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Soil Science Research Report - 1982

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DEPARTMENT OF AGRONOMY
UNIVERSITY OF NEBRASKA-LINCOLN
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SOIL SCIENCE RESEARCH REPORT - 1982

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IMPROVING NITROGEN FERTILIZER RECOMMENDATIONS FOR CORN

E.J. Penas and G.W. Rehm

Objectives:

1. Improve the accuracy of nitrogen recommendations and thereby improve net profit per acre in growing corn and reduce potential hazards of nitrogen pollution.

2. Relate grain yield increase from applied nitrogen to soil organic matter, residual soil mineral nitrogen, nitrates in irrigation water and other selected soil parameters.

3. Study the relationship of nitrogen concentration in leaves at silking time to the rate of nitrogen fertilizer applied in an attempt to define a critical level of nitrogen in leaf tissue.

Procedure: This study included 8 experimental plots selected in District III and V. Data were collected from all 8 sites. Other experiments with nitrogen rates and carriers on corn were conducted in 1982 and are being reported separately by the researchers involved. At three sites, experiments were conducted in two fields side-by-side where one field was in corn the previous year and the other was in soybeans.

Soil samples were collected to a depth of 6 feet at each site. The surface samples were analyzed for pH, nitrate-nitrogen, phosphorus, potassium, zinc and organic matter. Subsurface samples were analyzed for nitrate-nitrogen. These soil test data are reported in the accompanying tables.

Nitrogen fertilizer as ammonium nitrate was applied pre-plant or shortly after planting. Rates in 20 or 40 pound increments were used.

Plant and leaf samples were collected during the growing season and are being analyzed for nitrogen. Grain yields were determined and are reported at 15.5% moisture in the accompanying tables.

Results and Discussion: Nitrogen fertilizer increased the grain yield of corn at all sites except one. The non-responsive site had almost 200 pounds of nitrate-nitrogen in the 6-foot depth of soil. The responsive sites had lower levels of soil nitrogen -- 47 to 114 pounds per acre 6-foot of soil.

Corn yields were higher following soybeans rather than following corn when no nitrogen was applied. This difference was not predicted on the basis of soil nitrates. Nitrogen available for crop use must be present in some form other than nitrate. Also, grain yields from the optimum rate of nitrogen were higher following soybeans than following corn at 2 of the three locations where these comparisons were made.

These data show that soil nitrate-nitrogen does influence the amount of nitrogen fertilizer needed for optimum yields. They also show the benefit of soybeans in rotation; however, the contribution of soybeans is not consistant across locations. This aspect needs more study.

This research was supported impart by a grant from the Nebraska Corn Development, Utilization and Marketing Board.

NITROGEN ON CORN, 1982
SOIL TEST DATA

County & Cooperator	Soil pH	Nitrogen, lbs/ac 6 ft.	Phosphorus, ppm	Potassium, ppm	Zinc, ppm	Organic Matter, %
Burt						
Preston						
Corn	5.8	93	52 VHi	241 VHi	11.1 Hi	3.7
Soybeans	5.9	95	42 VHi	223 VHi	12.6 Hi	3.3
Butler						
Medinger						
Corn	5.8	74	11 Low	447 VHi	4.5 Hi	3.3
Soybeans	5.7	114	17 Med	533 VHi	3.9 Med	3.3
Saunders						
Hanson						
Corn	6.3	69	30 Hi	521 VHi	5.6 Hi	3.4
Soybeans	5.9	74	25 Hi	465 VHi	4.7 Hi	2.8
Northeast Station						
NSI (corn)	7.8	47	3 VLo	427 VHi	7.0 Hi	3.8
NSII (corn)	6.1	196	9 Low	246 VHi	7.5 Hi	2.7

NITROGEN ON CORN
GRAIN YIELDS

County:	Burt	Burt	Butler	Butler
Cooperator:	Preston	Preston	Medinger	Medinger
Previous Crop:	Corn	Soybeans	Corn	Soybeans
Nitrogen Rate, lbs/ac.	---------Grain Yield, bu/ac.-------------			
0	81	93	108	165
20	92	97	125	169
40	105	107	138	172
60	117	118	148	174
80	126	127	155	176
100	131	130	158	176
120	129	125	159	176
140	--	--	156	175
Response:	Yes	Yes	Yes	Yes
Soil NO_3-N, lbs/ac. 6 ft:	93	95	74	114
Starter N, lbs/ac.	0	0	7	7
N in Water:	Non-Irrigated		?	?

Location:	NS-I	NS-II
Previous Crop:	Corn	Corn
Nitrogen Rate, lbs/ac.	--Grain Yield, bu/ac.--	
0	69	88
20	74	88
40	77	84
60	80	86
80	81	87
100	82	87
120	83	88
Response:	Yes	No
Soil NO_3-N, lbs/ac. 6 ft:	47	196
Starter N, lbs/ac.	0	0

NITROGEN ON CORN, 1982
GRAIN YIELDS

County:	Saunders	Saunders
Cooperator:	Hanson	Hanson
Previous Crop:	Corn	Soybeans
Nitrogen Rate, lbs/ac.	--Grain Yield, bu/ac.--	
0	87	119
40	117	137
80	132	146
120	137	148
160	136	146
200	132	143
240	129	142
280	131	144
Response:	Yes	Yes
Soil NO_3-N, lbs/ac. 6 ft:	69	74
Starter N, lbs/ac:	0	0
N in Water:	0 ppm	0 ppm

THE INFLUENCE OF 7-21-7 PLUS AMMONIUM THIOSULFATE KNIFED-IN WITH ANHYDROUS AMMONIA ON YIELD OF IRRIGATED CORN GROWN ON CALCAREOUS SOIL

K. D. Frank

Objective:

Continue to evaluate (on calcareous soils with pH in excess of 7.7) the influence of a knifed-in (8 to 10 inches deep) mixture of nitrogen, phosphorus, and ammonium thiosulfate with anhydrous ammonia on irrigated corn yield.

Procedure:

The response from irrigated corn on high pH calcareous soils to an acid-forming product like ammonium thiosulfate when knifed-in with phosphorus and/or ammonia has not been consistent on experiments conducted on these soils during the last four years. Positive yield responses have been observed on some experiments while on others no response is observed. However, there have been no indications of yield reduction due to knifing-in the material.

This experiment was established on the Harrison Sear farm on a loam to sandy loam soil. Each plot was six, 36-inch rows by approximately 1,100 feet long. All treatments were replicated 3 times. Mr. Sear planted the field in early June. The treatments were applied on June 24; leaf samples taken on July 30. On August 2, 80 pounds of N were applied to small plots within the check plots. The plots were combine-harvested on October 27. The small nitrogen plots were hand-harvested.

Mr. Sear and Fox Grain of Gibbon have cooperated extensively in these experiments. Their assistance is greatly appreciated.

The treatments are shown in Table 1. A standard treatment of 120 pounds of N as anhydrous occurs on each side of the treatments. In addition to replications, the standard treatments provide a means of further reducing variation across the experimental area. In this experiment, using analysis for an unbalanced design, the deep placement of 7-21-7 and ammonium thiosulfate is evaluated by making use of the standard treatment.

Table 1. Treatment Combinations 1982 Irrigated Corn Experiment, Sear Farm, Kearney Co.

Treatment Number	Nitrogen Rate #/A	10 Gal/A: 5 Gal 7-21-7-1 Zn[1/]; 5 Gal 12-0-0-26 S
1	0	Yes
2	70	Yes
3	110	Yes
4	150	Yes
5	Standard 120 N	No

[1/] Provides 10# N, 11# P_2O_5, 4# K_2O, .5# Zn, 14# Sulfur.

Results:

Grain yield for 1982 was not as high as on similar plots in 1980 and 1981. One probable reason was excessive moisture in early spring resulting in a later than normal planting date. Even though this field has a pH above 7.7 for the entire root zone, the overall fertility level is high. Soil samples from the top four feet of soil showed considerable carryover nitrogen. However, from the time of soil sampling to July 1, more than 15 inches of rain occurred at the plot site. The check plots (those receiving 10 pounds of N) showed visual nitrogen deficiency symptoms, and as shown in Table 4, leaf nitrogen at silking was low. With a mean yield of 107 bu/A, it is obvious that some of the carryover nitrogen was utilized.

Analysis of the data showed that the standard treatment when used as a covariate was not significant, thus the standard was used as a treatment and the (General Linear Model) procedure for unbalanced designs analysis for yield is shown in Table 2.

Table 2. Analysis of Variance for Grain Yield as Influenced by Treatments - Sear Farm, 1982.

Source	df	SS	MS	F	Prob > F
Treatment	4	2,401.7	600.4	10.7	.0001
110 N plus knife-in P & S vs 120 N	1				.37
150 N plus knife-in P & S vs 120 N	1				.39
Error	22	1,232	56.0		

R^2 = .66 C.V. = 5.6 Mean Yield 133

Table 3. Fisher's LSD for Grain Yield.

Treatment	Number of Observations	Mean Yield
150 N plus 10 Gal/A Mixture	3	141 A[1/]
120 N, No Mixture	15	137 A C
110 N plus 10 Gal/A Mixture	3	133 A C
70 N plus 10 Gal/A Mixture	3	133 A C
80 # N applied Aug. 2	3	125 C
Zero N plus 10 Gal/A Mixture	3	107 B

[1/] Means followed by the same letter are not significantly different at the 5% level.

Grain yield was significantly influenced by applied nitrogen (Tables 2 and 3); however, as shown, the first increment of applied nitrogen was sufficient for optimum yield. Further, the single degree of freedom comparisons (Table 2) show that deep placement of the solution mixture did not influence grain yield. As previously stated, 80 pounds of nitrogen was applied to small plots within the check plots on August 2. Yield from these plots averaged 125 bu/A compared to 107-bushel check and 132 bu/A for the 70 pounds applied on June 24. The 125 bushel yield is significantly different from the check and 150 pound N rate, but not the 70 and 110-pound treatments. This response from late-applied nitrogen is consistent with observations from numerous past nitrogen experiments where yield responses to applied nitrogen are minimal because late in the season roots reach nitrate nitrogen deep in the profile (4 to 5 feet).

Nutrient Content of Leaf:

Leaf samples were taken at silking and analyzed for several nutrients. Table 4 shows that the mean content of nitrogen, zinc, iron, manganese, and phosphorus was influenced by treatment. These data provide an excellent example of how tissue analysis can be misleading. The treatment variable was nitrogen, thus leaf N would be expected to be influenced. However, by plotting the relationships between leaf N and phosphorus, zinc, manganese, and iron, it shows that the significant influence of treatment on iron, zinc, phosphorus, and manganese was not direct but indirect. That is, when nitrogen content of the plant is low, most other nutrients are likely to be low.

Table 4. Select Nutrients in Ear Leaf at Silking as Influenced by Treatment. Sear Farm - 1982.

Treatment[1/]	Mean Nutrient Content				
	%		PPM		
	N	P	Zn	Fe	Mn
Zero N	1.88 B[2/]	0.23 B	29 B	62 B	36 B
70 N	2.64 A	0.26 A	43 A	75 A	44 B A
110 N	2.73 A	0.26 A	46 A	76 A	41 B A
150 N	2.75 A	0.27 A	52 A	84 A	45 A

1/ All treatments received deep placement of 10 gal of the 7-21-7-1 Zn plus 12-0-0-26 sulfur.

2/ Means followed by the same letter are not significantly different at the 5% level.

Summary:

Under the conditions of this experiment, knifing-in 7-21-7 + zinc and ammonium thiosulfate (12-0-0-26 S) did not influence yield. From the standpoint of nitrogen, grain yield was not significantly influenced by rates of nitrogen over 80 pounds/A. Soil samples to four feet showed carryover nitrogen present, and since yields were in the 130 bushel range, some of the carryover nitrogen was obviously utilized. This is encouraging in view of the large amount of rainfall in spring and early summer. The check yield (10 # of N) of 107 bu/A also supports the fact that the corn plant can utilize carryover nitrogen even under extreme adverse conditions.

Interseeded Rye and Alfalfa in Irrigated Corn Production

R. J. Lewis, M. P. Russelle and R. A. Olson

Objectives:

1. Determine what if any N benefit can be expected from interseeding alfalfa in irrigated corn receiving no N fertilizer.

2. Evaluate effects of interseeded rye on N conservancy in irrigated corn plots receiving substantial N fertilizer treatment.

Procedure:

This study is carried out on irrigated Sharpsburg sicl devoted to continuous corn production. Alfalfa is seeded immediately after ridging for irrigation in plots that receive no fertilizer, the check plots of the long term study on N management for irrigated corn. Rye is seeded at the same time to plots that continuously receive 240 lbs N/a. These seedings were initiated in 1974 with rye and 1976 with alfalfa.

Experimental Results:

Little effect from rye interseeding was apparent on corn production during the first several years of the study. In 1981 and 1982, however, the rye appears to have had a highly beneficial effect on yields. Whether this benefit was due to N conserved by the cover crop during fall, winter and early spring months or to enhanced soil physical condition from the incorporated green manure cannot be confirmed by the data at hand.

Neither did alfalfa seedings have any pronounced yield effects during the first years. There has been a consistent response to the alfalfa in recent years, however, which almost certainly reflects a N contribution to the crop's nutrition and perhaps as well some benefit to soil physical condition.

To date the additional yield obtained from the two interseedings would barely pay for the seed and effort expended and it remains to be seen how important the long term effects will be. Germane to the issue is the fact that stands of the rye and alfalfa have not persisted in some years due to dry weather or overshading by the corn. We need to develop means for assisting these seedings to become more consistent in stand maintenance so that a good green manure crop is available for incorporation each spring. Earlier seeding would help which could certainly be done in sprinkler irrigated fields where the ditching requirement for furrow irrigation does not exist.

Table 1. Influence of interseeded rye and alfalfa on yield of irrigated corn, Mead Field Lab

Year	Grain yield, bu/a	
	RYE in 240 lb N/a plots	
	with rye	without rye
1974	87	98
1975	128	129
1976	133	115
1977	111	109
1978	165	178
1979	-- *	170
1980	126	125
1981	171	142
1982	181	149
	ALFALFA in no N plots	
	with alfalfa	without alfalfa
1977	86	85
1978	146	152
1979	144	96
1980	70	59
1981	121	109
1982	93	72

*Experiment was not initiated this year.

Maximizing Fertilizer N and Water Use Efficiency on Irrigated and Rainfed Corn

J. Wilson and R. A. Olson

Objective:

To determine best combination of N and crop management practices for optimizing N and water use efficiencies by corn, irrigated and rainfed, on Sharpsburg sicl. This is a project supported by Phillips Chemical Co.

Procedure:

The irrigated experiment was hand planted to a stand of 30,000 plants per acre with Pioneer 3377 in either 30" or 20" row spacing, the latter on beds with rows 10" apart and 30" between beds. Nitrogen was applied as NH_4NO_3 at the three rates of 80, 160 and 240 lbs N/a and three different times: all at planting, all sidedressed at 18" growth stage, and split with 1/3 at planting and the rest in two simulated fertigations. Irrigation was programmed either in 2" increments frequently or 4" increments correspondingly less frequently to a total of 22" seasonal total moisture, but the excessive rainfall compromised this phase of the study. Water consumption by the crop was measured by neutron access tubes placed in check and 160 N plots.

The nonirrigated experiment was planted to Pioneer 3541 to a stand of either 14,000 or 21,000 plants per acre in 20" or 30" row spacing. Ammonium nitrate was applied either at planting or as a sidedressing at 18" growth at rates of 60, 120 or 180 lbs N/acre.

Experimental Results:

Great difficulty was experienced in making the projected treatments for this study in 1982 because of excessive rainfall received during the spring and summer. Planting was not completed until June 1, almost a month later than intended. The over abundance of rainfall essentially eliminated any possibility of response to irrigation treatments.

Table 1 summarizes results for the irrigated experiment, with yields ranging from around 60 to in excess of 200 bu/acre. Response to N was striking with 70 bushels corn obtained for the first 80 lbs N, 33 bushels for the second 80, and still another 17 bushels for the third 80 on this N deficient soil (substantial residue had been incorporated before planting). A 7 bushel advantage was measured for 20" over 30" row spacing but there was no significant difference for irrigation routine. Sidedressing of N across all rates was 10 bushels better than planting time N with no further advantage for a 3-way split of the N on this fine textured soil.

The non-irrigated experiment yielded almost as well as the irrigated in this above-normal rainfall year (Table 2). Again, response to N was striking with 77 bushels obtained for the first 60 N, 26 bushels for the second 60, and 15 bushels for the third. Twenty-inch row spacing exceeded 30" rows by 9 bu/acre, and sidedressing was 6 bushels superior to planting time N. The higher plant population was especially advantageous, providing an added 21 bu/acre.

When isotope ratio analyses have been completed it will be possible to calculate fertilizer use efficiencies under the various N and crop management systems employed.

Table 1. Yield response of irrigated corn to fertilizer N, time of N application, row spacing, irrigation system, Mead Field Lab, 1982

Row spacing and N rate	Time of N and Irrigation System					
	Planting N		Sidedress N		Split N	
	Lo Irrig*	Hi Irrig	Lo Irrig	Hi Irrig	Lo Irrig	Hi Irrig
	bu/a					
	Irrigated					
30" Rows						
0 N	70	59				
80 N	132	136	128	153	142	151
160 N	170	143	163	175	150	153
240 N	166	184	179	187	192	181
20" Rows						
0 N	67	52				
80 N	122	137	130	141	144	118
160 N	156	181	181	172	191	195
240 N	180	174	203	195	185	209

Ave. for R.S.	Ave. for N	Ave. for N time	Ave. for irrigation
30"--160	0 -- 65	Planting--157	Low --162
20"--167	80 --136	Sidedress-167	High--166
	160 --169	Split --168	
	240 --186		

*'Low' irrigation refers to light, frequent irrigation to the same seasonal total as applied for heavier, less frequent irrigation with the 'High' system.

Table 2. Yield response of nonirrigated corn to fertilizer N, time of N application, row spacing, and plant population, Mead Field Lab, 1982.

Row spacing and N rate	Time of N and Plant Population			
	Planting N		Sidedress N	
	14,000 plants	21,000	14,000 plants	21,000
	bu/a			
30" Rows				
0 N	46	74		
60 N	124	141	131	139
120 N	147	157	153	170
180 N	160	185	169	186
20" Rows				
0 N	58	63		
60 N	131	143	140	144
120 N	145	185	154	194
180 N	163	197	167	199

Ave. for R.S.	Ave. for N	Ave. for N time	Ave. for plant population
30"--155	0 -- 60	Planting --156	14,000 -- 149
20"--164	60 -- 137	sidedress--162	21,000 -- 170
	120 -- 163		
	180 -- 178		

NITROGEN BALANCE FOR CONTINUOUS CORN

By

M.A. Lueking, F.N. Anderson, and G.A. Peterson

Objective:

To account for applied fertilizer N use and losses on a Tripp very fine sandy loam soil.

Procedure:

The plots were established in 1912 as part of a crop rotation study at the Mitchell Station near Scottsbluff, NE. The plots planted to continuous corn were maintained until 1942 with no manure or fertilizer having been applied up to that point. In 1942, a second replication was added and the plots were split with half receiving 27 metric tons of manure/ha/yr since that time. In 1953, each manured and non-manured plot was subdivided into smaller plots (5.5 x 12.5m) that have received annual additions of 0, 45, 90, 135, and 180 Kg N/ha as NH_4NO_3 in the spring prior to planting.

To prepare the balance sheets, we estimated addition of N due to mineralization and losses due to immobilization, leaching, and crop removal. Mineralization was determined by a 14 week incubation study, with samples leached at 2 week intervals and the inorganic N determined by steam distillation. Leaching losses were determined after drilling soil samples to a depth of 15 m (water table at 14 m), and colorimetrically estimating the NO_3^--N values. The grain was harvested by hand and total N determined by semi-micro-Kjeldahl digestion with reduced iron to include oxidized N compounds. Immobilization was determined from the difference of total soil N values for 1980 and those measured in 1972.

Results:

The completed balance sheets for non-manured and manured plots respectively are shown in Tables 1 and 2. Unaccounted for N losses are calculated by subtracting total losses from total additions.

Nitrogen mineralization was affected by manuring but there was no effect due to N fertilization rate. Total N additions ranged from 33 Kg/ha in the non-manured plots to 365 Kg/ha in the manured plots.

There was a significant interaction of N and Manure in crop removal (.05 level of probability) as well as a significant response to Manure (.10). There was also a significant linear response of grain removal to N rate in the non-manured plots (.01).

There was no response of leaching loss to Manure. N rate was significant at the .20 level of probability.

Unaccounted for losses are large and thought to be due to denitrification. These losses are higher in manured plots which is reasonable due to the higher C content available for microbial use.

Table 1. NITROGEN BALANCE SHEET FOR NON-MANURED PLOTS

Additions	Kg N/ha				
N fertilizer	0	45	90	135	180
Mineralization	33	35	37	35	35
Total Additions	33	80	127	170	215
Losses					
Grain removal	33	52	74	95	120
Leaching	0	0	10	64	19
Immobilization	3	6	4	6	8
Total Losses	36	58	88	165	147
Unaccounted for N losses	-3	22	39	5	68

Table 2. NITROGEN BALANCE SHEET FOR MANURED PLOTS

Additions	kg N/ha				
N fertilizer	0	45	90	135	180
Manure	130	130	130	130	130
Mineralization	56	60	61	54	55
Total Additions	186	235	281	319	365
Losses					
Grain removal	124	156	148	145	151
Leaching	0	19	6	20	27
Immobilization	3	4	8	4	10
Total losses	127	179	162	169	188
Unaccounted for N losses	59	56	119	150	177

HIGH YIELD CORN-SOYBEANS-WHEAT ROTATION STUDY

R A. Olson and R.J. Lewis

Objective: To determine nutritional limitations that may exist for exceptionally high yields of crops grown on irrigated Sharpsburg sicl.

Procedure: This experiment initiated in 1981 on Sharpsburg sicl involves a rotation of corn-soybeans-wheat in three separate blocks such that each crop is produced annually. Treatments include varied rates of N, P and K along with singular rates of S, Zn, Cu, B and manure. Selected rates of N are greatest for corn, intermediate for wheat and least for soybeans. Only corn was harvested in 1981 but all three were harvested in 1982.

Experimental Results: The unusually wet spring was responsible for diseases in wheat that radically reduced yields from the potential that existed with early growth. Nonetheless, respectable and best yields were obtained with manure and with the combination of 160 lbs N and applied P (Table 1). Visual response was most striking to manure and plots receiving P fertilizer during the vegetative stage. The yield data are not very meaningful because of the disease problem.

Soybean yields ranged from 47 to 53 bu/a. There was a small response to fertilizer all of which could be attributed to N. The manured plot and all others receiving 40 or more lbs N/a afforded the maximum yield.

Lodging was a serious problem for the corn plots in this experiment during 1982 due to wind, high plant population and possible rootworm damage, with resulting substantial yield variability. Yield response to fertilizer, however, was obviously substantial with predominant effect from applied N. The 80 lb N rate provided only about half the response of the 160 lb rate with some indication that slightly over that amount was needed for maximizing yield. For the 2-year period the 20T manure applied in 1981 was approximately equivalent to the 80 lb N rate applied annually.

Table 1. High yield corn-soybeans-wheat rotation results in 1982.

Treatment[1/]	Corn			Soybeans		Wheat	
	Moisture 1982	Yield 1982	Yield 1981-82	Moisture	Yield 1982	Moisture	Yield 1982
	%	bu/a		%	bu/a	%	bu/a
1. Control	19.7	88	116	6.4	47	12	26
2. 20T manure	21.0	139	148	6.7	51	12	43
3. 80+0+0	20.7	135	151	6.7	48	12	25
4. 160+0+0	21.6	182	177	6.6	52	12	30
5. 160+40+0	19.0	164	169	10.0	53	12	33
6. 160+40+40	19.5	180	177	6.9	51	12	36
7. 160+40+40+20S +10Zn+1B+.5Cu	22.1	174	176	6.1	51	12	37
8. 320+80+80	18.8	189	181	8.6	53	12	41
9. 160+40+40 +20T manure	19.7	190	179	5.9	52	12	37

1/ N rates for soybeans were 1/4 those indicated here for corn, 1/2 for wheat.

DUAL PLACEMENT OF NITROGEN AND PHOSPHORUS ON WINTER WHEAT

E.J. Penas and D.H. Sander

Objective: To determine the relative effectiveness of methods and time of application of phosphorus for winter wheat using a liquid formulation of fertilizer applied at three rates of phosphorus.

Procedure: Studies were established in the fall of 1981 in Lancaster and Saunders Counties. Table 1 shows the soil test characteristics of these sites. The site in Lancaster County is moderately acid and is low in soil phosphorus. The site in Saunders County is slightly acid and very low in soil phosphorus.

Each plot area received 80 pounds of nitrogen per acre as ammonia and nitrogen from the 10-34-0 that was applied, except the no phosphorus plots which received all 80 pounds of nitrogen as ammonia.

Phosphorus was applied at rates of 10, 20 and 30 pounds of P per acre. Methods and times of application being studied included pre-plant application of 10-34-0 and ammonia and ammonia plus N-Serve in bands placed 4-6 inches deep using double-tube knives spaced 12 inches apart, broadcasting 10-34-0 fertilizer on the soil surface and incorporated with a tandem disc prior to seeding, fertilizer placed with the seed at seeding, and 10-34-0 knifed between the wheat rows in the spring.

Results and Discussion: Table 2 shows the grain yields for each treatment at both locations. Broadcast application of phosphorus did not increase wheat grain yield significantly in the Lancaster County test and was only slightly effective in the Saunders County test. Fall knife application and seed applied phosphorus both increased wheat grain yields dramatically and these two methods were equally effective. Spring knife application was not effective in Lancaster County. The addition of N-Serve with ammonia had no effect on grain yields.

Methods of applying phosphorus and rates of applied phosphorus were significantly different in terms of grain yield at both locations. At Lancaster County, there was a significant methods x rate interaction. This interaction is significant because increasing the rate of phosphorus applied broadcast or spring knifed did not increase yields significantly.

TABLE 1. SOIL TEST CHARACTERISTICS OF WINTER WHEAT TEST PLOT SITES, 1982

Soil Test	Site: Lancaster	Site: Saunders
Soil pH	5.3	6.0
Buffer pH	6.3	6.6
Phosphorus, ppm	9	4
Potassium, ppm	190	232
Organic Matter, %	1.5	1.2

TABLE 2. WINTER WHEAT GRAIN YIELDS, bu/ac., AS INFLUENCED BY PHOSPHORUS FERTILIZER RATE AND METHOD OF APPLICATION, 1982

Phosphorus Applied	County Location: Lancaster			Saunders		
P, lbs/ac:	10	20	30	10	20	30
	---------Bushels per acre-------					
None		(8)			(14)	
Broadcast	9	11	11	15	19	22
Seed	15	24	29	26	38	38
Fall Knife	16	23	30	24	32	35
Spring Knife	10	11	13	--	--	--
Fall Knife with N-Serve	16	--	--	24	--	--

Effect of Depth of P Application on the Yield of Winter Wheat

S.G. McConnell, D.H. Sander and G.A. Peterson

Objective

To determine if the depth at which APP is band applied affects grain yield, P uptake, and the components of yield. Also, to determine how the depth treatments compare to a seed placement, a surface treatment, and a no P check.

Procedure:

Four depth treatments (0, 2, 4, and 6 inches), a seed treatment, a surface treatment (P placed directly above seed on soil surface), and a no P check were applied at 5 locations in Nebraska. The depth treatments were knifed in immediately prior to seeding in such a way that the band split seeded rows. APP was applied at a rate of 10 lbs P/acre. Nitrogen was topdressed with NH_4NO_3 in the spring according to soil test results. Centurk 78 seed was planted at all locations. Above ground plant tissue samples were taken at fall tillering, stem elongation, boot, flowering, and grain harvest. Dry weight and P concentration was determined and P uptake was calculated for all samplings. Head counts and wt/100 seeds was measured and seeds/head was calculated to determine the components of yield. Analysis of variance using non-orthogonal contrast was used to determine differences between treatments at individual locations and across locations.

Results and Discussion:

Grain yield:

A yield increase due to P was noted at all locations (Tables 1 and 2). A linear response to increasing depth occurred at locations 82-24 and 82-41. A trend toward a linear increase occurred at location 82-10 with a probability level of 0.17. A quadratic response to depth occurred at location 82-17. Over all locations a linear effect of depth and a trend toward a quadratic effect occurred. However, location x linear depth and location x quadratic depth interactions occurred making combined interpretation inappropriate. The row treatment was better than the best depth treatment at location 82-40 only.

The row was better than the surface treatments at location 82-40 only. This result is surprising since the surface treatment was placed on top of the ground where root contact and moisture availability would seem to be limited. However, soil probably was moved into furrow by wind and water action, and with tillering and root development in this area, it acted similarly to the seed placement. The surface treatment was not different than the 2 in. treatment at any location. These 2 treatments are in the same horizontal plane. The difference being that the surface is directly in the seed row while the 2 in. depth treatment is between the rows.

P Uptake:

Total P uptake (Tables 1 and 2) responded similarly to grain yield except that no differences occurred between the best depth vs row and the row vs surface at any location.

Early utilization of phosphorus does not seem to be critical for producing high yields. Table 3 shows the dry weight ratio of the best depth treatment over the seed treatment at five sampling times over all locations. At fall tillering, the best depth produced only 71% as much dry matter as the seed placed treatment. The difference was very significant. However, the difference was not significant at any other sampling time and dry matter production was essentially equal at harvest.

Table 1. Effect of Depth of P Placement on Grain Yield and Total P Uptake. 1982

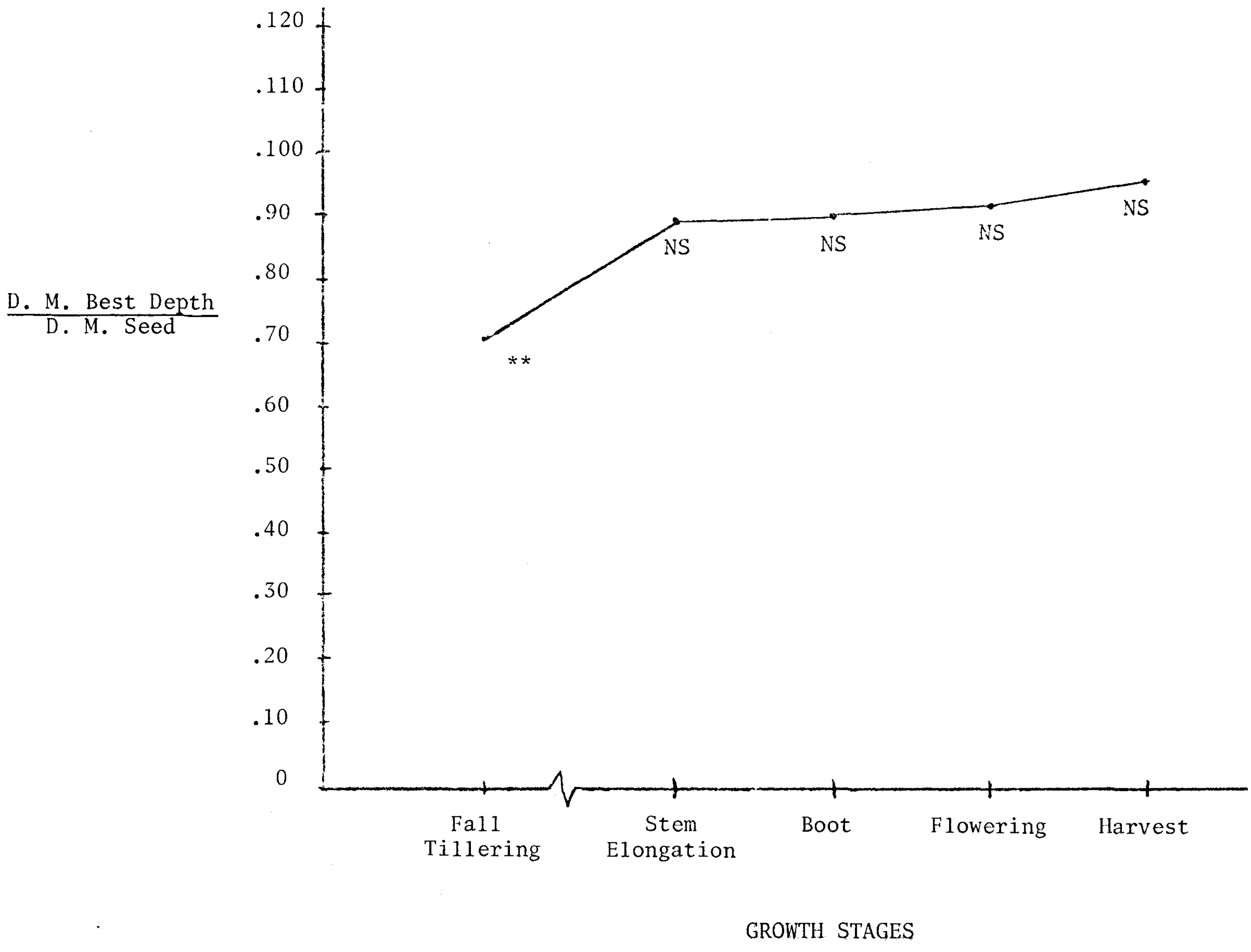
	County (Location No.)											
	Frontier Co. 82-10		Custer Co. 82-17		Custer Co. 82-24		Saunders Co. 82-40		Saunders Co. 82-41		Overall	
Treatment	Grain (bu/a)	Total P uptake (lbs/a)	Grain (bu/a)	Total P uptake (lbs/a)	Grain (bu/a)	Total P uptake (lbs/a)	Grain (bu/a)	Total P uptake (lbs/a)	Grain (bu/a)	Total P uptake (lbs/a)	Grain	T.P.U.
0"	48.7	11.0	45.7	9.5	50.4	15.2	27.1	9.4	15.9	5.3	35.5	9.8
2"	49.7	11.1	58.4	11.4	53.9	15.6	28.3	9.5	19.1	5 7	39.7	10.5
4"	50.4	10.8	58.0	11.9	52.0	14.8	28.2	9.5	29.9	8.4	41.6	10.8
6"	52.0	11.3	50.9	9.9	58.8	16.3	28.3	9.2	26.9	8.6	41.3	10.8
Row (Seed)	49.9	11.0	59.3	12.1	54.6	15.5	33.4	10.1	25.9	7.4	43.1	11.1
Surface	51.9	11.3	60.2	11.9	52.3	16.1	28.1	9.3	21.5	6.6	41.1	11.0
Check	44.6	9.9	40.9	8.6	49.1	13.9	23.8	8.0	11.5	4.0	32.6	8.7

Table 2. Depth of P Placement Statistical Analysis of Grain Yield and Total P Uptake.

Source of Variation	County - Location No.										Overall	
	Frontier Co. 82-10		Custer Co. 82-17		Custer Co. 82-24		Saunders Co. 82-40		Saunders Co. 82-41			
	Grain	Total P uptake	Grain	Total P uptake	Grain	Total P uptake	Grain	Total P uptake	Grain	Total P uptake	Grain	TPU
Check vs others	**	*	**	**	*	*	**	**	**	**	**	**
Linear Depth	NS	NS	NS	NS	*	NS	NS	NS	**	**	*	*
Quadratic Depth	NS	NS	**	**	NS	NS	NS	NS	NS	NS	NS	NS
Best Depth vs Row	NS	NS	NS	NS	NS	NS	*	NS	NS	NS	NS	NS
Row vs Surface	NS	NS	NS	NS	NS	NS	*	NS	NS	NS	NS	NS
Surface vs 5 cm	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Coefficient of Variation %	7.5	8.0	11.2	11.8	8.5	10.1	16.4	15.2	25.5	23.2	12.4	13.1

**, * indicates significance at the 0.01 and 0.05 levels of probability, respective.
NS indicates not significant.

Table 3. Ratio of dry weights of best depth treatment/seed treatment at five sampling times over all locations. 1982



8.5

INFLUENCE OF RATE AND PLACEMENT OF PHOSPHORUS FERTILIZER ON THE GRAIN YIELD OF WINTER WHEAT IN SOUTHEAST NEBRASKA

E.J. Penas

Objective: To compare the relative effectiveness of phosphorus fertilizer at various rates of application placed with the seed to that broadcast and mixed in the soil before seeding.

Procedure: Experimental plots were established in farmers' fields in Lancaster and Richardson Counties in the fall of 1981. The basis for site selection was a low level of soil phosphorus and an acid soil pH. These studies parallel studies being conducted in Western Nebraska on neutral to alkaline soils. The soil tests characteristics are presented in Table 1.

Results and Discussion: The site in Lancaster County was abandoned in the spring because of extreme plot variability due to factors other than treatments. The influence of phosphorus fertilizer on grain yield of wheat at the site in Richardson County is shown in Table 2. Phosphorus fertilizer, applied broadcast and incorporated prior to seeding or applied with the seed, increased grain yield of the winter wheat. Grain yield continued to increase as the rate of application was increased.

Even though phosphorus increased grain yield, broadcast application did not result in economic returns with wheat valued at $3.00 per bushel and phosphorus costing 25¢ per pound of P_2O_5. Response to phosphorus fertilizer was economical when the fertilizer was applied with the seed. An application of 34 pounds of phosphorus with the seed was the most profitable in this experiment.

This site was infected with the disease "scab" which was prevalent in Southeast Nebraska this year. Yield levels were reduced significantly by the disease.

Table 1. Soil Test Characteristics of Winter Wheat Test Plot Site, Richardson County, 1982

Soil pH	5.5
Buffer pH	6.2
NO_3-Nitrogen, lbs/ac. 6 ft.	49
Phosphorus, ppm	12
Potassium, ppm	296
Organic Matter, %	2.8

Table 2. Winter Wheat Grain Yields, bu./ac., as Influenced by Phosphorus Fertilizer Rate and Placement, Richardson County, 1982.

Phosphorus Rate, P_2O_5, lbs/ac.	Phosphorus Placement: Broadcast		Phosphorus Placement: With Seed
0		27.2	
9			28.9
17	28.1		29.9
26			30.8
34	29.1		31.5
43			32.0
52	30.2		32.3
60			32.5
69	31.0		32.7
86	31.8		32.9
103	32.5		
120	33.1		
134	33.5		

RESULTS OF 1982 FERTILIZER EXPERIMENTS ON WHEAT

D. H. Sander and G. A. Peterson

Summary of 1982

1. Soil test correlation and calibration of both P and N soil tests for wheat leaves a lot to be desired.
2. A knifed-in spring topdressing of P appears to be a promising method for both N and P fertilization for wheat.
3. Knife-in phosphorus is as effective and sometimes more effective than seed applications but performed poorly at the low rate.
4. DAP (18-46-0) was, in two experiments, more effective than either 10-34-0 or 0-44-0.
5. P source studies suggest that particle size of P fertilizers may affect efficiency.
6. Long term row vs broadcast studies suggested that the relative effectiveness of row applications compared to broadcast may decline over several years of application.
7. P source studies suggest that N with the P fertilizer may be even more important than we thought.
8. DAP (18-46-0) was as effective broadcast as other two sources were seed applied or there may be source x method interactions.
9. It is apparent that the effect of time of knifing-in P during fallow needs to be studied similar to present studies with N application.

Wheat yields in 1982 were excellent. Both Custer County and Frontier County locations had grain yields of over 4,500 kg/ha or nearly 70 bu/A and straw yields of over 9,000 kg/ha or 4.0 tons/A. However, in early spring some of the wheat was damaged by high winds especially in Custer County where one experimental location was lost.

To reduce costs, more than one experiment was usually established at each location. There was one "expanded row vs broadcast" study in Red Willow County and one in Frontier County. These experiments included a P rate study of 0, 8, 17, 25, 33, and 42 kg P/ha, applied with the seed and broadcast as 0-44-0. In addition P sources as 10-34-0, 18-46-0, and 0-44-0, were compared at 8 and 17 kg P/ha. All sources were applied with the seed or broadcast. APP (10-34-0) was also knifed into the soil prior to planting (30 cm spacing).

Two "Dual application" or "Preplant Band" experiments were established in Frontier and Custer County. These studies included knife (fall), broadcast, seed applied and knife (spring) at three P rates (11, 22, and 34 kg P/ha).

Three permanent row vs broadcast experiments were harvested in 1982. Two locations in Hitchcock County and one in Red Willow County. This was the fourth harvest for the Carter location in Hitchcock County and the third harvest for the other two locations.

A nitrogen rate study was also harvested on four locations to provide data for soil residual nitrate calibration.

P Source Studies

The effect of different phosphorus sources on wheat grain and straw yields are shown in table 1a, b, and c. The Red Willow County site had a Bray No. 1 P soil test of 17 ppm in the top 10 cm but was only 3 ppm in the next 20 cm. The top 20 cm averaged 10 ppm. Wheat yield should have been increased with P application, but the response was very weak. However, seed application was significantly better than broadcast although only by 180 kg/ha (3 bu/A) (Table 1b). Rate of P application did not affect wheat yield. However, 18-46-0 was a significantly better P source than 0-44-0 (11% level for grain, 3% level for straw). There was no difference between liquid and dry P carriers.

P increased wheat yield significantly at the Frontier County site where the Bray No. 1 P soil test was 8 in the top 20 cm. Seed application was significantly better than broadcast and 18-46-0 was again a significantly better P fertilizer than 0-44-0 or 10-34-0. Since 10-34-0 and 18-46-0 are not identical P compounds, one can only speculate as to the reason for the good performance of 18-46-0. The N content could make it a better source than 0-44-0 especially when seed applied, but 18-46-0 was a superior P source when broadcast. While the method x source interaction was only significant for straw yield, 18-46-0 broadcast performed very well compared to other sources seed applied. While the performance difference between 10-34-0 and 18-46-0 could be due to the ortho vs poly difference, it could also be due to the difference in form or particle size (liquid vs dry). While the liquid vs dry comparison is significant, this difference is due to the good performance of 18-46-0. The differences in performance between carriers warrants additional research with different P sources and forms for wheat production even though much research has been done.

Preplant band (Knife) Studies

Yield means and the analysis of variance for the knife, seed, and broadcast treatments for the Red Willow Co. (82-2) and Frontier Co. (82-8) locations is shown in Table 1c. While wheat yields were increased with applied P in Red Willow Co., there was no difference between method of application on this poor P responsive site. On the Frontier Co. site, wheat yields were increased with applied P, but no significant difference between band (knife + seed applied) and broadcast. Knifed-in P was however significantly better than seed applied or broadcast. This experiment is one of few over the years where knifed in P is significantly better than seed applied. However, knifed-in P is nearly always at or near the top in yield. In this study P was knifed in as 10-34-0 without NH_3. Nitrogen was topdressed in the spring as NH_4NO_3 according to soil test. Both locations received 45 kg/ha of N.

Knifed-in P was also compared on one location in Frontier Co. (82-10) and Custer Co. (92-17) (Table 2). In these studies all plots received 90 kg N/ha as NH_3 with the NH_3 and 10-34-0 being placed together in the fall knifed treatments. Spring knife treatments were with 10-34-0 only using "back-swept" knifes at a placement depth of about 8 to 10 cm. All knife treatments were in 30 cm spacing.

We have believed that the Bray No. 1 P soil test was doing a good job predicting P needs in these slightly alkaline or near neutral soils especially for winter wheat. However, in recent years wheat yields have not been increased on several low P testing soils. The Frontier Co. site (82-10) is an example of a soil with a Bray No. 1 soil test of 5 ppm P in the surface 20 cm, where applied P did not increase wheat yield significantly. Yield response was weak and variability too great to show differences.

P increased yields greatly on the low P testing soil in Custer Co. Yields were increased from 2,800 kg/ha to 4,500 kg/ha (25 bu/A) which is "incredible." Seed and knifed P was better than broadcast and seed placement was significantly better than knifed. (4,221 kg/ha vs 4,139.) The big difference came at the low P rate (11 kg P/ha) where knifed P performed poorly. Spring knifed-in P was not as good as fall applied P but still performed as well as broadcast. Application time in the spring was somewhat late (April 20). Earlier applications may be better. These results indicate that NH_3 + P (10-34-0) applications topdressed in the spring need to be investigated. Topdressing of N and P in the spring allows producers the option to wait until wheat stands are evaluated before the investment is made for both N and P fertilizer.

Three experiments were harvested comparing row vs broadcast 0-44-0 at six rates of application. These three experiments are the last series of experiments over the last six years designed to try and predict the relative efficiency of row or seed application of P compared to broadcast. Evaluation of these 35+ experiments is currently being done by a graduate student for his masters thesis. Seed application was a superior method of application at both the Frontier Co. (82-8) and Red Willow Co. (82-2) sites. Less P was required when P was seed applied to maximize yields than when broadcast.

Permanent Row vs Broadcast Studies

In 1982, three permanent row vs broadcast experiments were harvested. This was the fourth harvest at the Carter location. This soil has been a very marginal P responding soil. In 1982, P did not increase yields. However, there was a method x rate interaction which indicates wheat yield tended to be depressed by the broadcast treatments compared to a tendency to increasing yields as the rate increased when row applied. This was the third crop for the Red Willow (78-7) and Hitchcock Co. (78-14) locations. However, due to hail and other problems, the 1982 harvest represents only the second year of harvest data. Wheat yields were increased with applied P on both locations. However, the method of application was not significant at either location. This may indicate that broadcast P is more effective in succeeding years compared to row application that during the initial year of application. If true this is an important observation that can certainly affect our recommendations concerning row vs broadcast P. It also would indicate P fixation is less of a factor affecting fertilizer P availability than we have thought. Both the Hitchcock and Red Willow sites have high pH soils (pH 8.0 or above).

Residual NO_3-N Studies

In 1982, N rate studies were established at four locations (Table 6). Residual nitrates ranged from 62 to 271 kg N/ha. Nitrogen increased wheat yields on all locations except where the soil contained 271 kg N/180 cm. The UNL N recommendation was 45 kg H/ha for each of the three locations and was short of the optimum N requirement on each of the locations.

Table 1a. Effect of different methods and sources of phosphorus on winter wheat yields. 1982.

Fertilizer Treatment Source	Rate kg/ha	Red Willow Co. (82-2) Grain	Red Willow Co. (82-2) Straw	Frontier Co. (82-8) Grain	Frontier Co. (82-8) Straw
		kg/ha			
		Broadcast			
Check		3325	5623	3342	5265
0-44-0	8.4	3550	6115	3598	5370
	16.8	3247	5415	3915	5222
10-34-0	8.4	3468	5960	3743	5174
	16.8	3620	5974	3548	5179
18-46-0	8.4	3510	6084	4015	6073
	16.8	3677	6346	4324	6532
		Row			
Check		3575	6254	3593	5399
0-44-0	8.4	3584	5782	4126	6352
	16.8	3761	6426	4205	6790
10-34-0	8.4	3508	6184	3806	5495
	16.8	3761	6639	4289	6984
18-46-0	8.4	3886	6603	4188	6151
	16.8	3653	6165	4329	6813
		Knife			
10-34-0	8.4	3554	6233	4355	6559
	16.8	3886	6824	4595	7184

Table 1b. Effect of different methods and sources of phosphorus on winter wheat yields. Summary of means with analysis of variance. 1982.

Treatment	Red Willow Co. (82-2) Grain	Red Willow Co. (82-2) Straw	Frontier Co. (82-8) Grain	Frontier Co. (82-8) Straw
		kg/ha		
Check	3450	5938	3468	5332
Method				
Row	3692	6300	4159	6430
Broadcast	3512	5982	3857	5592
Rate				
8.4 kg/ha	3584	6121	3913	5769
16.8 kg/ha	3620	6160	4102	6253
Source				
0-44-0	3543	5934	3959	5933
18-46-0	3682	6300	4214	6392
10-34-0	3589	6189	3847	5708
Dry vs Liquid				
Liquid Source	3589	6189	3847	5708
Dry Source	3612	6117	4086	6162
	Analysis of Variance 1/			
Check vs rest	.12	NS	.01	.01
Row vs Broad	.02	.02	.01	.01
Rate	NS	NS	.05	.01
Rate x Source	NS	NS	NS	NS
18-46-0 vs 0-44-0	.11	.03	.03	.04
Method x Rate	NS	.18	NS	.04
Form (dry vs liquid)	NS	NS	.02	.02
Method x form	NS	NS	NS	NS
Method x Source	NS	NS	NS	.05
Method x 18-46-0 vs 0-44-0	NS	NS	.17	.02
Rate x form	.11	NS	NS	NS
Rate x 18-46-0 vs 0-44-0	NS	NS	NS	NS
C.V.	7.8	8.4	9.1	11.6

1/ Probability level expressed as percent

NS = non-significant

Table 1c. Effect of different methods of P placement with 10-34-0 on winter wheat yields. 1982.

Treatment	Red Willow Co. (82-2) Grain	Red Willow Co. (82-2) Straw	Frontier Co. (82-8) Grain	Frontier Co. (82-8) Straw
	kg/ha			
Knife				
8.4	3554	6233	4355	6559
16.8	3886	6824	4595	7184
Mean	3720	6528	4475	6871
Broadcast				
8.4	3468	5960	3743	5174
16.8	3620	5974	3548	5179
Mean	3544	5967	3646	5176
Row				
8.4	3508	6184	3806	5495
16.8	3761	6639	4289	6984
Mean	3634	6412	4048	6240
Check	3450	5938	3468	5332
Analysis of Variance[1/]				
Check vs rest	.01	.01	.01	.01
Band vs Broad	NS	.17	NS	NS
Knife vs row	NS	NS	.01	.03
Rate	.01	.01	.19	.01
Band vs Broad x rate	NS	NS	.11	.02
Knife vs row x rate	NS	NS	NS	.13
C.V.	5.2	4.8	9.1	10.6

1/ Probability level expressed as percent

NS = non-significant

Table 2. Effect of different methods of P placement and rates of P application on yield of winter wheat. 1982.

Treatment	Frontier Co. (82-10) Grain		Frontier Co. (82-10) Straw		Custer Co. (82-17) Grain		Custer Co. (82-17) Straw	
				kg/ha				
Check	3892		5965		2841		5195	
Knife, fall								
11	3723		5531		3547		6574	
22	4479		6612		4358		8191	
34	4518		6776		4512		8823	
Mean		4240		6306		4139		7863
Knife, spring								
11	3949		5781		3072		5672	
22	4257		5750		3520		6955	
34	3772		5286		3595		7526	
Mean		3993		5606		3396		6718
Row (seed)								
11	4258		6324		3958		7417	
22	4247		6368		4228		8457	
34	4432		6733		4477		9328	
Mean		4312		6475		4221		8401
Broadcast								
11	3837		5613		3297		6328	
22	4141		5872		3969		7296	
34	4214		6120		3760		6226	
Mean		4064		5868		3675		6617

Analysis of Variance[1/]

	Frontier Grain	Frontier Straw	Custer Grain	Custer Straw
Check vs rest	NS	NS	.01	.01
Band vs Broadcast	NS	NS	.18	.01
Row vs Knife (Fall)	NS	.04	.02	.06
Fall vs Spring	.18	.02	.01	.09
Rate - Linear	.07	.09	.01	.01
Quadratic	.17	NS	.15	NS
C.V.	12.2	12.6	15.8	25.3

1/ Probability level expressed as percent

NS - non-significant

Table 3. Effect of seed and broadcast P placement in yields of winter wheat. 1982.

Treatment P rate	Custer Co. 82-24		Frontier Co. 82-8		Red Willow Co. 82-2	
	Grain	Straw	Grain	Straw	Grain	Straw
kg/ha	kg/ha x 10^{-2}					
0	33.3	72.9	34.7	53.3	34.2	59.2
Seed Applied						
8	35.4	81.4	41.2	63.5	35.8	57.8
17	33.8	80.0	42.0	66.8	37.1	63.4
25	35.3	81.2	43.8	63.8	37.1	64.0
33	32.5	74.5	45.6	68.5	34.2	57.6
42	33.4	81.4	45.9	67.4	35.5	59.8
Mean	34.1	79.7	43.7	65.9	35.9	60.5
Broadcast						
8	32.4	75.0	36.0	53.4	35.2	60.6
17	34.5	77.2	39.1	52.2	32.5	54.1
25	34.6	78.6	42.4	64.4	34.1	59.7
33	35.4	79.4	44.2	64.1	36.1	61.6
42	34.9	78.6	43.4	67.4	34.2	57.6
Mean	34.4	77.8	41.0	60.3	34.4	58.7
Analysis of Variance						
Rate	NS	NS	**	**	NS	NS
Linear	NS	NS	**	*	NS	NS
Quadratic	NS	NS	*	NS	NS	NS
Method	NS	NS	**	**	**	*
Rate x Method	NS	NS	NS	**	*	**
C.V.	10.4	10.1	8.4	11.0	7.7	7.3

Table 4. Effect of P placement on wheat yields from three long term study locations (78-14, 78-7, Carter) 1982

Treatment P rate	Hitchcock Co. 78-14 Grain	Hitchcock Co. 78-14 Straw	Hitchcock Co. Carter Grain	Hitchcock Co. Carter Straw	Red Willow Co. 78-7 Grain	Red Willow Co. 78-7 Straw
kg P/ha	kg/ha x 10^{-2}					
0	29.5	43.7	42.4	73.9	22.8	33.9
Seed Applied						
8	29.1	42.3	38.8	67.7	30.5	47.0
17	34.7	51.2	41.6	72.7	31.1	46.8
25	35.2	51.5	41.9	75.3	33.9	53.9
33	40.1	56.9	44.1	75.9	36.3	58.6
42	40.9	60.6	43.6	76.0	38.2	60.3
Mean	34.6	50.2	42.0	72.9	31.8	49.8
Broadcast						
8	26.2	39.4	44.9	76.5	30.8	38.7
17	30.1	43.4	41.7	70.4	28.7	45.0
25	36.4	49.6	40.3	70.8	34.9	53.1
33	37.8	48.7	40.0	70.2	38.2	57.7
42	43.8	59.8	43.0	71.7	43.6	67.4
Mean	34.2	48.3	42.1	72.8	33.4	51.2
Analysis of Variance						
Rate	**	**	NS	NS	**	**
Linear	**	**	NS	NS	**	**
Quadratic	+	+	NS	NS	+	++
Method	NS	+	NS	NS	NS	NS
Rate x Method	NS	NS	*	+	NS	NS
C.V.	17.7	19.4	8.2	8.6	13.2	14.2

Original Soil Test

Soil test Depth	pH	Bray P	pH	Bray	pH	Bray P	$NAHCO_2P$
cm							
0-10	8.0	9	6.7	11			
10-20	8.2	1	7.0	5	8.0	6	2
20-30	8.2	2	7.2	6	8.2	3	.3

Table 5. Soil tests for locations in 1982.

Depth	pH	P NaHCO$_3$	P Bray 1
cm		ppm	ppm
	Frontier Co. (82-8) SW 1/4, SE 1/4, Sec 12, R29W, T5N		
0-10	6.6	5.2	9.5
10-20	6.9	2.7	5.6
20-30	7.4	2.7	4.9
	Custer Co. (82-24) NE 1/4, SE 1/4, Sec 31, T14N, R22W		
0-10	6.5	6.6	8.0
10-20	6.4	2.7	2.6
20-30	6.9	5.9	2.6
	Red Willow Co. (82-2) SW 1/4, NW 1/4, Sec 21, T4N, R28W		
0-10	6.6	11.0	17.0
10-20	6.7	2.1	3.6
20-30	7.1	1.5	3.0
	Frontier Co. (82-10) SW 1/4, NW 1/4, Sec 11, T7N, R27W		
0-10	6.8	4.6	7.1
10-20	7.0	2.7	3.0
20-30	7.3	2.7	4.0
	Custer Co. (82-17) SW 1/4, NW 1/4, Sec 2, T17N, R24W		
0-10	6.0	3.4	5.1
10-20	6.6	4.0	2.3
20-30	6.8	2.7	2.0

Table 6. Effect of N rate on wheat yield on soils with different levels of residual nitrate N. 1982 1/

N rate	Red Willow Co. 82-2		Frontier Co. 82-8		Frontier Co. 82-10		Custer Co. 82-17	
	Grain	Straw	Grain	Straw	Grain	Straw	Grain	Straw
kg N/ha	kg/ha							
0	3324	5777	4230	6031	2668	3505	4193	8043
34	3538	6152	4187	5796	3272	4306	4047	7815
68	3895	7248	4498	6275	3830	5142	4380	8421
101	4094	7065	4519	6975	4471	5805	4311	8134
134	4061	7079	4544	6756	4261	5518	4270	8310
Analysis of Variance								
Rate								
Linear	.01	.02	.07	.05	.01	.01	NS	NS
Quadratic	.24	.20	NS	NS	.01	.05	NS	NS
C.V.	6.4	10.1	5.8	9.8	6.0	9.9	8.0	12.0
kg NO_3-N/180 cm	94		112		62		271	
Recommended N	45		45		45		0	

1/ All plots received 25 kg P/ha

INFLUENCE OF AGROPLUS ON IRRIGATED SOYBEAN YIELD

K. D. Frank

Objective:

AgroPlus is distributed by KMI, Inc., Hawkins, Texas, and is sold as a biological growth activator. Product for this experiment was obtained from Strong and Sons, Stromsburg, Nebraska.

The objective of this experiment is to obtain information from a replicated experiment on the influence of this product on irrigated soybeans. The experiment will be continued for more than one year.

Procedure:

The experiment was established on a Hastings silty clay loam soil at the University of Nebraska South Central Station, Clay Center, Nebraska. Each treatment is four, 30-inch rows, 1,100 feet long. The four treatments are:

1. Check
2. 12.5 oz AgroPlus/A surface applied
3. 25 oz AgroPlus/A surface applied
4. 12.5 oz AgroPlus/A surface applied plus 12.5 oz after crop emerged

Each treatment is repeated four times. Mead soybeans were planted on June 4, 1982. The treatments were applied on June 5 in approximately 40 gallons of water per acre. The second application of Treatment 4 was made on July 13. The beans were cultivated once and hilled for irrigation. The plots were irrigated two times for an approximate total application of five inches of water. The plots were machine-harvested on October 15, 1982.

Results:

1982 soybean yields on the South Central Station were not as good as prior years. Table 1 shows the analysis of variance for grain yield and grain moisture. Grain yield and moisture content at harvest are shown in Table 2.

Yield:

As shown in Table 1, there were no significant differences in grain yield due to treatments. Yields were variable throughout the experiment, however, the variability was uniform across replications as shown by the lack of significance for replications in Table 1. From the standpoint of field research, the probability of F (last column in Table 1) should be at least 0.2 or below when deciding if one yield is different than another. Thus, based on the results of this experiment, there is no reason to believe that grain yield was influenced by the applied treatments.

Grain Moisture:

As shown in the analysis of variance, Table 1, there is a significant difference in grain moisture due to treatment. The planned comparisons shown were planned prior to the experiment. That the contrast, "check vs the AgroPlus," is significant is due to Treatment 3. Treatment 1 (check), 2 (12.5 oz AgroPlus/A at planting), and 4 (12.5 oz/A at planting + 12.5 oz/A July 13) are not different. Thus, two AgroPlus treatments are not different than the check, so it is difficult to explain why Treatment 3 is significantly different than the others.

This experiment will be continued in 1983.

Table 1. Analysis of Variance for Grain Yield and Grain Moisture of Irrigated Soybeans as Influenced by AgroPlus.

Source	df	MS	F	Prob. F[1/]
Grain Yield				
Replication	3	4.79	.19	0.90
Treatment	3	12.68	.49	0.69
1 vs 2, 3, 4 Zero vs AgroPlus	1	3.9	.15	0.70
2 vs 3, 4 12.5 oz vs 25 oz + 12 oz at planting + 12.5 oz in July	1	4.5	.18	0.68
3 vs 4 25 oz at planting vs 12.5 oz applied at planting in July	1	29.6	1.15	0.31
Error	9	25.7		
Grain Moisture				
Replication	3	.05	0.36	.78
Treatment	3	.593	4.19	.04
Zero vs AgroPlus	1	.65	4.61	.06
12.5 oz vs 25 oz + 12.5 oz at planting and 12.5 oz in July	1	.0001	.01	.91
25 oz at planting vs 12.5 oz planting + 12.5 oz	1	1.125	7.94	.02

1/ For field research of this type the probability of F should be below 0.2 in order to make statements about treatments influencing dependent variables (such as yield or grain moisture).

Table 2. Mean Grain Yield and Grain Moisture Content at Harvest of Irrigated Soybeans as Influenced by AgroPlus. Univ. NE. South Central Station - 1982.

Treatment	Grain Yield Bu/A	Grain Moisture %
1. Zero AgroPlus	33.4	12.4
2. 12.5 oz AgroPlus	33.7	12.0
3. 25 oz AgroPlus	33.0	11.6
4. 12.5 oz at planting 12.5 oz July	36.9	12.3
Experiment Mean	34.3	12.1

Time of Irrigation and N Application for Optimum Soybean Production

J.A. Schild, M.P. Russelle, A.D. Flowerday and R.A. Olson

Objectives:

1. Investigate levels of soil pH as a factor influencing seed yield.
2. Investigate timing of irrigation as a factor influencing seed yield.
3. Investigate parameters under which fertilizer N may be needed for the optimum production of the soybean crop.
4. Investigate the interactions of the above three factors.

Procedure:

Differing levels of soil pH, timing of irrigation, rates and timing of N fertilization, and residual mineral N in the soil at planting are integrated into both field and greenhouse studies for estimating their combined influence on yield of seed and the symbiotic N-fixing process. Fertilizer N tagged with ^{15}N isotope was used for determining the source of N in the seed and Stover through isotope ratio analysis.

The 1982 field study included two pH levels of 5.6 and 6.5. Two irrigation regimes were established, one beginning at final cultivation and the other at early bloom, both supplying sufficient supplemental water to provide 24 inches total growing season moisture. Tagged N rates of 0, 40, and 80 lb N/acre were applied at either planting, at mid vegetative, or at bloom. The experiment was conducted on a Sharpsburg sicl. The determinate, high yielding, dwarf variety "Elf' was grown in 20 inch rows. Individual plots 3m x 3m, were diked up on all sides for creating a basin into which water was measured.

The 1982 greenhouse experiment is just being completed at time of writing. The study involved two pH and two moisture levels, depletion to 3/4 available water capacity and depletion to 1/4 available water capacity. Tagged N rates of 0, 40, and 80 lbs N/acre were applied at planting, at mid vegetative, or at bloom. The variety Clark was chosen for this study due to the availability of a non-nodulating isoline. Combinations of the above factors were applied to both the nodulating and non-nodulating isolines. The isotope dilution method will be used with the ^{15}N data acquired to estimate nitrogen fixation.

Results and Discussion:

Field

A complex interaction of pH, irrigation and N application time was observed on seed yield (Fig. 1). At pH 5.5 highest yields were attained when N was applied at planting and when irrigation was initiated at the last cultivation. At pH 6.5 the highest yields were obtained at the mid vegetative N application time, also when irrigation was initiated at bloom as opposed to last cultivation. Yields were increased 8 bu/A when N was applied at planting and 5 bu/A when applied at mid vegetative stage. Stover yields were increased by the 80 lb N rate over the 40 lb N rate at every N application time except mid vegetative. Percent fertilizer N in the seed followed a quadratic response for N time of application for both pH 5.5 and pH 6.5. The 80 lb N rate doubled the amount of fertilizer N found in the plant over that of the 40 lb N rate at every N application time. Percent fertilizer N in Stover followed the same trends as those observed in seed tissue.

Summary:

During 1982, which had a very wet fall, yields were generally decreased by increasing pH as opposed to 1981 where increasing pH showed significant increases in yields. In both 1981 and 1982 the highest percent fertilizer N found in the seed was when N was applied at the early bloom stage. Both years N application decreased yields in the field where residual soil N was at a moderate level.

Table 1. Harvest data from 1982 field experiment.

pH	Irrigation Initiation	N Rate	N Time	Seed Yield	Stover Yield	Population	Pod Number	Seed Number	Hundred Seed weight	Percent Fertilizer N in the Plant	
		lb N/A		bu/A	lb DM/A	plants/m^2	pods/plant	seeds/pod	g/100 seeds	Grain	Stover
5.6	Last Cultivation	0	----	84	4100	28	70	1.4	18.1	0	0
		40	Planting	77	4900	31	59	1.4	18.3	7	3
			Vegetative	68	4900	30	60	1.4	17.5	12	14
			Bloom	70	4700	32	60	1.3	18.1	14	9
		80	Planting	77	5500	28	63	1.4	18.7	16	8
			Vegetative	80	4100	30	60	1.5	18.5	25	23
			Bloom	70	5100	31	64	1.2	17.8	23	20
	Early Bloom	0	----	70	4600	29	70	1.2	17.5	0	0
		40	Planting	74	5100	30	64	1.3	17.7	10	6
			Vegetative	73	4800	32	70	1.1	17.8	13	13
			Bloom	69	4800	28	79	1.1	17.8	16	10
		80	Planting	72	5000	26	63	1.6	17.5	9	7
			Vegetative	73	4800	29	59	1.4	18.1	31	27
			Bloom	69	4600	31	67	1.2	17.1	28	22
6.5	Last Cultivation	0	----	71	4800	30	57	1.4	19.0	0	0
		40	Planting	63	4900	31	62	1.1	18.4	8	5
			Vegetative	70	4900	33	50	1.4	18.3	14	14
			Bloom	72	5200	32	52	1.4	19.0	10	10
		80	Planting	67	5000	30	46	1.6	19.1	19	11
			Vegetative	69	4400	36	65	1.0	18.3	20	24
			Bloom	67	5100	27	64	1.3	18.4	22	19
	Early Bloom	0	----	61	4800	34	56	1.2	17.5	0	0
		40	Planting	77	4700	32	62	1.3	18.0	7	6
			Vegetative	80	5000	31	55	1.6	18.2	11	14
			Bloom	69	4200	37	61	1.1	17.6	14	13
		80	Planting	70	6000	26	67	1.4	18.6	19	10
			Vegetative	71	5000	32	70	1.1	18.2	29	28
			Bloom	64	5300	30	67	1.1	17.9	30	22
Overall average for early I.I.				72	4800	31	59	1.3	18.4	13	12
Overall average for late I.I.				71	4900	30	65	1.3	17.8	15	13
Overall average for pH 5.6				73	4800	30	65	1.3	17.8	14	12
Overall average for pH 6.5				69	4900	32	59	1.3	18.3	14	13
Overall average for no. N checks				71	4600	30	63	1.3	18.0	0	0
Overall average for 40 lb N/A @ planting				73	4900	31	62	1.3	18.1	8	5
Overall average for 40 lb N/A @ vegetative				73	4900	32	59	1.4	18.0	12	14
Overall average for 40 lb N/A @ bloom				70	4700	32	63	1.2	18.1	14	11
Overall average for 80 lb N/A @ planting				72	5300	28	59	1.5	18.4	16	9
Overall average for 80 lb N/A @ vegetative				73	4500	32	63	1.3	18.2	26	26
Overall average for 80 lb N/A @ bloom				68	5100	30	66	1.2	17.8	25	21

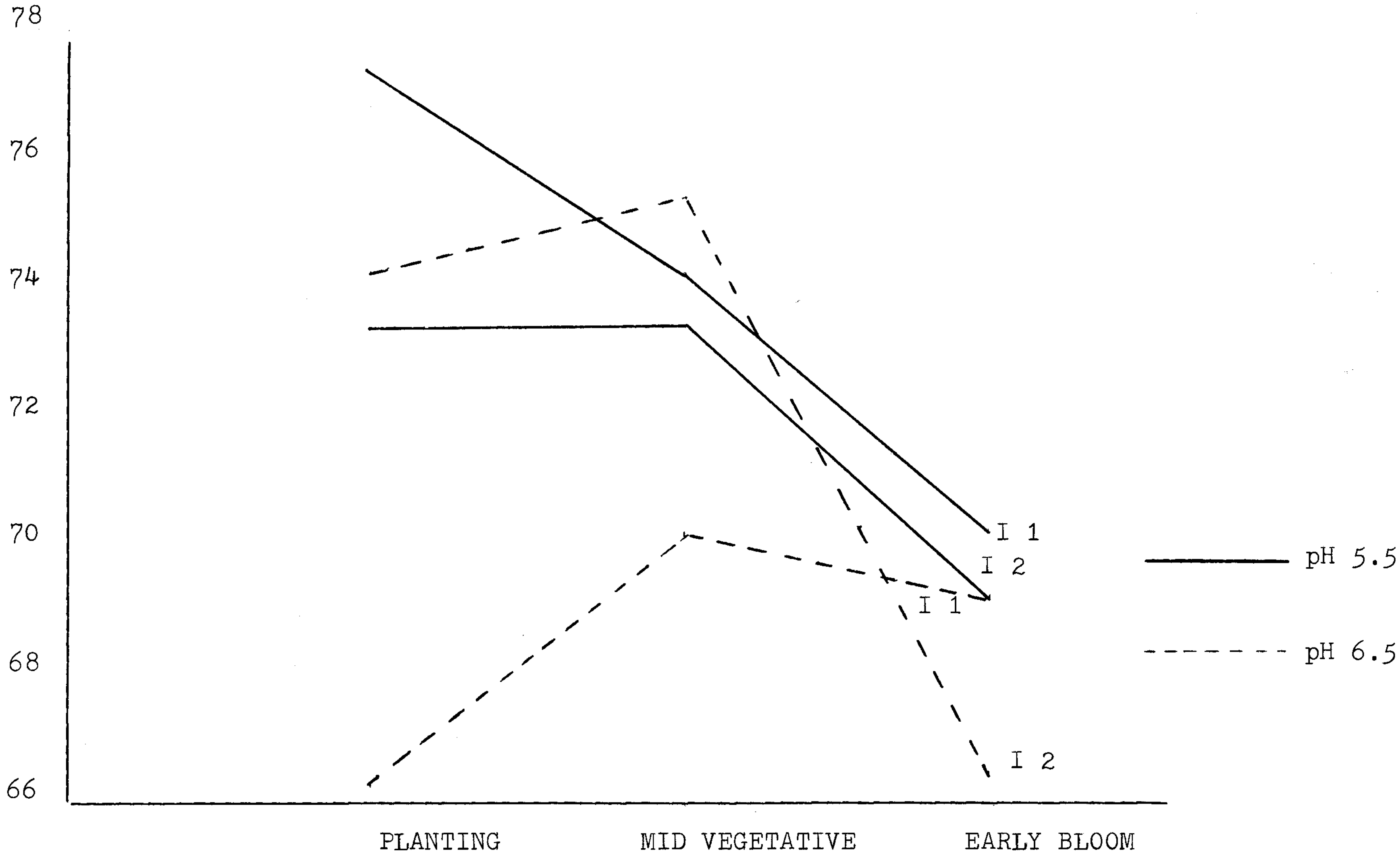


Figure 1. Seed yield (bu/A) Mead 1982.

LIME-INDUCED CHLOROSIS IN.SOYBEANS

R. A. Wiese

Introduction:

Chlorosis in Nebraska crops is a common occurance on high pH soils. Coupled with high soil pH, the chlorotic field sites are frequently, but not always, characterized by somewhat poor internal drainage and variable amounts of exchangeable sodium. High levels of bicarbonate anions in the soil solution has been documented as a causative factor in a number of research reports.

Soybean acreage is expanding in areas of calcareous soils heretofore exempted from growing soybeans. In the past decade the economics of soybean production has increased and several new substances for chlorosis treatment have entered commercial channels.

Objective:

The objective of this research is to evaluate the effects of several substances in reducing chlorosis in soybeans with different methods of application.

Procedure:

High pH soil sites, usually above 7.7, with increasing pH and calcium carbonate to soil depths of 24 inches were selected as test sites. All sites had a previous history of soybean chlorosis.

Various rates of different materials were either applied with the seed at planting, as a foliar spray or as a post emergence treatment.

Results and Discussion:

Experiment I. Seed spacing and treatment with Iron-Sul[1/]

Soybeans were planted at 4, 6 and 12 seeds per foot of row in 30-inch rows using a Mead variety, with and without Iron-Sul at a rate of 150 lbs/A on a Gibbon silty clay loam site. Treatments were replicated 4 times.

The rate of Iron-Sul at 150 lbs per acre is nearly twice the recommended safe rate of 70 to 90 lbs per acre for seed placement at planting. Stand depressions occurred with ultimate yield reductions. Yield was reduced 18, 36 and 53 percent for the 12, 6 and 4 seeds per foot of row respectively when Iron-Sul was applied at the excessive rate of 150 lbs per acre (Table 1). As planting density increased from 4 to 6 to 12 seeds per foot of row yield increases averaged about 10 bushels per acre with and without Iron-Sul.

Experiment II. Post emergence row placement two sulfur sources compared with foliar Fe-DPS and no treatment.

Two materials, Iron-Sul and Cal-Sul[2/] were placed 3 inches deep and 1-1/2 inches beside the row of Stine 2050 variety soybeans at the monofoliate leaf stage at rates of 450 lbs/A. Fe-DPS[3/] was foliar applied at 5 lbs of material

1/ A product of Duval Sales Corporation, containing 20% Fe and 30% sulfur.
2/ Cal-Sul is granular gypsum; American Pellitizing Corp.
3/ Fe-DPS is Hamp-Iron 845, containing 5% Fe; W. R. Grace Co.

per acre on the same day as the row placed sulfur sources. Treatments were replicated 5 times. Stine 2050 variety soybeans were planted on a Gibbon silty clay loam site having a surface soil pH of 7.9 in late June.

Treatment took place prior to full development of the first trifoliate leaf and prior to development of any visible chlorosis symptoms. Both Iron-Sul and Cal-Sul increased yields equally (Table 2). Both products contain sulfur. The Cal-Sul contains 2% ligno-sulfonate used as a binding agent, which as a chelating substance may also be contributing to the measured yield gain. The highest yield was attained by Fe-DPS. Final stands of the Stine 2050 variety averaged about 6 plants per foot of row on the experimental site. The lower plant stand may have contributed to the significant yield increases.

Table 1. Effect of seed placed treatment and planting density on yield of soybeans.

Planting Density No. of seeds/foot of row	Iron-Sul Applied (lbs/A)	Soybean Yield (bu/A)
12	0	41.2 a
	150	29.6 bc
6	0	31.3 b
	150	19.9 d
4	0	22.4 cd
	150	10.5 e

L.S.D.$_{.05}$ = 7.37, Dodge Co., North Bend, Emanuel

Table 2. Effect of post emergence row placed sulfur sources on soybean yield.

Treatment	Rate/A (lbs)	Method of Application	Soybean Yield (bu/A)
Iron-Sul	450	Row	43.9 b
Cal-Sul	450	Row	43.6 b
Fe-DPS	5	Foliar	64.6 a
Check	--	--	24.7 c

L.S.D.$_{.05}$ = 17.9, Dodge Co., Fremont, Kracl

Experiment III. Foliar application of materials on soybean Stine 2050 variety at an early onset of chlorosis.

Four different materials were foliar applied at selected rates on Stine 2050 soybeans at the time the first trifoliate leaf was very visibly chlorotic. Fe-EDDHA, Fe-DPS, $CaSO_4$ and Malic acid were applied and a repeated application was made one week later on 4 replications. All materials were applied in a volume of 20 gal. per acre.

Fe-EDDHA gave the highest reduction in chlorosis (Table 3). Yield increases, however, have to be around 2 to 3 bushels per acre to be economical to use for one pound of Fe-EDDHA. Fe-DPS not known for consistent yield increases on chlorotic plants from foliar application, did show a respectable yield increase compared to the check. $CaSO_4$ was tested to determine effects of the $SO_4^{=}$ anion as was malic acid, reported to be related chlorophyll metabolism in C-4 plants.

Plant population at an average of 6 plants per foot is one factor which may have contributed to yield increases from the treatments in this experiment.

Table 3. Effect of foliar application of materials on soybeans.

Foliar Treatment	Amount of material applied per acre in a 20 gallon volume	Soybean yield (bu/A)
Fe-EDDHA	1 lb	57.7 a
Fe-DPS	1/2 gal	43.1 b
Malic Acid	5 lbs	36.8 bc
$CaSO_4$	0.4 lb	34.7 bc
Check	--	27.1 c

$L.S.D._{.05}$ = 11.2, Dodge Co., Fremont, Kracl.

Experiment IV. Effects of residual Iron-Sul rates on soybean yields, 2 years after application.

Rates of Iron-Sul were broadcast at 0, 300, 600 and 900 lbs per acre and replicated four times on a Gibbon silty clay loam site in 1980 prior to planting soybeans. Soybean yields were increased and visible differences in chlorosis and growth were recorded in the year of application. Calland variety was used in the year of application. In the subsequent year corn was grown in the experiment site and soybeans (Stine 2050 variety) was grown in 1982. Residual effects of treatment were measured by soybean yield in 1982.

No significant differences in soybean yields were obtained from the residual effects of Iron-Sul applied 2 years ago (Table 4).

Table 4. Effect of residual Iron-Sul on soybean yields.

Treatment lbs Iron-Sul/A	Soybean yield (by/A)
0	48.6 a
300	50.2 a
600	50.1 a
900	53.4 a

$L.S.D._{.05}$ = 7.9, Dodge Co., Fremont, Kracl.

Experiment V. Application of selected materials and selected rates seed placed at planting.

Seed placed materials at planting is an approach aimed at preventing chlorosis during the seedling growth stage and is a practical way for soybean growers to treat known field problem areas. Eleven treatments were selected for seed placement. Mead variety soybeans were planted in late June at a rate of 9 seeds per foot of row. Treatments were replicated four times.

Iron-Sul was included in this treatment at a rate of 150 lbs per acre. This rate was too heavy and resulted in no soybean germination. The experimental site had a history of mild chlorosis some years in contrast to other experimental sites which were known to give soybean chlorosis most years. No significant difference in yields were obtained. No chlorosis was observed during the growing season (Table 5).

Table 5. Seed placed treatment of materials on Mead soybean yields.

Treatment material	Rate per acre	Soybean yield (bu/A)
Agri-Plex	1 gal	45.8
4/Iron Ke-Min	50	42.1
Check	--	41.4
5/Dow XP73021	1 gal	41.3
Cal-Sul	150 lbs	40.2
6/Alka-6	20 lbs	40.0
Fe-DPS	1 gal	39.6
7/DPS (L)	1 gal	38.4
Fe-DPS (v)	60 lbs	38.4
Fe-EDDHA	5 lbs	37.2

$L.S.D._{.05}$ = 8.20, Dodge Co., North Bend, Emanuel

Experiment VI. Foliar application of selected materials on Stine 2050 soybeans.

Five materials were applied as a foliar spray on Stine 2050 variety soybeans. Materials were applied 16 days after planting at the time the first trifoliate leaf was two-thirds fully developed and slight chlorosis was exhibited on the leaf. The experimental site was on a Gibbon silty clay loam which was too wet to plant until June 28 and subsequently heavy rains caused flooding across the plot area on two occasions. All treatments were replicated five times and applied in volume of 20 gallons per acre.

No differences in yield were measured as a result of foliar application of materials. The early chlorosis at the time of foliar application disappeared and soybeans retained a normal green the remainder of the growing season (Table 6).

4/ Iron Ke-Min is a lignosulfonic acid based complex chelate containing 4.4% Fe; Georgia Pacific.
5/ Dow XP73021, an experimental product from Dow Chemical Co.
6/ Alka-6, a complex chelate, Cornbelt Chemical.
7/ DPS, The chelate was used with iron, without iron (L) and with iron on vermiculite (v).

Table 6. Effect of foliar treatment on soybeans.

Material	Rate/Acre	Soybean Yield (bu/A)
Fe-DPS	0.5 gal	30.8
Fe-EDDHA	1 lb	29.0
Check	--	27.8
Malic Acid	5 lbs/A	27.3
Gypsum	0.2 lbs/A	26.2

$L.S.D._{.05}$ = 7.27, Dodge Co., North Bend, Emanuel.

EFFICIENT NITROGEN USE FOLLOWING SOYBEANS IN ROTATION

E.J. Penas and M.D. Clegg

Objectives:

1. Determine the nitrogen equivalent contribution of soybeans as measured by the yield response of the crop following soybeans.

2. Determine the amount of supplemental nitrogen which results in maximum economic yield of the crop following soybeans.

Procedure: This study involved sites in Lancaster and Otoe Counties. Soil samples were collected to a depth of 6 feet at each site. Surface soil samples were analyzed for pH, phosphorus, potassium and organic matter, and all samples were analyzed for nitrate nitrogen. These data are presented in the accompanying table.

Nitrogen was applied shortly after planting using ammonium nitrate. Rates in 20 pound increments were used. Plant samples were collected during the growing season and grain yields were determined at maturity.

Results and Discussion: All data from this past year have not been completed at this time; however, the following information has been obtained.

Soil nitrogen was low at the Lancaster County site. There was 61 pounds per acre nitrate nitrogen in the 6 foot depth of soil following grain sorghum and 44 pounds per acre following soybeans. At Otoe County, the soil following grain sorghum contained 156 pounds of nitrate nitrogen per acre 6 feet and the soil after soybeans contained 89 pounds per acre 6 feet.

Nitrogen increased grain sorghum yields in both soils in Lancaster County. Yield was increased from 72 bushel to 82 bushels per acre with 60 pounds of nitrogen per acre on the sorghum ground. On the soybean ground yield was increased from 76 bushels to 92 bushels per acre with 60 pounds of nitrogen per acre; however, the maximum yield of 96 bushels per acre was achieved with 100 pounds of nitrogen per acre following soybeans. Grain sorghum yield, where no nitrogen fertilizer was applied, was 4 bushels per acre higher even though soil nitrogen was 17 pounds per acre lower and maximum yield was 14 bushels per acre higher where soybeans were grown the previous year. These data suggest that soybeans had a nitrogen replacement value of approximately 60 pounds of nitrogen per acre.

At Otoe County, nitrogen application had no effect on grain sorghum yields. Where soybeans had been grown the previous year, soil nitrogen content of 89 pounds per acre plus the benefits of soybeans was adequate for the 90 bushel per acre yield of grain sorghum. Where sorghum was the previous crop the soil did contain 156 pounds of nitrate which is sufficient for the 97 bushels produced without nitrogen.

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

NITROGEN RATES ON GRAIN SORGHUM

SOIL TEST DATA

County & Previous Crop	Soil ph	Nitrogen lbs/ac 6 ft.	Phosphorus, ppm	Potassium, ppm	Organic Matter, %
Lancaster					
Sorghum	5.9	61	5 VLo	200 VHi	2.4
Soybeans	6.1	44	17 Hi	305 VHi	2.4
Otoe					
Sorghum	5.7	156	8 Low	306 VHi	2.8
Soybeans	5.8	89	9 Low	257 VHi	2.8

GRAIN YIELDS

County:	Lancaster		Otoe	
Previous Crop:	Sorghum	Soybeans	Sorghum	Soybeans
Nitrogen Rate, lbs/ac	--------Grain Yield, bushels per acre-------------			
0	72	76	97	90
20	78	83	103	86
40	81	89	88	92
60	82	92	92	90
80	81	95	91	90
100	78	96	92	85
Response:	Yes	Yes	No	No
Soil Nitrogen, lbs/ac 6 ft:	61	44	156	89
Organic Matter, %:	2.4	2.4	2.8	2.8

Availability of Nitrogen Fertilizer as Affected by Tillage

J. F. Power

Since 1979, Dr. J. F. Power and associates with the Agricultural Research Service (USDA) at the University of Nebraska-Lincoln in Lincoln have been studying the availability and utilization of fertilizer nitrogen by winter wheat produced on plowed, stubble-mulched, or nontilled (ecofallow) fallow systems. This research has been conducted at the High Plains Agricultural Lab at Sidney, Nebraska, in cooperation with C. R. Fenster and G. W. Peterson. Ammonium nitrate containing tagged (isotopic) nitrogen was surface broadcast on winter wheat at 40 lb N/acre in April of both 1979 and 1980 (crop-fallow sequence). Soil and plant materials were sampled periodically for three growing seasons until two crops of wheat had been harvested after the tagged fertilizer was applied. The amount of tagged N in the growing crop, crop residues (both undecomposed and partially decomposed), and remaining as inorganic N in the top 4 inches of soil was measured during this period.

About 22% of the fertilizer N applied to the 1979 crop was removed in the grain of that crop, with no significant differences between methods of fallow (Table 1). The straw remaining after wheat harvest contained 10, 6, and 4% of the fertilizer N applied, respectively, for wheat produced on plowed, stubble-mulched, and nontilled fallow. Fertilizer N present as inorganic (ammonium plus nitrate) N in the soil after harvest amounted to 26% of that applied for plowed fallow, 14% for stubble mulched, and 10% for nontilled. Up to 10% of the fertilizer N applied in April 1979 was present in the crop residues by June of that year.

During the fallow period (plowed and stubble-mulched tillage were not initiated until April 1980), fertilizer N present as inorganic soil N practically disappeared from the plowed and stubble-mulched soil, but remained in the 4 to 7% range of that applied for the nontilled soil. Similar trends continued through the 1981 cropping season. Likewise, fertilizer N in the crop residues amounted to only 2 to 3% of that applied for plowed fallow, around 5% for stubble-mulched fallow, and near 10% for nontilled fallow. Uptake of N from the 1979 fertilizer treatment by the 1981 wheat crop accounted for 5 to 8% of the fertilizer applied, with the higher values for no-till. Recovery of fertilizer N in the grain of the two 1979 plus 1981 wheat crops combined was 23, 26, and 27%, respectively, for plowed, stubble-mulched, and nontilled fallow. After harvest of the second wheat crop, only 5% of the fertilizer N applied in 1979 was still present in soil inorganic N and crop residues combined for the plow and stubble-mulch treatments, and 9% for the no-till treatment. Fate of the fertilizer N applied to the 1980 wheat crop was similar to that discussed above for fertilizer N applied to the 1979 crop.

These results indicate that nontilled fallow tends to accumulate more fertilizer N in the crop residues and as soil inorganic N in the upper 4 inches of soil than does tilled fallow. Most of the fertilizer N recovered in wheat grain occurs during the year of fertilization, although a small amount is recovered in the second wheat crop. Generally, slightly more fertilizer N is recovered by wheat produced on nontilled fallow than by that produced on plowed fallow. However, for all tillage systems, only about 25% of the fertilizer N applied was finally removed from the field in harvested grain, indicating the extreme inefficiency of present fertilizer practices.

Table 1. Percent of fertilizer N accounted for after application in April 1979 to winter wheat growing on soil fallowed by different methods at Sidney, Nebraska.

N fraction	Sampling date							
	5/79	7/79	10/79	4/80	7/80	9/80	5/81	7/81
	-------------------% of fertilizer N applied------------------							
				A. PLOWED FALLOW				
Soil inorganic	48	23	3	0	1	0	1	0
Whole plant	18	31	10*	0	0	0	5	3*
Grain	0	21	21	21	21	21	21	23
Visible residues	0	8	3	2	1	1	2	1
Decaying residues	1	0	3	2	1	1	1	1
Total	67	83	40	25	24	23	30	28
				B. STUBBLE-MULCHED FALLOW				
Soil inorganic	39	14	5	0	1	0	1	0
Whole plant	28	28	6*	0	0	0	7	2*
Grain	0	22	22	22	22	22	22	26
Visible residues	1	6	3	5	3	3	3	2
Decaying residues	1	1	2	3	2	3	2	1
Total	69	71	38	30	28	28	35	31
				C. NONTILLED FALLOW (ECOFALLOW)				
Soil inorganic	36	10	7	6	7	4	4	4
Whole plant	26	28	4*	0	1	0	8	3*
Grain	0	24	24	24	24	24	24	27
Visible residues	2	8	7	5	7	6	4	4
Decaying residues	1	2	5	4	5	6	1	2
Total	65	72	47	39	44	40	41	40

*Standing straw.

The effects of time and tillage on soil nitrogen

in a wheat fallow rotation.

J.A. Lamb, G.A. Peterson, J.W. Doran, and C.R. Fenster

Many researchers have noted a loss of soil nitrogen from native soils when placed under cultivation. All of these studies to date have looked at this effect of tillage in an "after the fact" fashion. A set of experiments were started at the High Plains Ag Lab, Sidney, NE in 1970 in a native sod pasture to study soil N changes with time under three tillage systems. A nitrogen budget was used to evaluate the nitrogen losses or gains (table 1). Table 2 provides the statistical analysis for the budget. Total N was affected by tillage in both experiments. Most of the nitrogen changes occurred in the 0 - 10 cm. depth. Grain removal did not account for all the N loss from the soil in the plow and stubble mulch tillage systems but did in the no-till. To account for the losses, erosion, leaching, and denitrification were evaluated. Since the soil is a dynamic system, gains from rainfall and non-symbiotic N_2 fixation were also examined. The budget shows a differential loss of nitrate-N beneath the rooting zone of each tillage system from leaching. The plow system lost the largest amount where no-till lost the least. When this was taken into consideration, the nitrogen budget was balanced for the plow and stubble mulch tillage systems and showed a positive account for no-till. The exception is the plow in tillage C which showed a negative budget. This was due to a flooding event which occurred before the leached nitrate-N samples were taken. The balanced or positive budgets indicate that denitrification was not a predominate force in the N budget. Erosion was also ruled out due to the landscape position of the experiment. A gains from rainfall would be equal for all tillages due to the small area they encompass.

One possible process that could cause a positive budget was non-symbiotic N_2 fixation. Table 3 shows results from the first year (1982) of sampling. These results indicate that no-till in the early fallow portion of the rotation had the greatest potential to fix N_2. This was obtained through use of acetylene reduction assay on intact soil cores. In the cropped portion of the rotation there does not appear to be a difference in the potential to fix N_2 between tillage systems. The differences in ethylene production with acetylene reduction were related to the water filled pore space of the soil. More work with acetylene reduction is planned in 1983.

To determine the origin of the N losses, soil N was fractionated into four parts, fixed ammonia, exchangeable ammonia, nitrate-N, and nonhydrolyzable-N. Table 4 shows the amounts of N in kg N/ha in each fraction and total N for the 0-30 cm depth. The nitrate-N and exchangeable ammonia fractions were too variable to detect a trend. The fixed ammonia fraction was not changed by cultivation. Nonhydrolyzable-N has been changed by tillage. More tillage disturbance resulted in more loss from this N fraction. Included in the nonhydrolyzable-N fraction is the fixed ammonia and very resistant organic N fractions. Since the fixed ammonia amounts have not changed, it seems that that a substantial amount of highly resistant organic N was released into the mineral form.

Table 1. Nitrogen balances for Tillage C and D wheat-fallow rotations at High Plains Ag Lab, Sidney, NE.

	Tillage C 1982			Tillage D 1981		
	No-till	Stubble mulch	Plow	No-till	Stubble mulch	Plow
	kgN/ha					
Total N in soil	4540	4280	3760	4050	3720	3580
Total N in sod	4610	4610	4610	4200	4200	4200
Total N change	-70	-330	-850	-150	-480	-620
Grain removal	280	260	240	260	320	280
Unaccounted N	+210	-70	-610	+110	-160	-340
Leached nitrate-N > sod	30	0	100	270	250	370
Balance	+240	-70	-510	+380	+90	+30

Table 2. Statistical analysis for elements in balance.

Source	Total Nitrogen 0-30		0-10		10-20		20-30	
	C	D	C	D	C	D	C	D
Tillage	**	**	**	**	NS	*	NS	++
Sod vs Cropped	**	**	**	**	NS	**	NS	+
No-till vs tilled	**	*	**	**	NS	NS	++	NS
Stubble mulch vs plow	*	NS	**	*	NS	NS	**	++

	Leached Nitrate-N Tillage C	Tillage D
Tillage	++	+
No-till vs tilled	*	*
Stubble mulch vs plow	*	++

**, *, ++, and + are 0.01, 0.05, 0.10, and 0.20 significance levels, respectively.

Table 3. Ethylene (N_2 fixation potential) values and statistics for Tillage C and D ,1982.

Treatment	Ethylene g/ha/da Tillage C Fallow			Tillage D Cropped		
	5/82	6/82	9/82	5/82	6/82	9/82
Sod	9.0	10.0	25.0	8.0	6.0	37.0
No-till	13.0	12.0	13.0	5.0	5.0	11.0
Stubble mulch	7.0	9.0	13.0	7.0	4.0	11.0
Plow	5.0	5.0	7.0	5.0	5.0	11.0
Rep	+	NS	NS	NS	*	NS
Tillage	+	NS	NS	NS	NS	++
Sod vs rest	NS	NS	NS	NS	++	*
No-till vs tilled	*	+	NS	NS	NS	NS
Stubble mulch vs plow	NS	NS	NS	NS	NS	NS

**, *, ++, and + are 0.01, 0.05, 0.10, and 0.20 significance levels, respectively.

Table 4. The amount of Nitrogen (kg/ha) in four fractions in the 0-30 cm layer.

Fraction	Nonhydrolyzable N	Fixed ammonia	Exchangeable	Nitrate N	Total N
	kgN/ha				
	Tillage C				
Sod	1127	288	22	1	4600
No-till	1088	297	23	25	4523
Stubble mulch	1029	301	20	19	4241
Plow	953	290	20	16	3757
	Tillage D				
Sod	851	228	27	11	4194
No-till	789	249	24	12	4054
Stubble mulch	718	212	24	22	3692
Plow	692	234	23	27	3596

DEEP SOIL SAMPLING TO IMPROVE FERTILIZER RECOMMENDATIONS

J. S. Schepers, K. D. Frank, and C. Bourg

Soil samples were collected to a depth of 4 feet and analyzed by 1-foot increments as part of the Hall County Water Quality Special Project for the years 1979 to 1983. These samples were used to make fertilizer N recommendations for those producers who participated in the N management and irrigation scheduling practices. On the average, one soil core was taken for each 20 acres of land, and field averages were used to make N recommendations.

One objective of this study is to evaluate whether deep sampling can significantly improve N recommendations without reducing yields. For the years 1980 to 1982, combine harvest yields were not affected by these improved N fertilization and irrigation practices, although N fertilizer rates were reduced by an average 83 lb N/acre. Residual nitrate in the soil between 1 and 4 feet was assumed to be 70% effective when making these fertilizer N recommendations. Perhaps this effectiveness value is low because no yield reductions were observed. Another consideration is the nitrate made available to the plant through mineralization, which is not currently a part of N fertilizer recommendations.

Potential N mineralization was determined on four common soil types within the project area. These determinations are made under ideal temperature and water conditions, and, as such, are three to four times greater than what is actually observed in the field. Assuming that about 25% of the laboratory value could be realized in the field, then one could expect the following N mineralized during the growing season:

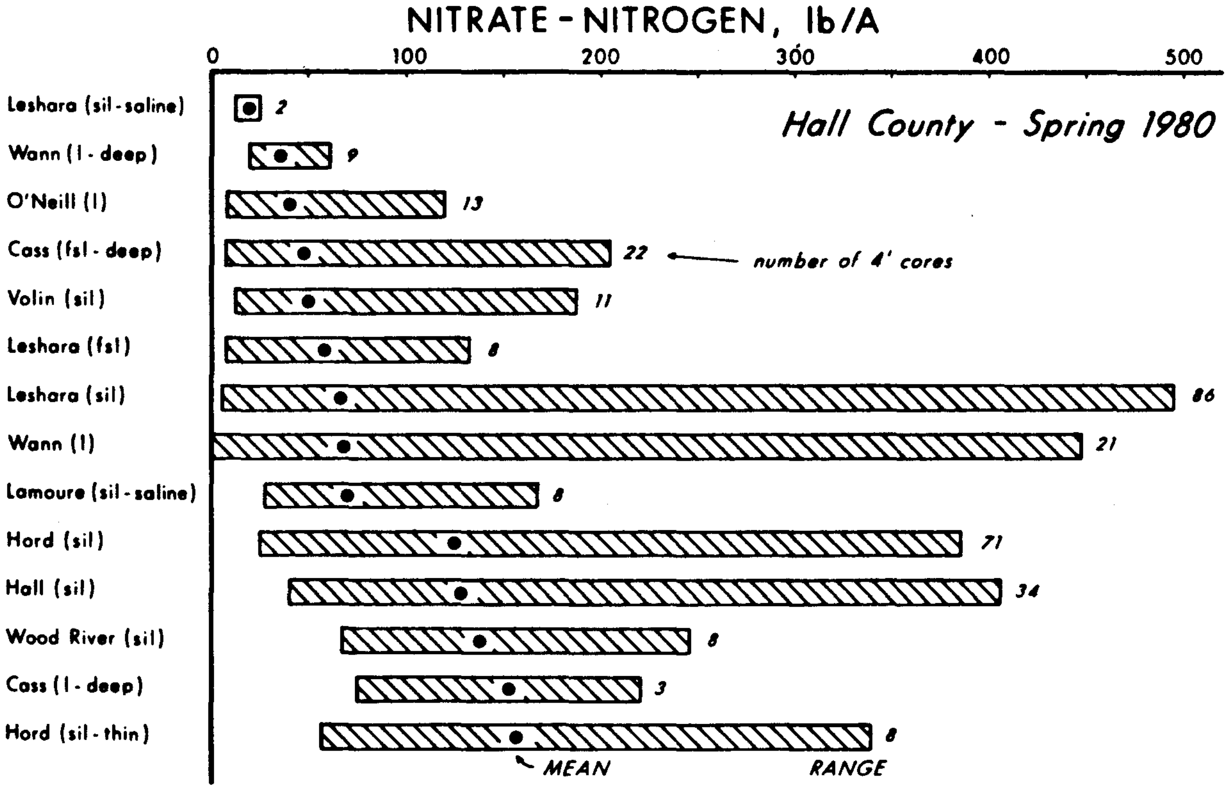
Field	Soil type	N mineralized (lb N/acre) 0 - 8"	8 - 16"
1	Wood River silt loam	74	33
2	Hall silt loam	52	18
3	Cass loam	46	23
4	Wann loam	52	29

Individual fields may vary, depending on cropping history, but these data illustrate the general magnitude of nitrate contributed to the plant by mineralization on soils under irrigation in this area of the Platte River Valley.

Fertilizer N recommendations were made on these same soil types from samples collected throughout the project area before the 1980 growing season to illustrate the importance of deep sampling. For purposes of comparison, a yield goal of 150 bu/acre was assumed, and all residual nitrate was assumed to be available to the plant.

No. of cores	Soil type	N recommended (lb N/acre) 1-ft sample	2-ft sample	3-ft sample	4-ft sample
8	Wood River silt loam	129	97	71	46
34	Hall silt loam	142	107	76	55
22	Cass loam	164	158	143	129
21	Wann loam	156	138	122	109

Variability among various fields was large; therefore, any assumptions about residual nitrate below 1 foot would not be overly reliable. A summary of the preplant residual N for 1980 and the variability is shown below.



Crop and Soil Response to Applied P and K
In a Long-term Buildup/Depletion Study

R. A. Olson, G. W. Rehm, F. A. Andersen and G. A. Peterson

Objectives:

1. Determine level of soil P and K required for assuring most economic yields of corn and wheat.

2. Establish required rates of P and K for maintaining adequate soil test levels for optimum yields on representative Nebraska soils.

Procedure:

This experiment is conducted with irrigated corn on Sharpsburg sicl at the Mead Field Lab, non-irrigated corn on Moody-Nora sil at the Northeast Station, and non-irrigated wheat on Keith sil and Rosebud fsal on the High Plains Ag Lab. There were no yield results for wheat in 1982, accordingly, only data for the corn plots are presented here. All P and K treatments are broadcast before final tillage and planting except for one row treatment at planting on the Mead Lab site.

Results and Discussion:

There was no significant effect of P or K treatments on yield of corn at either location in 1982.

The long term average reveals optimum yield on both soils with 20 lbs P applied annually. There has been no positive yield response to applied K on either soil, although a decided trend of yield reduction exists with the heavier K rate and with row application of the low rate. Precisely why this has occurred is not clear, but it certainly raises question to the practice of adding more nutrient to a soil that is already high to very high in that element.

Surface soil test P of the control plot has declined perceptibly over the 10-year period, especially on the Sharpsburg soil. On both soils ten lbs applied P has approximately maintained soil P at its original level, 20 lbs has approximately doubled and 30 lbs tripled it.

Surface soil test K has not changed perceptibly in the Sharpsburg soil even in the control plots and that added in the treated plots has disappeared in the large existing pool. Soil K appeared to be declining in the Moody-Nora soil through 1980 but was back up to the original values in 1982. The discrepancy probably attributes to the fact that the 1973 and 1982 samples for this soil were collected in the spring, the others in the fall, giving evidence of the significant effect that time of sampling can have on soil test results. As with Sharpsburg, the annual K treatments have essentially disappeared in the native soil pool of exchangeable K.

Table 1. Grain yield and soil test response to applied P and K in a long term P and K buildup/depletion study with irrigated corn on Sharpsburg sicl, Mead Field Lab, 1973-82.

Treatment 1/		Application	Grain yield		Soil Test P (surface) 2/					Soil Test K (surface) 2/				
P	K	Schedule	1982	1973-82	1973	1975	1977	1980	1982	1973	1975	1977	1980	1982
			bu/a				ppm					ppm		
0	0	Control	177a	165	15	12	14	6	7e	320	350	320	361	330a
10	0	Every year @	163a	166	15	15	18	12	12de	311	301	347	341	333a
20	0	Every year @	172a	171	16	16	24	20	27bc	310	323	337	330	328a
30	0	Every year @	171a	171	19	27	34	29	33ab	300	286	334	329	306a
20	0	Every other year	155a	163	16	20	30	9	15de	300	321	391	331	300a
30	0	Every 3rd year @	180a	168	25	12	21	12	11de	288	297	360	309	306a
60	0	Every other year	176a	166	22	41	51	27	33ab	283	307	402	309	292a
60	0	Every 6th year	156a	161	30	14	19	19	15de	288	285	377	315	302a
20	25	Every year @	171a	171	16	16	30	18	18d	296	316	389	329	311a
20	50	Every year @	167a	163	14	20	24	18	20cd	296	304	326	352	330a
10	25	Every year row @	161a	161	11	14	18	10	12de	268	285	420	330	332a

1/ Uniform N application made across all plots for optimum yield (200 lbs N/a in 1982); P and K treatments broadcast before final tillage except for indicated row application; grain yield on 15.5% moisture basis. An @ indicates treatment made in 1982. Means followed by the same letter are not significantly different (p = 0.05) based on Duncan's Multiple Range Test.

2/ Soil P by Bray and Kurtz no.1 extraction; soil K is exchangeable with NH_4OAc extraction.

Table 2. Grain yield and soil test response to applied P and K in a long term P and K buildup/depletion study with irrigated corn on Moody-Nora sicl, Northeast Station, 1973-82.

Treatment1/		Application	Grain yield2/		Soil Test P (surface)2/					Soil Test K (surface)3/				
P	K	Schedule	1982	1973-82	1973	1975	1977	1980	1982	1973	1975	1977	1980	1982
			bu/a				ppm					ppm		
0	0	Control	100a	108	10	10	9	8c	8	223	185	195	169b	242
10	0	Every year @	100a	116	9	11	13	9bc	12	220	179	179	157b	220
20	0	Every year @	106a	119	12	12	16	11bc	20	228	177	187	164b	230
30	0	Every year @	103a	117	22	20	27	17a	31	234	175	198	164b	266
20	0	Every other year	102a	113	9	11	12	8c	10	218	179	196	181ab	228
30	0	Every 3rd year @	99a	114	17	9	12	8c	10	224	178	190	166b	224
60	0	Every other year	109a	118	11	13	22	17a	41	213	173	202	155b	248
60	0	Every 6th year	100a	114	11	12	11	9bc	11	202	166	189	175b	220
20	25	Every year @	105a	117	10	12	16	13abc	22	220	181	204	170b	272
20	50	Every year @	105a	113	11	14	19	14ab	22	238	210	218	214a	271

1/ Uniform N application made across all plots for optimum yield (80 lbs N/a in 1982); P and K treatments broadcast before final tillage; grain yield on 15.5% moisture basis. An @ indicates treatment made in 1982. Means followed by the same letter are not significantly different (p = 0.05) based on Duncan's Multiple Range Test.

2/ No yield in 1974 due to drouth.

3/ Soil P by Bray and Kurtz no.1extraction; soil K is exchangeable with NH_4OAc extraction.

AVAILABILITY OF THREE DIFFERENT PHOSPHATIC FERTILIZER SOURCES ON FOUR SOILS

P.J. Sutton, G.A. Peterson and D.H. Sander

Problem:

The essentiality of available P for maximum yield response is well documented. Effective P fertilization is predominantly dependent upon the soil environment into which it is placed. Two of the more important soil factors influencing P availability are soil minerals and soil-solution pH. Traditionally, various forms of calcium phosphate fertilizers have been employed to correct P deficiencies of field crops. The nature of the soil chemical reactions instigated by this practice results in many mineral components coming into solution. This increases the potential of P being precipitated out of the system as insoluble and unavailable P compounds.

The solubilities of various calcium phosphates are directly related to the pH of the system, decreasing in solubility with increasing pH. Both variscite ($AlPO_4 \cdot 2H_2O$) and strengite ($FePO_4 \cdot 2H_2O$) increase in solubility with increasing pH and because of this behavior, it is possible that iron and aluminum phosphates may supply a more readily available source of P in systems of higher pH.

Soils high in carbonates and having pH's in the range of 7.2-8.2 are representative of many western Nebraska soils. Phosphorus availability from calcium phosphate sources in these calcareous soils is strictly limited due to the relatively rapid rate of P precipitation and lower solubility of the calcium phosphates in this soil environment.

Objective:

To determine the availability of equivalent rates of $AlPO_4$, $FePO_4 \cdot 2H_2O$, and $Ca(H_2PO_4)_2 \cdot H_2O$ on 3 calcareous Rosebud soils and one acid Sharpsburg soil over time.

Procedure:

An incubation study was started using 4 soils (Table 1) and 3 phosphorus fertilizer sources (applied at equivalent P concentrations of 45 $KgHa^{-1}$) over a 16 week period. The soils were kept at field capacity and at a constant temperature of 25 C throughout the study. To evaluate changes in P availability, each week, one sample from every soil and P-fertilizer source was air-dried and analyized for P using either the $NaHCO_3$ or Bray & Kurtz 1 extracting techniques.

Table 1: Characteristics of Soils Used

Soil Type	Soil pH soil:H_2O	Soil pH $CaCl_2$	%OM	$CaCO_3$	Initial ppm P B&K 1	Initial ppm P $NaHCO_3$
Soil 1:						
Aridic Argiustoll, Fine-loamy, mixed, mesic Rosebud loam, 0-1%	7.4	6.8	1.6	0.45	---	7.8
Soil 2:						
Aridic Argiustoll, Fine-loamy, mixed, mesic Rosebud loam, 0-1%	8.0	7.4	2.0	1.36	---	10.7
Soil 3:						
Ustic Torriorthent, loamy, mixed (calcareous), mesic, shallow Canyon loam, 3-5%	8.2	7.8	1.1	8.40	---	3.7
Soil 4:						
Typic Argiudoll, Fine, montmorillonitic, mesic Sharpsburg sicl, 3-5%	5.7	---	2.4	---	20.1	---

Results & Discussion:

In all 3 calcareous soils, the Al-P and Fe-P sources show a gradual increase over a 16 week period in the concentration of $NaHCO_3$ extractable P (Figure 1). The concentration of P being extracted from the calcareous soils having the Ca-P source is initially higher than that the Al-P or Fe-P sources, but appears to level off, or as in Soil 3, to decrease over time. If these trends are linearly extrapolated, there appears the possibility that the Al-P source, and more likely the Fe-P source will equal, if not surpass the Ca-P source in the concentration of extractable P being measured.

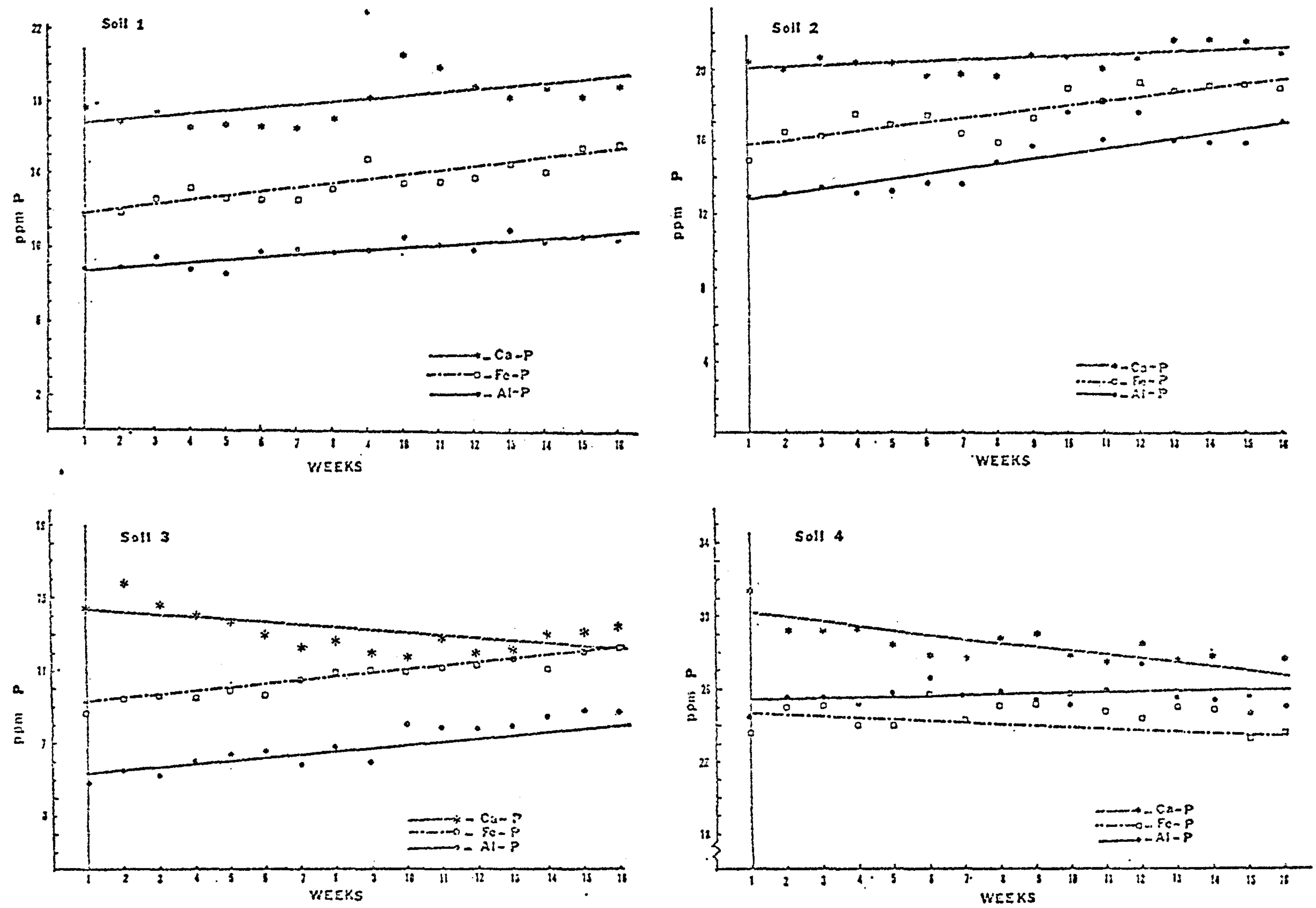
The acid soil shows both the Fe-P and Ca-P decreasing in the P concentration over the 16 week study (Figure 1). The Al-P source appears to be staying relatively constant over time with respect to P concentration.

The incubation study is being continued for an additional 36 weeks to better determine if these trends in the amount of P being released from these 3 phosphorus fertilizer sources remains the same, levels off and/or decreases over time.

Table 2: Statistics relevant to the regression of ppm P in the soil on incubation period.

	Intercept	*b*	Std. Error of *b*	R^2	Lack of fit
Soil 1:					
Al-P	8.64	0.03	0.20	0.76	NS
Fe-P	11.54	0.24	0.28	0.83	NS
Ca-P	16.47	0.18	0.53	0.44	**
Soil 2:					
Al-P	12.46	0.28	0.45	0.71	NS
Fe-P	15.48	0.24	0.37	0.75	NS
Ca-P	19.89	0.08	0.28	0.33	NS
Soil 3:					
Al-P	5.07	0.17	0.20	0.83	NS
Fe-P	8.88	0.20	0.18	0.90	NS
Ca-P	14.46	-0.14	0.45	0.40	NS
Soil 4:					
Al-P	25.29	0.03	0.34	0.05	NS
Fe-P	24.71	-0.02	0.39	0.02	NS
Ca-P	30.15	-0.22	0.51	0.55	NS

Figure 1. Plots for the regression of ppm P on the number of weeks incubated for three phosphatic fertilizer sources applied to three calcareous and one acid soil.



Plant Response to Added Topsoil and Fertilizer on an Eroded Loess Soil

L. N. MIELKE AND J. S. SCHEPERS

Objective:

Determine crop response on a deep loess soil where topsoil was replaced after removal by erosion or stripped during construction of erosion control structures.

Location and Soil Description:

The field site was in Stanton County in northeast Nebraska 9.5 miles (15.3 km) south of Stanton. The soils are a Crofton-Nora [fine-silty, mixed (calcareous), mesic Typic Ustorthent] - [fine-silty, mixed, mesic Udic Haplustolls] complex consisting of deep, well drained, moderately steep soils on ridges and side slopes of uplands. These soils form on loess and represent the major soil complex in the county, consist of loess uplands and till plains, and are included in Major Land Resource Area 102B. The A_1 horizon is 0 to 127 mm; dark grayish brown (10YR412) (10YR3/2 moist); the AC_1 horizon 127 to 279 mm was a pale brown (10YR6/3) (10YR5/3 moist); the C_1 horizon 279 to 559 mm was a light, yellowish brown (2.5Y6/4) (2.5Y5/4 moist); and the C_2 horizon 559 to 1525 mm, pale yellow (2.5Y7/4) (2.5Y5/4 moist). All horizons were silt loam in texture .

Procedure:

The research site was on the nose of the ridge where the A_1 and AC_1 horizons had been eroded, exposing the C_1 horizon. Topsoil was added in depths of 0 (S_0), 100 (S_{100}), or 200 (S_{200}) mm of 1980 in a randomized, complete block design with six replicates for each treatment with plots 6 x 12 m. In the spring of 1981 each group of two replicates was combined into pairs. One of the topsoil application replicates within each pair was randomly selected to receive supplimental fertilizer above that applied by the producer. The amount of supplimental fertilizer was based on soil test data and observations that severely eroded soils in the area sometimes respond to N and P fertilizer above that recommended by testing procedures (Table 1). Zinc was added because the exposed subsoil was very light in color and it frequently gives a response not consistent with the high level indicated by the acid soluble soil test on these calcareous soils.

Soil was added in the fall and the field was chisel plowed to 200-mm depth in the spring, disked, and planted on May 23, 1981 to corn in 1.02 m row sporing. Corn was cultivated once and harvested September 29. The average depth of added topsoil was measured at four places in each plot. Soil bulk density was determined for the 0- to 76-, 76- to 152-, and 152- to 304-mm depth. Corn Seed placement depth was measured 5 days after planting, and emergence index was measured 13, 18, and 20 days after planting. Precipitation was determined with an 8-inch standard rain gauge and a recording weighing rain gauge within 100 m of the site. Soil water content was determined gravimetrically in the surface 300 mm five times during the growing season. Corn yield was calculated from two 7.6-m length of rows, hand-harvested, and corrected to 15.5% water content. Plant population was measured and average ear weight and ears per plant were calculated.

Oats were planted after a light disking the first week of April in 1982. Dry-matter weight was determined based on 1-m^2 sample of plants May 28, June 15, July 2, and July 20. Grain and plant dry matter yield were measured on the July 20 sample. Plants were clipped at the soil surface and dried at 65°C.

Plant samples were ground, subsampled and analyzed for total Kjedaluhl nitrogen (TKN).

Results and Discussion

The topsoil treatment, applied in December, was sampled for depth 3 months later. Average depth for S_{100} was 132 mm, with a range of 114 to 157 mm, and S_{200} was 227 mm, with a range of 205 to 250 mm. Bulk density was greatest for S_0 for all depths through 304 mm .

Depth of seed after planting was not affected by topsoil depth. Average depth determined from five observations and six replications for S_0, S_{100}, and S_{200}, was 61, 56 and 66 mm, respectively. The percent emergence 13 days after planting was only 40% for S_0 compared to 90% for S_{100} and S_{200} . Five days later, the percent emergence increased to 90% for S_0, but was still less than for S_{100} and S_{200}. Twenty days after planting, emergence was the same for all treatments.

Precipitation was 72 mm in May, which was 26 mm below normal; however, there was good distribution through the month that provided adequate preplant soil water. Soil water available to the crop generally decreased until mid-July in spite of an 86 mm rainfall June 28. Effectiveness of that rain was partially lost because of very high intensity (76 mm hr^{-1}), resulting in runoff losses. Other research at this location showed there was as much as 50% runoff over large areas of the field. Observations of erosion on the plots also suggested great runoff losses of water. In the S_0 treatment, rills formed between the rows that were more than 150 mm deep. Rills were not observed between the rows in the S_{100} and S_{200} treatments. The C_1 horizon is defined in the Soil Survey as weak, coarse, prismatic structure; slightly hard, very friable, but when exposed and dried out, the soil melts down under rainfall and is powdery and essentially structureless. These physical characteristics contributed, in part, to the 7 and 12% increase in plant population for the S_{100} and S_{200} respectively, over the S_0 treatment (Table 1).

Corn yields were greater for S_{100} and S_{200} than S_0. The number of ears per plant was greatest for S_0, which was probably caused by lower plant populations. The smaller average ear weight and fewer plants resulted in reduced yield for the S_0 treatment. Yield of corn was not changed by additional N, P, K, ZN and S fertilizer.

Cool temperatures and above-normal rainfall produced oat plants that were visibly different in color and size on the various treatments. The plants on the S_0 and, to a less extent, S_{100} treatments were yellow and stunted early in the growing season. These observations are also supported by the larger N uptake and dry matter production for S_{200} on May 28 (Table 2). In spite of these conditions, additional fertilizer applied in 1981 did not produce a growth response which suggests the yield response to either added topsoil or topsoil remaining after erosion may be influenced by soil physical properties. This is not to say fertilizer management is not important in restoring productivity to disturbed areas, but when fertilizer applications are nearly adequate, additional fertilizer did not increase yields further. Oat response to the addition of topsoil in terms of dry matter production and N uptake was consistent throughout the growing season. Differences in dry matter production due to topsoil depth became smaller as the plant matured. At harvest, plant dry matter, grain yield and total dry matter were not different for treatments S_0 and S_{100}, were less than for treatment S_{200}. The amount of topsoil added did not affect either plant material or grain N content, however total N uptake was the greatest for S_{200} which was due to the increased grain yield. Since additional fertilizer did not affect oat N content during the season or at harvest but the depth of topsoil did influence dry matter production and N uptake, at least with S_{200}, it suggests the beneficial effects of added topsoil are evident throughout the season. These effects may be partially chemical in nature, but are closely related to the improved rooting conditions and soil physical properties where topsoil is returned after erosion or land shaping operations.

Table 1. Corn yield and plant growth response to depth of topsoil for a Crofton-Nora series. 1981.

Topsoil Depth (mm)	Yield (kg ha^{-1})	Population (plants ha^{-1})	Ear Wt. (g)	Ears (no. $plant^{-1}$)
0	7,729	27,434	264	1.08
100	8,686	29,265	288	1.04
200	8,637	30,663	284	1.00
LSD (0.05)	729	NS	NS	0.06

Table 2. Oats dry matter and plant nitrogen uptake during growing season on a Crofton-Nora soil in northeast Nebraska. 1982.

Date 1982		S_0 (kg ha^{-1})	S_{100} (kg ha^{-1})	S_{200} (kg ha^{-1})	LSD (0.05)
May 28	PDM	1318	1484	1934	162
	PNU	27.7	38.2	51.3	9.1
June 15	PDM	2602	3846	4823	693
	PNU	28.0	40.9	64.4	9.0
July 2	PDM	4784	6219	7868	450
	PNU	43.7	55.2	90.1	5.6
July 20	PDM	6793	6957	8656	973
	PNU	34.9	38.2	38.5	6.2
	GDM	2037	2369	2888	645
	GNU	38.0	47.9	56.5	11.2
	TDM	8831	9326	11544	1458
	TNU	72.9	86.2	94.9	12.1

PDM Plant Dry Matter
PNU Plant N Uptake
GDM Grain Dry Matter
GNU Grain N Uptake
TDM Total Dry Matter
TNU Total N Uptake

POTASSIUM RELEASE FROM MICA, FELDSPAR, AND MIXED MINERALOGY SYSTEMS

D. L. McCallister

Objective:

The principal objective of this study was to determine the relative importance of two factors known to affect potassium (K) release from soil minerals. The specific factors studied were temperature and acidity of the equilibrating medium.

Procedure:

In this preliminary study, specimen grade minerals from geologic sources, rather than soils, were used. This was done so that any changes in the experimental systems could be attributed to the minerals of interest. Small quantities of mica (muscovite), feldspar (microcline), or an equal mixture of the two minerals were equilibrated in acid solutions of varying concentrations at different temperatures for periods of time from 30 minutes to 28 days. The temperatures were chosen to bracket natural conditions and ranged from 278°K (41°F) to 318°K (113°F), whereas the acidity of the solutions was kept fairly high to speed the reactions along. At the time of sampling, the equilibrating solution was separated from the remaining solid by filtration, and the solution was analyzed for acidity (pH), K concentration, and aluminum (Al) concentration. Aluminum was measured because it is an index of decomposition of the mineral structure, which is one way by which K maybe released from soil minerals.

Results and Discussion:

In general, both pure minerals and the mixture of the two minerals showed increases in the quantity of K released with time, with higher temperature, and with increased acid concentration. The pattern of K release in the three cases is somewhat different, however. Figure 1a shows that the initial release of K from the muscovite mica is extremely rapid, so much so that the reaction is essentially complete in less than 7 days for all acid concentrations. The most concentrated acid solution (10^{-1} M) did result in the most K release, but all other reacting solutions released K as well. Figure 1b shows the K release from the microcline feldspar to be similar to that from the muscovite in that the most acidic solution released the most K, but the pattern of release is different. Potassium is released from the microcline more slowly than from the muscovite because we can see the curve still rising at 28 days when the experiment was stopped. The way in which K is released from feldspar minerals is the probable cause of this slower release. Feldspars must be decomposed by acidity to release K, whereas mica can remain essentially intact. This conclusion is supported by higher quantities of Al in the feldspar weathering solutions than in the mica weathering solutions. Aluminum is a major structural component of both minerals and is released during decomposition. Figure 1c shows the K release from the system consisting of equal parts of muscovite and microcline. While the quantity of K released is intermediate between that of the two pure minerals, it is higher than just the simple average of the two. Thus it appears that in a system containing both minerals, K is released preferentially from the muscovite.

While the research reported here is preliminary, it still has application to Nebraska agriculture. Potassium nutrition in the state has rarely been found to be a problem mainly because most intensive cropping has been carried out on medium and fine textured soils which contain large supplies of mica-type minerals such as muscovite. As intensive cropping becomes more common in the sandy soils such as those of the Sandhills, we would expect the possibility of more K fertility problems because the major source of mineral K in these soils is feldspar. Further research in this area will focus on potassium release from predominantly sandy soils and the factors affecting this release.

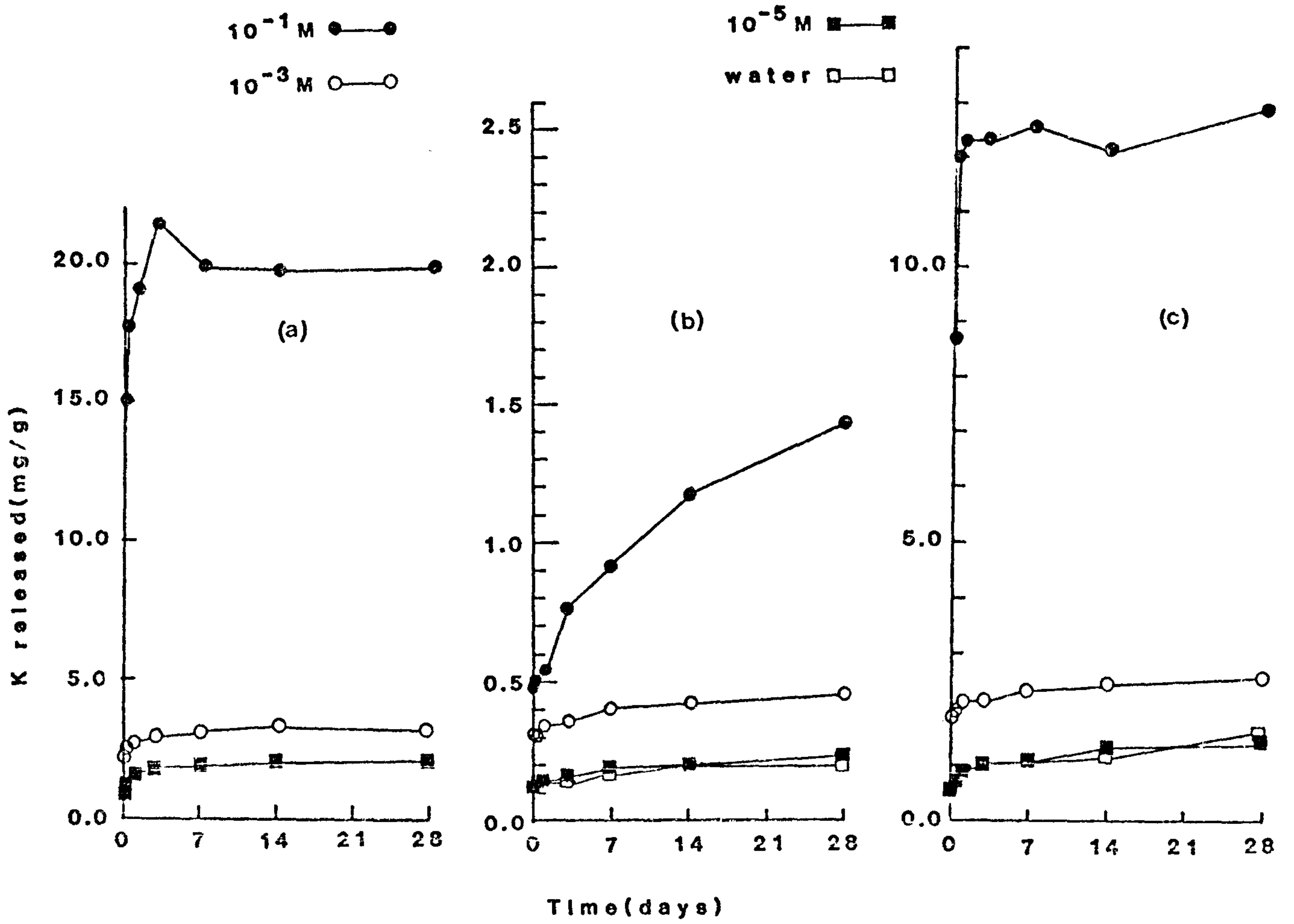


Figure 1. Potassium release from pure mineral systems at 298° K (77°F). a) mica (muscovite); b) feldspar (microcline); c) mixed mica and feldspar. Note that the y axis scales are different on all three figures.

PHYSICS OF WATER IN SOILS AND POROUS MEDIA

D. Swartzendruber

Objective:

The general objective of this project 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 will be considered, under both flooded and unflooded modes of water application.

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.

Results and Discussion:

Downward and upward water intake in narrowly sized (0.15-0.21 mm) quartz sand were measured and analyzed in detail. The classic Green and Ampt equation described downward infiltration very well, but failed badly for upward water rise. Water-content transients (water content versus time at different fixed positions) within the nonswelling sand columns were measured with a single-energy gamma-ray beam (Cs-137). The equation of the cumulative normal distribution was fitted to these data with excellent precision, and provided a quantitative measure of abruptness of the water-content transients. Distinct abruptness is required by Green and Ampt theory. Nevertheless, even for times when upward-rise transients were as abrupt as downward-infiltration transients, the upward Green and Ampt equation still failed. It is hoped to glean these data for further important understanding of the soil-water infiltration process.

For downward infiltration of water into an initially air-dry 1:1 mixture of coarse silt and Wyoming bentonite that swells upward when wetted, water contents and bulk densities were measured with dual-energy gamma-ray attenuation. For several water-content variables plotted against a so-called Boltzmann variable composed of time and material coordinate of the clay-silt, the data points can be reasonably well coalesced into a single curve for all times and positions. This is a basic expression of clay-silt-water behavior, and, for the complicated process of water movement in swelling soils, offers hope that mathematical description may not be nearly as intractable as might have been supposed.

Extensive data were taken with water and optically flat glass plates, to determine the optimal resolving-time correction for the dual-energy gamma-ray beam. Across four replications of glass-water data, the consistently best correction was obtained with a different equation than commonly used heretofore.

SOIL TEST COMPARISON RESULTS IN 1982

F.N. Anderson, K.D. Frank, P.H. Grabouski,
R.A. Olson and G.W. Rehm

Objectives, Procedures:

As in previous years, 1973-81. An additional location was employed on sandy soil in Antelope County in 1982 with the same 5 labs as before plus commercial labs F and G. Also, the long term plot on the South Central Station was terminated and another added on Holdrege sil that had been heavily graded recently for irrigation, with the same 5 labs as before plus lab F employed.

1982 Results:

Tables 1-6 report soil test results, fertilizer recommendations and costs, and yield results for the 1982 experiments. Additionally, the 8 to 10 year averages are given for those sites with long tenure.

As in prior years there were large differences in the kinds and amounts of fertilizer recommended with associated great disparity in costs for fertilizer. Only the Antelope site on very sandy soil evidenced any significant yield difference, and that apparently because lab F provided no S recommendation. The long term results at North Platte, Mead, Northeast Station and Scottsbluff Ag Lab do not in any case reveal significant yield differences.

Table 1. Soil test results, fertilizer recommendations, fertilizer cost and grain yields for the NORTH PLATTE STATION site on Cozad sil, 1982

Measurement	A	B	C	D	E	Check
	Soil Test Results by Labs					
pH	6.3	7.0	6.6	6.0	6.8	
pH (buffer)	7.1	---	---	6.7	---	
P, ppm	52	42	72	112	26	
K, ppm	435	530	560	988	489	
O.M., %	1.6	1.2	1.8	1.5	1.7	
NO_3-N, lb/a	50	70	nil	nil	72	
Ca, ppm	1478	4140	2700	2816	---	
Mg, ppm	205	400	310	432	---	
SO_4-S, ppm	14	23	32	5	19	
Zn, ppm	2.5	3.8	1.27	2 32	1.96	
Fe, ppm	17.6	24	5.7	34	9.6	
Mn, ppm	15.4	15.4	12.2	23.2	8.8	
Cu, ppm	0.7	0.9	2.3	1.1	.49	
B, ppm	0.8	1.6	0.7	0.3	.48	
Na, ppm	13	37	49	---	---	
CEC, meq/100g	11.8	23.5	---	12.1	---	
	Suggested Fertilizer Program, lbs/a					
N	205	135	200	200	160	
P_2O_5	---	30	50	---	---	
K_2O	30	30	---	---	---	
MgO	15	15	10	---	---	
S	---	20	50	15	---	
Zn	---	---	3	---	---	
Cu	---	0.5	0.5	---	---	
B	1	---	0.5	1	---	
	Fertilizer Cost $/acre					
	$42.95	$42.85	$62.00	$35.60	$24.00	
	Grain yield, bu/a					
1982	148	171	168	186	177	169
Total, 1974-82	1502a	1546a	1496a	1521a	1514a	991

Table 2. Soil test results, fertilizer recommendations, fertilizer cost and grain yields for the CLAY CENTER site on leveled Holdrege sil (new site, topsoil removed), 1982

Measurement	Soil Test Results by Labs						Check
	A	B	C	D	E	F	
pH	7.6	6.5	7.3	7.3	7.4	7.4	
pH (buffer)	---	7.3	---	---	---	---	
P, ppm	15	36	13	13	11	25	
K, ppm	412	480	500	629	481	512	
O.M., %	1.2	0.8	0.9	1.0	1.1	1.1	
NO_3-N, lb/a	109	120	106	163	164	132	
Ca, ppm	3186	3070	3970	2940	---	2573	
Mg, ppm	572	720	661	742	---	499	
SO_4-S, ppm	11	34	12	4	17	2.3	
Zn, ppm	0.9	1.9	1.6	1.5	0.9	1.3	
Fe, ppm	16.1	43	15.6	18	13.7	16.5	
Mn, ppm	6.6	16.2	10.6	6	10.4	5.8	
Cu, ppm	1.3	2.4	1.6	1.4	1.4	1.4	
B, ppm	0.4	---	0.8	0.7	0.3	---	
Na, ppm	55	130	68	116	---	146	
CEC, meq/100g	21.9	23.1	---	23.0	---	---	
	Suggested Fertilizer Program, lbs/a						
N	215	220	190	235	87	97	
P_2O_5	80	30	30	90	---	30	
K_2O	30	35	---	---	---	---	
S	5	10	10	20	---	---	
Zn	11	3	---	3.5	4	---	
Mn	---	---	---	5	---	---	
B	1.2	---	---	1	---	---	
	Fertilizer Cost, $/a						
	$70.97	$50.05	$38.30	$72.15	$16.65	$22.35	
	Grain Yield, bu/a						
1982 only	108a	127a	115a	123a	104a	111a	30

Table 3. Soil test results, fertilizer recommendations, fertilizer cost and grain yields for the MEAD LAB site on Sharpsburg sicl, 1982.

	Soil Test Results by Labs					
Measurement	A	B	C	D	E	Check
pH	6.5	6.6	6.4	6.7	6.6	
pH (buffer)	---	7.1	---	---	---	
P, ppm	26	28	90	29	16	
K, ppm	258	400	350	363	338	
O.M., %	1.9	1.5	3.0	2.0	2.6	
NO_3-N, lb/a	8	11	50	15	---	
Ca, ppm	1959	3050	3000	2730	---	
Mg, ppm	333	400	670	358	---	
SO_4-S, ppm	12	18	35	4	10	
Zn, ppm	2.6	2.1	1.6	2.2	1.7	
Fe, ppm	32.7	38	13.7	34	27.2	
Mn, ppm	11.4	15.4	13	14	9.5	
Cu, ppm	1.0	1.1	1.9	1.0	0.7	
B, ppm	0.7	1.2	0.7	1.0	0.3	
Na, ppm	25	47	110	74	---	
CEC, meq/100g	13.3	20.5	---	17.9	---	
	Suggested Fertilizer Program, lb/a					
N	215	210	170	200	180	
P_2O_5	75	50	20	35	---	
K_2O	30	55	30	---	---	
MgO	---	5	---	---	---	
S	---	25	20	12	---	
Zn	---	2	---	2	---	
B	1	.25	.5	---	---	
	Fertilizer Cost, $/a					
198	$58.25	$66 20	$39.90	$43.30	$27.00	
	Grain Yield, bu/a					
1982	192	192	189	191	184	82
1973-82	1613a	1559a	1548a	1565a	1575a	

Table 4. Soil test results, fertilizer recommendations, fertilizer cost and grain yields for the NORTHEAST STATION site on Moody sil, 1982.

Measurement	Soil Test Results by Labs					
	A	B	C	D	E	Check
pH	6.0	5.8	5.4	5.7	5.9	
pH (buffer)	6.8	6.7	---	6.6	6.6	
P, ppm	26	26	43	35	12	
K, ppm	224	290	120	257	274	
O.M., %	2.3	1.7	3.8	3.4	3.0	
NO_3-N, lb/a	32	---	---	146	110	
Ca, ppm	1865	3020	1750	2010	---	
Mg, ppm	373	610	365	496	---	
SO_4-S, ppm	5	14	15	5	4.5	
Zn, ppm	1.5	1.6	.9	1.5	1.7	
Fe, ppm	46	48	6.3	63	39	
Mn, ppm	37.4	27.2	22.3	60	30	
Cu, ppm	1.3	1.5	1.3	1.8	1.2	
B, ppm	.7	1.4	0.5	1.7	.3	
Na, ppm	8	94	22	---	---	
CEC, meq/100g	16.0	24.3	---	18.8	---	
	Suggested Fertilizer Program, lbs/a					
N	48	60	70	25	30	
P_2O_5	40	20	---	20	40	
K_2O	30	15	---	30	---	
S	15	15	---	10	---	
Zn	---	1	---	2.5	---	
	Fertilizer Cost, $/a					
	$24.50	$20.05	$10.50	$17.10	$14.90	
	Grain Yield, bu/a					
1982	143a	150a	151a	149a	152a	
1975-82	834a	831a	844a	825a	845a	

Table 5. Soil test results, fertilizer recommendations, fertilizer cost and grain yields for the ANTELOPE COUNTY location on sandy soil, 1982.

Measurement	Soil Test Results by Labs						
	A	B	C	D	E	F	G
pH	6.5	6.4	5.9	6.6	6.8	6.8	6.6
pH (buffer)	---	7.2	---	7.0	---	---	6.8
P, ppm	30	36	45	35	26	32	27
K, ppm	101	130	115	121	116	161	113
O.M., %	0.7	1.5	1.8	1.1	1.2	1.2	1.1
NO_3-N, lb/a	34	64	---	14	22	---	30
Ca, ppm	615	1300	800	890	---	811	950
Mg, ppm	78	130	85	100	---	82	45
SO_4-S, ppm	11	21	14	5	4	6.8	12
Zn, ppm	1.5	2.0	0.5	1.8	1.4	2.1	1.6
Fe, ppm	24.8	29.0	4.0	22.0	10.4	19.8	22.1
Mn, ppm	3.3	12.6	4.2	5.0	2.5	4.8	4.9
Cu, ppm	0.3	0.3	1.1	0.4	0.3	0.3	0.4
B, ppm	0.3	1.4	1.5	0.8	0.3	---	---
Na, ppm	11	52	24	---	---	51	8
CEC, meq/100g	4.0	8.1	---	6.0	---	5.0	7.4
	Suggested Fertilizer Program, lbs/a						
N	171	205	180	180	180	200	210
P_2O_5	75	30	---	40	---	10	30
K_2O	140	100	90	140	40	---	50
MgO	20	45	10	15	---	---	25
S	5	20	40	20	25	---	10
Zn	---	2	---	4	---	---	---
Mn	6.5	2	---	3	---	---	---
Cu	2	1	---	2	---	---	---
B	1.5	0.5	---	1	---	---	---
	Fertilizer Cost, $/a						
	$85.53	$77.85	$50.50	$78.55	$37.20	$32.60	$57.30
	Grain Yield, bu/a						
1982 only	130ab	129ab	136ab	141a	135ab	127b	138ab

Table 6. Soil test results, fertilizer recommendations, fertilizer cost and grain yields for the SCOTTSBLUFF AG LAB site on Tripp rfsl, 1982.

Measurement	Soil Test Results by Labs				
	A	B	C	D	E
pH	7.8	7.8	7.2	7.8	7.7
P, ppm	9	16	9	51	17
K, ppm	238	350	270	620	313
O.M., %	0.9	0.9	---	1.8	---
NO_3-N, lb/a	15	15	32	103	15
Ca, ppm	1786	2920	1220	4300	---
Mg, ppm	323	450	366	690	---
SO_4-S, ppm	24	18	5	110	18
Zn, ppm	4.0	4.7	4.7	0.5	4.3
Fe, ppm	10.7	12	7	3.8	---
Mn, ppm	4.0	5.2	6	8.6	0.5
Cu, ppm	1.0	1.7	1.1	1.9	0.9
B, ppm	0.7	---	0.9	2.3	---
Na, ppm	6.1	---	95	452	---
CEC, meq/100g	12.4	19.6	10.3	---	---
	Suggested Fertilizer Program, lbs/a				
N	185	220	230	210	130
P_2O_5	30	110	120	70	---
K_2O	15	75	50	100	---
MgO	---	10	---	30	---
S	---	---	40	30	---
Zn	---	---	---	8	---
Mn	---	5	---	---	---
Fe	7.5	---	---	---	---
Cu	---	---	---	---	---
B	1	---	---	---	---
	Fertilizer Cost, $/a				
	$44.60	$78.90	$83.00	$87.30	$19.50
	Grain Yield, bu/a				
1982	119	118	120	119	126
1981-82	273a	280a	290a	270a	286a