text{Limited Irrigation - Dryland Irrigation (0)}}$$

$$\text{IWUE (Full Irr.)} = \frac{\text{Full Irrigation Yield - Limited Irrigation Yield}}{\text{Full Irrigation - Limited Irrigation}}$$

In this context irrigation water use efficiency is the return in yield for the irrigation water applied over and above the other water treatment level in each of the respective equations. How much yield was gained from adding each increment of irrigation water? The results are in Table 3. Irrigation returned positive yield gains in all cases except fully irrigated wheat. IWUE was greater for limited irrigated corn and soybeans than for fully irrigated corn and soybeans. There was more soil moisture left in the root zone at the end of the season in the fully irrigated than in the limited irrigated plots, which contributed to lower IWUE in the fully irrigated plots. The IWUE then can be used to evaluate the economics of pumping water for either limited or full irrigation. Can the extra yield return offset the extra pumping and operating costs? Fully irrigated wheat cannot be justified. The other cases need more evaluation and production history.

Summary

The limited irrigation cropping system research at North Platte has demonstrated that continuous crop rotations including winter whet and row crops have possibilities for stretching limited water supplies. The goals have been to conserve all water with no-till farming and crop residue management and to apply water when the best potential yield benefit occurs. Timely management of all operations is critical for the system to work. Soybean weed control in the no-till environment is still the most troublesome cultural practice.

The other limitation to the system was pointed out by Gilley et al (1980): "Where climatic conditions are more extreme in terms of water demand during the vegetative period, one would expect depression if extreme drought stress occurred during vegetative development. However, our results suggest that some water savings can be obtained with little negative effect by permitting moderate stress development during early growth periods. The hazard involved is in not getting irrigation started soon enough so as to avoid excessive stress during the pollination period. We emphasize that early stress development can be encouraged only where there is an ample soil water supply so that stress will come on gradually rather than rapidly."

Challenges remain with the limited irrigation cropping system, however there are possibilities for the approach in areas of limited water allocations.

Reference

Gilley, J. R., D. G. Watts, and C. Y. Sullivan. 1980. Management of irrigation agriculture with a limited water and energy supply. FINAL REPORT to the OLD WEST REGIONAL COMMISSION. Project No. 10670259.

Table 1. Grain yields from cropping system research at North Platte, NE.

CORN YIELDS

Rotation	Dryland Cont. Corn	Dryland W-Corn-Soy	Limited Irrig. Cont. Corn	Limited Irrig. W-Corn-Soy	Fully Irrig. Cont. Corn	Fully Irrig. W-Corn-Soy
Year	bu/A				bu/A	
1982	-	-	128	140	-	-
1983	72	75	117	123	-	-
1984	72	77	129	131	-	-
1985	36	42	125	135	165	159
1986	78	100	135	155	179	185
4 year avg (82-86)	65	74	127	137	-	-
2 year avg (85, 86)	57	71	130	145	172	172

WHEAT YIELDS

Rotation	Dryland Wht-Corn-Soy	Dryland Wht-Soy	Limited Irrig. Wht-Corn-Soy	Limited Irrig. Wht-Soy	Fully Irrig. Wht-Corn-Soy	Fully Irrig. Wht-Soy
Year	bu/A					
1982	-	-	50	58	-	-
1983	35	33	63	67	-	-
1984	66	65**	63	75***	-	-
1985	30	24	83	81	79	74
1986	62	53	67	59	62	63
4 year avg (82-86)	48	44	69	71	-	-
2 year avg (85, 86)	46	39	75	70	71	69

SOYBEAN YIELDS

Rotation	Dryland Wht-Corn-Soy	Dryland Wht-Soy	Limited Irrig. Wht-Corn-Soy	Limited Irrig. Wht-Soy	Fully Irrig. Wht-Corn-Soy	Fully Irrig. Wht-Soy
Year	bu/A					
1982	-	-	53	55	-	-
1983	21	(21)*	50	(50)*	-	-
1984	31	25	54	57	-	-
1985	19	29	47	50	61	69
1986	(46)*	46	(62)*	62	67	67
4 year avg (82-86)	29	30	56	57	-	-
2 year avg (85, 86)	33	38	55	56	64	68

*Herbicide damage - value calculated as missing plot

**No 1983 Soybean crop had no influence on 1983 wheat yield

***No soybean crop in 1983 significantly increased 1984 wheat yield

Table 2. Irrigation applied on cropping system research at North Platte, NE.

	CORN		WHEAT		SOYBEANS	
	Limited Irrig.	Full Irrig.	Limited Irrig.	Full Irrig.	Limited Irrig.	Full Irrig.
1985	6.1	14.0	5.8	8.5	6.1	11.9
1986	6.1	15.7	3.8	3.8	6.1	13.0
Average	6.1	14.9	4.8	6.2	6.1	12.5

Table 3. Irrigation water use efficiency for cropping system research at North Platte, NE.

	IRRIGATION WATER USE EFFICIENCY FOR CORN			
	Limited Irrig.		Fully Irrig.	
Rotation	Cont. Corn	W-Corn-Soy	Cont. Corn	W-Corn-Soy
Year	----------bu/inch----------			
1985	14.5	15.2	5.1	3.1
1986	9.3	9.0	4.5	3.1
2 year avg (85, 86)	11.9	12.1	4.8	3.1

	IRRIGATION WATER USE EFFICIENCY FOR WHEAT			
	Limited Irrig.		Fully Irrig.	
Rotation	Wht-Corn-Soy	Wht-Soy	Wht-Corn-Soy	Wht-Soy
Year	----------bu/inch----------			
1985	9.1	9.8	0.0	0.0
1986	1.3	1.6	0.0	0.0
2 year avg (85, 86)	5.2	5.7	0.0	0.0

	IRRIGATION WATER USE EFFICIENCY FOR SOYBEAN			
	Limited Irrig.		Fully Irrig.	
Rotation	Wht-Corn-Soy	Wht-Soy	Wht-Corn-Soy	Wht-Soy
Year	----------bu/inch----------			
1985	4.6	3.4	2.4	3.3
1986	2.6	2.6	0.4	0.4
2 year avg (85, 86)	3.6	3.0	1.4	1.9

DYNAMICS OF WATER IN RIGID AND SWELLING SOILS

D. Swartzendruber

Objective:

The general objective of this report is to analyze and quantify the processes by which water flows into and through porous media and soils under both saturated and unsaturated conditions. Swelling and nonswelling soils are considered.

Procedure:

As far as reasonably possible, each flow process is approached as a mathematical boundary-value problem to be solved by classical mathematical means or by computer if necessary. Experiments are conducted in the laboratory with vertical flow columns on which measurements of water content and soil bulk density are obtained by the attenuation of dual-energy gamma radiation. Other flow measurements are taken as needed.

Results and Discussion:

Further investigation has been carried out on the quasi solution for water infiltration into soil. Simplification of mathematical form has been achieved by reducing the number of terms in the primary exponential function from the 3 originally employed to 2, and then to 1. The maximum error in describing water-content profiles changed from about 2% for the 3-term case to 3% and 6% for the 2- and 1-term cases, respectively. Even this largest error may not be excessive, especially when variable field data are being analyzed. The quasi solution (3-term case) was also found to predict abrupt, step-function water-content profiles when applied to the Green and Ampt model of infiltration, thus demonstrating further the versatility of the quasi solution.

Water entry into initially air-dry, 1:1 mixtures of Wyoming bentonite and coarse quartz silt has been measured extensively in laboratory experimentation. Extensive analysis of the data has been rather successfully carried out, on the basis of a new mathematical solution based on the material coordinate. Within the framework of the solution, several functions have been devised that coalesce the experimental data very well. In a separate theoretical study, another approach has been employed that simply uses the ordinary spatial coordinate instead of the material coordinate. This approach has also been capable of coalescing the data effectively, and would appear to be capable of easier conception and use than the material coordinate. Though preliminary, the approach appears worthy of maximum exploitation to establish its character and applicability. Finally, some new terms for swelling media have been proposed and published.

THE ECONOMIC EFFECTS ASSOCIATED WITH THE USE OF A ROOTPLOW ALONG TREE WINDBREAKS IN NORTHEAST NEBRASKA

S.D. Rasmussen and C.A. Shapiro

Objective: To determine the most efficient use of a rootplow along field windbreaks. Soil moisture, crop growth and yields associated with the reduction in tree root competition for available moisture are being evaluated.

Procedure: Along approximately 6,000 feet of windbreak systems, four different 100 foot treatments and a control were established in a total of 12 replications along the north and south sides of the east-west oriented windbreaks adjacent to dryland cropfields. The multi-rowed windbreaks were all chosen for consistency in design and age. Composition consisted of predominately outside rows of Siberian elm with Black locust, Mulberry, Green ash and Redcedar also present within the system. Average height is 30-40 feet tall. Soil classification is a Thurman loamy fine sand. The rootplow used was a three-point hitch mounted blade furnished by the Nebraska Game and Parks Commission.

The treatments consisted of rootplowing combinations of either 12" or 24" depth and either at 20' from the adjacent outside tree row (approximate dripline), or 40' from the adjacent outside tree row (approximately 1-1 1/2 x the height of the trees). Crop measurements were collected in the center of the treatment units at a distances of 25', 45', and 65' from the adjacent outside tree row. Soil moisture data was collected at the aforementioned distances at 6", 18", and 30" depths.

Results and Discussion: Although a statistical analysis has not been completed, and 1986 was considered a relatively "wet" year, there were some noticeable differences in a number of the evaluations that were collected on the grown crop (soybeans) on the south side of the windbreak systems. Single degree of freedom contrasts (alpha = 0.10) showed the shallow (12") and short (20') treatment had greater yields than the control at 45', 65' from the tree rows.

The results presented here would be greater in magnitude during a normal or drier growing season. Also, more drought sensitive crops will respond to the "sapping" effect the rootplowing reduces. This experiment will be continued during the 1987 growing season.

TABLE 1: Effect of rootplow treatments on soybean yields. Pierce County 1986.

Treatment	Distance From Tree Row 25'	45'	65'
Control	16.0	20.6	23.0
12" depth, 20' distance	12.9	25.6	31.0
12" depth, 40' distance	15.0	18.8	30.1
24" depth, 20' distance	13.8	19.8	26.7
24" depth, 40' distance	10.5	21.5	26.7
ANOVA for treatments	NS	S	NS
Alpha = 0.10			