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Soil Science Research Report - 1978

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DEPARTMENT OF AGRONOMY
UNIVERSITY OF NEBRASKA-LINCOLN
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SOIL SCIENCE RESEARCH REPORT - 1978

Department of Agronomy
University of Nebraska-Lincoln
Lincoln, Nebraska

FACULTY

Personnel located at Department of Agronomy; University of Nebraska; Keim Hall; East Campus; Lincoln, Nebraska 68583:

Leon Chesnin, Waste Management
John W. Doran, USDA-SEA - Soil Microbiology
James Ellis, USDA-SEA - Soil Microbiology
Robert G. Gast, Head
Phillip W. Harlan, Land Use Management
Mark L. Hooker, Soil Fertility
Delno Knudsen, Soil Fertility
Gary D. Lemme, Instructor
David T. Lewis, Soil Classification
T.M. McCalla, USDA-SEA - Soil Microbiology
Lloyd N. Mielke, USDA-SEA - Soil Physics
Robert A. Olson, Soil Fertility
Gary A. Peterson, Soil Fertility
Donald H. Sander, Soil Fertility
James S. Schepers, USDA-SEA - Soil Physics
Robert C. Sorensen, Soil Chemistry
Dale Swartzendruber, Soil Physics
Richard A. Wiese, Soil Fertility

Personnel located at Panhandle Station; 4502 Avenue I; Scottsbluff, Nebraska 69361:

Frank N. Anderson, Soil Fertility
Louis A. Daigger, Soil Fertility

Personnel located at North Platte Station; Box 429; North Platte, Nebraska 69101:

Philip H. Grabouski, Agronomist
Gary W. Hergert, Soil Fertility

Personnel located at South Central Station; Box 66; Clay Center, Nebraska 68933:

Kenneth D. Frank, Soil Fertility

Personnel located at Northeast Station; Concord, Nebraska 68728:

George W. Rehm, Soil Fertility

Personnel located at Southeast Extension Headquarters; Miller Hall; East Campus; Lincoln, Nebraska 68583:

Edwin J. Penas, Soil Fertility

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NITROGEN RATES ON CORN

Ed Penas, George Rehm, and Dick Wiese

Objective: To determine the relationship between soil test for residual soil nitrate-nitrogen and other soil test characteristics and the amount of nitrogen fertilizer needed to produce a crop of corn.

Procedure: Sites in farmers fields in Northeast, East Central, and Southeast Nebraska were selected. Soil samples were collected to a depth of six feet. Topsoil samples were analyzed for pH, nitrate-nitrogen, phosphorus, potassium, zinc, and organic matter. Subsoil samples were analyzed for nitrate-nitrogen. Soil test data are shown in the attached tables. Nitrogen as ammonium nitrate was applied prior to or soon after planting of the corn. Rates of nitrogen applied ranged from 0 to 240 or 280 pounds of N per acre in 40-pound increments (0 to 150 or 175 pounds N per acre in 25-pound increments for non-irrigated sites).

Plant and leaf samples were collected during the growing season and are being analyzed for nitrogen. Grain yield was determined and yields are reported at 15.5% moisture and shown on the attached tables.

Discussion: These data are experimental results for the third year of a three-year study. Of the 18 sites harvested, 11 responded to the application of nitrogen. Six of these responsive sites were irrigated sandy soils and only one of these had more than 150 pounds of nitrate-nitrogen in the six-foot depth of soil. The efficiency of soil nitrogen utilization was good on these sandy soils except for the two sites that had the largest amount of nitrate-nitrogen in the soil.

Four of the six sites on fine-textured irrigated soils were responsive to the application of nitrogen. The two sites where nitrogen did not increase corn yields had more than 150 pounds of nitrogen in the soil. Also, one of these sites was severely hailed just prior to tasseling, which may have influenced crop response to nitrogen application.

Only one site out of six on fine-textured non-irrigated soils responded to the application of nitrogen. This site had 68 pounds of nitrogen in the six-foot depth of soil and the application of 75 pounds of nitrogen increased the yield from 146 bushels per acre to 166 bushels per acre.

The five non-responsive sites had almost 100 pounds of nitrogen or more in the soil and this was adequate for the non-irrigated yield that was produced (107 to 132 bushels per acre).

This project will be phased down in the future. A complete report for the three-year study will be developed.

NITROGEN RATES ON CORN, 1978
SOIL TEST DATA

County & Cooperator	Soil pH	Nitrogen, lbs/ac 6 ft.	Phosphorus ppm	Potassium ppm	Zinc ppm	Organic Matter, %
Butler (P)	6.1	156	41 VHi	643 VHi	7.1 Hi	3.7
Colfax (J)	6.4	56	24 Med	287 VHi	5.7 Hi	2.8
Dodge (B)	5.7	92	14 Low	432 VHi	4.1 Hi	3.1
Johnson (T)	6.7	136	9 Low	223 VHi	4.9 Hi	2.5
Platte (W)	6.4	111	21 Med	403 VHi	5.1 Hi	3.0
Polk (H)	6.5	66	34 VHi	253 VHi	4.5 Hi	1.2
Sarpy (L)	6.2	68	6 Low	224 VHi	5.2 Hi	2.0
Saunders (S)	5.8	233	23 Med	403 VHi	4.2 Hi	3.0
I	7.2	596	30 Hi	400 VHi	5.8 Hi	2.6
II	5.3	188	24 Med	246 VHi	5.5 Hi	3.2
III	6.0	137	21 Med	328 VHi	6.7 Hi	2.9
V	5.5	110	17 Med	173 VHi	4.1 Hi	1.4
VI	6.2	63	7 Low	190 VHi	6.4 Hi	2.3
VII	5.6	37	24 Med	146 Hi	5.2 Hi	1.3
VIII	5.3	75	16 Hi	116 Med	2.9 Hi	1.1
IX	5.8	54	5 VLo	84 Med	2.3 Hi	1.4
X	5.5	114	30 Hi	242 VHi	7.8 Hi	2.0
XI	5.3	174	72 Hi	347 VHi	15.4 Hi	1.3

NITROGEN RATES ON CORN, 1978
GRAIN YIELDS

	Sandy, irrigated soils					
Location:	V	VII	VIII	IX	X	XI
Nitrogen Rate, lbs/ac	Grain Yield, bushels/acre					
0	131	100	160	174	107	118
40	143	107	183	186	120	144
80	151	112	194	195	130	164
120	156	116	197	199	134	178
160	158	117	194	200	143	188
200	157	115	188	196	146	191
240	154	112	184	188	147	190
Response	Yes	Yes	Yes	Yes	Yes	Yes
Soil N					114	174
N in Water and Starter, lbs/ac	11	69	74	80	58	24

	Fine textured, irrigated soils					
Location:	Butler (P)	Colfax (J)	Platte (W)	Polk (H)	Saunders (S)	VI
Nitrogen Rate, lbs/ac	Grain Yield, bushels/acre					
0	126	157	153	133	127	140
40	128	171	174	150	129	143
80	130	182	181	163	131	146
120	132	190	181	172	133	148
160	134	195	175	177	135	148
200	136	196	171	178	137	147
240	137	194	170	175	139	146
280	139	190	179	168	142	---
Response	Hailed	Yes	Yes	Yes	No	Yes
N in Water and Starter, lbs/ac	10	3	4	2	10	14

NITROGEN RATES ON CORN, 1978
GRAIN YIELDS

Location:	Dodge (B)	Johnson (T)	Sarpy (L)
	Fine textured, non-irrigated soils		
Nitrogen Rate, lbs/ac	Grain Yield, bushels/acre		
0	109	110	146
25	114	105	158
50	119	113	164
75	119	106	166
100	116	110	165
125	103	104	164
150	114	108	166
175	108	100	172
Response	No	No	Yes
N in Starter lbs/ac	---	---	10

Location:	I	II	III
	Fine textured, non-irrigated soils		
Nitrogen Rate, lbs/ac	Grain Yield, bushels/acre		
0	121	130	117
25	116	133	112
50	120	136	109
75	122	131	108
100	117	131	109
125	117	134	112
150	118	131	117
Response	No	No	No
N in Starter lbs/ac	---	---	25

Project: Nitrogen Rates for Corn Grown in an Ecofallow Rotation

Personnel: Gary W. Hergert, UNL-North Platte Station

Goal: Establish relationship between soil test for residual soil nitrate and N rate needed for corn in this farming system.

Procedure: Two of four sites were harvested. One plot was lost to weeds, the other was accidently harvested by the farmer. Ammonium nitrate (AN) was broadcast at planting for the Schaffert site. The AN was broadcast in April on the UNL-North Platte Station Dryland Farm. Anhydrous ammonia was sidedressed June 27.

There was a significant response to N at the Schaffert site but yields were maximized at the first N rate of 25 lbs N/A. There was also a nitrogen response at the Dryland Farm in 1978 at the first N rate. The ammonium nitrate produced significantly more grain than the sidedressed NH_3. Moisture was very limited in 1978 and the late application of NH_3 probably did not allow good redistribution of nitrified N from the NH_3.

Schaffert plot soil analysis

pH	O.M.	NO_3-N	P	K
			-----ppm----	
6.2	1.2%	83 lbs/A-6'	17 M	380 VH

Schaffert Ecofallow Corn Yields

NH_4NO_3 lb/A	Grain Yield bu/A
0	87
25	93
50	90
75	93
100	91
125	93

Dryland Farm plot soil analysis

pH	O.M.	NO_3-N	P	K
			----ppm----	
6.2	1.5%	39 lbs/A-6'	16 M	455 VH

Dryland Ecofallow Corn Yields

Nitrogen lb/A	NH_4NO_3	NH_3
	Grain yield bu/A	
0	35	
25	49	39
50	45	37
75	40	36
100	34	40
125	46	41

Project: Anhydrous Ammonia and N-Serve for Irrigated Corn

Personnel: Gary W. Hergert, UNL-North Platte Station
Ken D. Frank, UNL-South Central Station
George W. Rehm, UNL-Northeast Station

Goal: Evaluate N-Serve as a nitrogen management tool for Nebraska soils and climate.

Procedure: Anhydrous ammonia with or without N-Serve was used in nitrogen rate studies at 5 locations. Soil analysis data are given in Table 1.

Table 1. Soil analysis of plot areas.

Soil	County		pH	O.M.	P	K	Zn	NO_3-N
				%	----ppm-----			lbs/A-6'
Thurman loamy sand	Holt		5.3	1.3	72	347		174
Hastings silt loam	Clay		6.3	2.8	17	500		
O'Neill sandy loam	Merrick	Preplant	6.1	1.3	11	135	5	
		Sidedress	5.8	1.0	18	92	3.3	
Cozad silt loam	Lincoln		7.6	1.3	8	450		73
Valentine sand	McPherson		6.3	1.0	17	170		

Preplant NH_3 with or without N-Serve was used in Holt County. Dry matter and grain yields on the Thurman loamy sand were significantly increased by N rate but no effect from N-Serve was noted (Table 2). Soil samples were taken 60 days after application through the NH_3 injection zone from the 0, 160 N, and 160 N + 0.5 lbs N-Serve/A plots. The N-Serve did delay nitrification significantly (Figure 1).

Table 2. Grain and dry matter yield on Thurman loamy sand.

N Rate	bu/A #2 Corn		Total dry matter/A	
lbs/A	N-Serve	w/o N-Serve	N-Serve	w/o N-Serve
0	112		4.7	
40	141	145	8.0	6.9
80	141	151	-	-
160	176	178	8.1	8.5
240	187	187	8.7	8.5

No nitrogen response was shown on the Hastings soil so no evaluation of the N-Serve effect is possible (Table 3).

Table 3. Effect of application time, N rate and N-Serve on irrigated corn - Hastings silt loam.

Nitrogen rate lbs/A	Fall		Spring	
	N-Serve	Without	N-Serve	Without
	-------------bu/A, #2 Corn-------------			
0	157		157	
45	158	152	154	162
90	154	162	154	160
135	150	158	167	159
180	155	161	164	170
225	160	156	163	161

The O'Neill sandy loam was irrigated by a center pivot. The farmer applied 7 lbs N/A in his starter, 20# from NO_3 in the irrigation water, and 40# as UAN solution through the pivot for a total of 67 lbs of N/acre. The crop did respond to N but yields were maximized at the first 40 lb increment of either preplant or sidedressed N (Table 4). Statistical analysis showed no effect of the N-Serve.

Table 4. Effect of application time, N rate and N-Serve on irrigated corn - O'Neill sandy loam.

N rate	Total N applied lbs/A	Preplant N		Sidedress N	
		N-Serve	Without	N-Serve	Without
		---------------bu/A, #2 Corn---------------			
0	67	175		163	
40	107	192	187	196	195
80	147	192	195	193	194
120	187	193	192	193	197
160	227	194	197	197	198
200	267	193	194	193	197

Soil samples taken through the ammonia injection zone, marked with twine, on the Cozad silt loam 60 days after the spring 1978 NH_3 applications showed a significant effect of N-Serve on nitrification (Figure 2). Fall-applied NH_3 with N-Serve showed more NH_4^+ than spring-applied NH_3 without N-Serve. Dry matter (grain + stover) and grain yields are shown in Tables 5 and 6. The analysis of variance showed a significant effect of N rate and N-Serve ($p = 0.05$). Treatments receiving N-Serve produced more yield than those without.

Table 5. Dry matter yields from the Cozad silt loam.

Nitrogen rate	Fall		Spring	
lbs/A	N-Serve	Without	N-Serve	Without
	Tons/Acre			
0	5.24		5.24	
40	6.03	5.52	6.85	5.86
80	7.06	6.23	6.64	6.03
120	7.07	6.75	7.43	6.48
160	6.23	6.53	6.40	6.14
200	7.45	7.39	7.39	6.44
240	6.84	7.32	6.75	7.17

Table 6. Grain yields from the Cozad silt loam.

Nitrogen rate	Fall		Spring	
lbs/A	N-Serve	Without	N-Serve	Without
	bu/Acre			
0	86		86	
40	125	123	125	105
80	135	132	145	120
120	147	140	149	125
160	147	138	154	135
200	153	144	150	133
240	150	145	155	142

The experimental design on the Valentine sand was a split-split plot. The main plot was watering rate. Irrigation amounts applied were a percentage of actual weekly evapotranspiration (ET) determined by the modified Penman equation. The five irrigation levels were: W1: 57% of ET; W2: 72% of ET; W3: 86% of ET; W4: 100% of ET; and W5: 142% of ET.

The first split of the plots was the N-Serve variable. The N-Serve rates were 0 and 0.5 lbs of N-Serve per acre in the anhydrous ammonia.

The next split was the nitrogen rate. Rates were 0, 41, 73, 104, 135, 166, and 198 lbs/A. Anhydrous ammonia was applied April 22-24, 1978. Treatment mean dry matter and grain yields are shown in Tables 7 and 8.

Table 7. Dry matter yields on the Valentine sand.

	Irrigation as % of ET									
	57		72		86		100		142	
N-Serve -	With	W/O	With	W/O	With	W/O	With	W/O	With	W/O
lbs N/A	Dry Matter kg/ha									
0	4.13		4.17		4.31		5.11		4.82	
41	3.69	3.51	4.31	4.00	3.84	4.89	5.28	5.68	4.12	4.39
73	4.60	3.77	4.89	4.64	5.69	4.79	5.73	4.94	4.15	4.78
104	5.02	4.22	5.32	5.76	7.56	6.01	6.97	6.75	6.77	5.63
135	5.06	5.55	6.67	6.25	7.86	7.19	8.23	7.85	7.29	6.65
166	5.20	4.74	7.34	6.69	7.82	7.99	8.36	8.49	7.70	7.52
198	4.87	4.73	7.24	6.66	7.43	8.36	8.34	8.05	9.47	7.79

Table 8. Grain yields on the Valentine sand.

	Irrigation as % of ET									
	57		72		86		100		142	
N-Serve -	With	W/O	With	W/O	With	W/O	With	W/O	With	W/O
lbs N/A	bu/A, #2 Corn									
0	67		75		77		87		81	
41	72	71	86	84	73	75	89	90	81	74
73	79	67	104	89	121	79	114	95	90	79
104	91	87	113	110	145	107	151	118	128	86
135	89	92	129	115	155	136	163	142	151	129
166	90	81	138	130	163	147	161	158	159	164
198	93	84	137	129	160	152	162	158	168	162

Dry matter yields at physiological maturity showed significant effects of irrigation, N rate and irrigation by N rate interaction (Table 9). Grain yield was significantly affected by irrigation, N-Serve and N rate (Table 9). The addition of N-Serve to the preplant NH_3 did show significant yield increases in 1978 at this site.

Where N loss is a problem, keeping N in the NH_4^+ form longer may improve N use efficiency and yields. This apparently was the case for the Cozad silt loam and Valentine sand. No significant N loss must have occurred on the Thurman loamy sand. Although NO_3-N does leach in sandy soils good irrigation management and timely rains can minimize N leaching in sandy soils.

Table 9. Condensed Analysis of Variance for corn dry matter and grain production on the Valentine sand.

Source of Variation	Probability of F	
	Dry Matter	Grain
Block		
Irrigation level	.0001	.0001
N-Serve	.23	.001
Irrigation X N-Serve	.99	.60
Nitrogen Rate	.0001	.0001
Irrigation X N Rate	.0001	.0001
N-Serve X N Rate	.30	.002
Irrigation X N Rate X N-Serve	.17	.37

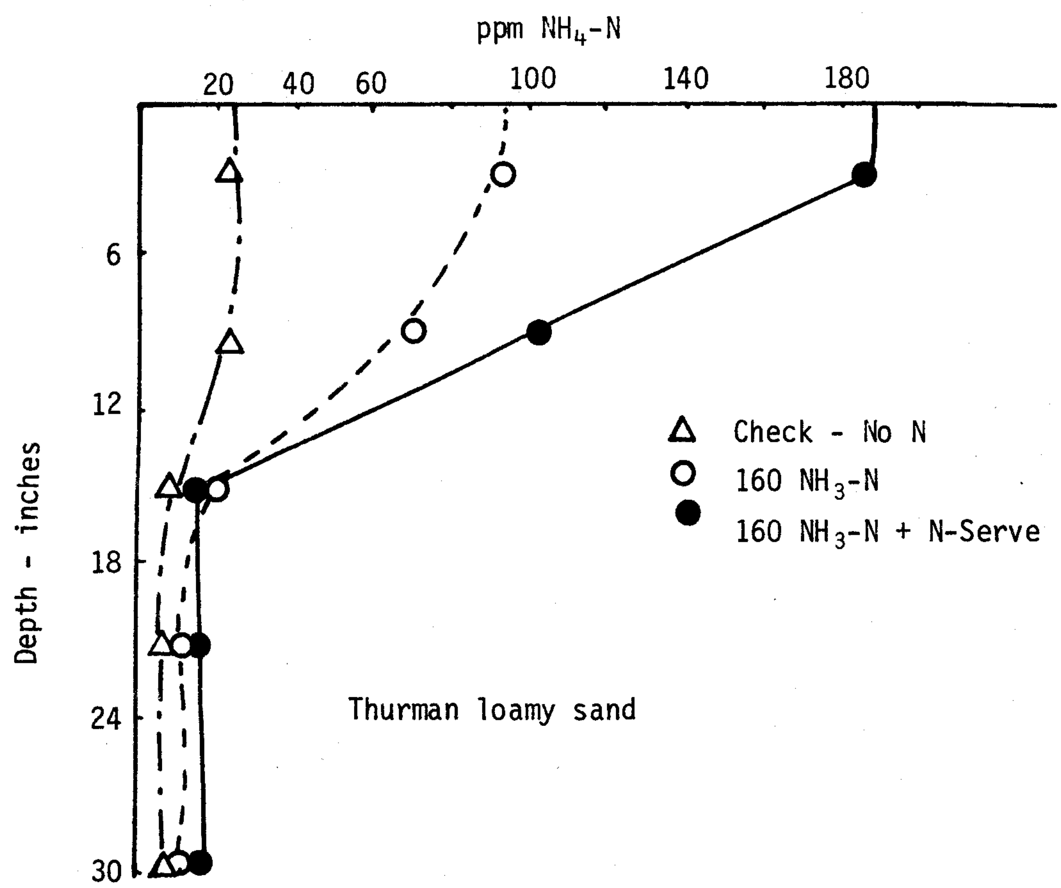

Figure 1. Ammonium-N concentrations with depth 60 days after NH_3 application.

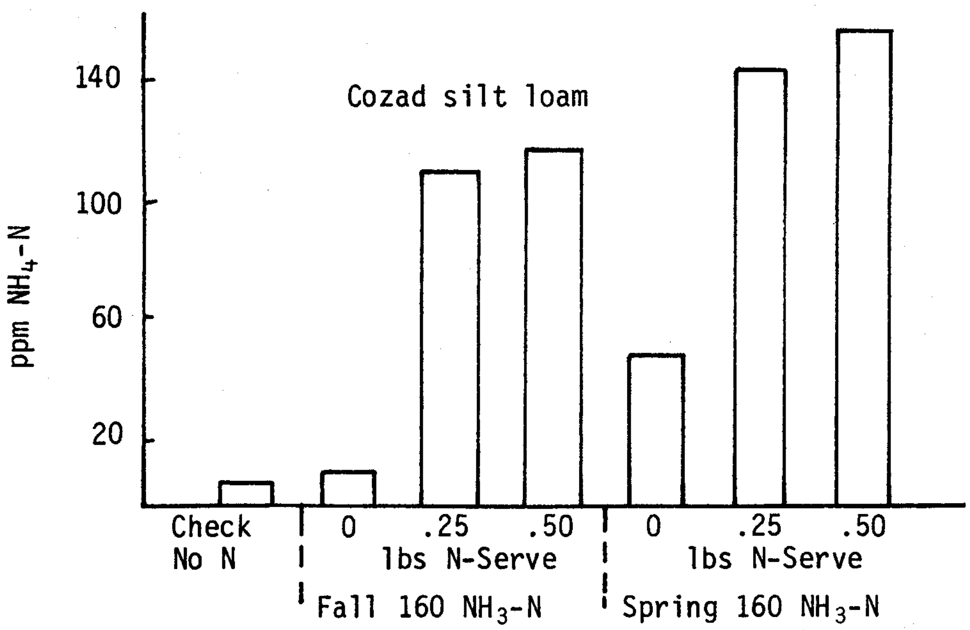

Figure 2. Ammonium-N concentrations in the 0-6 inch zone 60 days after spring NH_3 application.

Project: Nitrogen Losses from Sprinkler Applied Nitrogen Fertilizer

Personnel: Gary W. Hergert, UNL-North Platte Station

Goal: Quantify nitrogen leaching losses from sprinkler-applied urea-ammonium nitrate (UAN)

Procedure: Ceramic candle extraction systems were installed under 16 plots at the UNL-Sandhills Agricultural Laboratory in 1976. Treatments were two N sources (UAN and $Ca(NO_3)_2$) and two irrigation levels based on water use (85% and 130% of evapotranspiration) replicated four times. The nitrogen rate was uniform for all plots-210 kg N/hectare.

Grain Yields: No significant effect of nitrogen source or irrigation level was shown in 1976 or 1977 (Table 1). The lack of treatment effect for the water variable is encouraging because it indicates that optimum yields may be obtained with somewhat limited water applications.

Table 1. Grain yields of corn

	Irrigation			
	0.85 ET		1.30 ET	
Fertilizer	1976	1977	1976	1977
	------kilograms per hectare-------			
UAN	7878	9126	7288	9182
$Ca(NO_3)_2$	7928	8906	7991	9634
Average	7903	9016	7640	9408

The extractor data show the importance of good nitrogen fertilizer and irrigation practices to reduce losses of N. The 1.3 ET (overirrigated) plots lost sizeable amounts of N in 1976 even though N applications were split (Table 2). Losses occur even if the N is applied several times during the growing season if water applications exceed crop water use and soil water holding capacity. Over-winter losses of NO_3-N were substantial for 1976-1977 and 1977-1978 (Table 3) and contribute substantially to total yearly loss (83 vs 101 and 84 vs 127 kg for 0.85 ET and 1.3 ET treatments in 1977).

Table 2. Nitrate N and deep percolation losses.

Irrigation	1976	1977	1976	1977
	---kg NO_3-N/ha leached---		--cm of water leached--	
0.85 ET	28	101	3.6	13.2
1.30 ET	186	127	19.1	18.2

Table 3. Over-winter leaching losses of Nitrate-N.

Irrigation	Fall 1976 to Spring 1977	Fall 1977 to Spring 1978
	--------kg NO_3-N/ha leached--------	
0.85 ET	83	84
1.30 ET	84	94

The data show the importance of the proper nitrogen rate to just meet crop uptake requirements for maximum yield. The 210 kg N/ha was excessive for that need and resulted in nitrate leaching losses. Nitrogen applications must be closely matched to crop uptake and yield potential to reduce nitrate carryover. For this site 160 kg/ha is a reasonable N rate.

APPLICATION OF SULFUR FOR IRRIGATED CORN ON SANDY SOILS

G.W. Rehm, G.W. Hergert, R.A. Wiese

Objective:

Past research has shown that the application of S fertilizers will increase the yield of irrigated corn on some sandy soils. Although these studies provided a general range of rates of S needed for optimum yields, additional information was needed to define the rate of S needed for both broadcast and starter applications. The mobility of the $SO_4^=$ ion in sandy soils also causes some problems. In periods of heavy rainfall or excessive irrigation, this ion can be easily leached from the root zone of young corn plants. Some slow release fertilizers on the market may eliminate some of the leaching problem. Field evaluation of these materials was needed. The two objectives of this study were: 1) to evaluate the effect of rate of S either broadcast or applied in a starter fertilizer on yield of corn grown on an irrigated sandy soil and 2) to evaluate slow release fertilizer materials that might be suitable for use in the production of irrigated corn on sandy soils.

Procedure:

This study was conducted at two locations in 1978. Soil properties are listed in Table 1. Granular gypsum, applied at rates to supply 0, 12, 24, and 36 lb. S/acre, was broadcast and incorporated before planting. Four sources (granular gypsum, Sol-U-Sul, a mixture of granular gypsum and Sol-U-Sul, and a mixture of granular gypsum and sulfur-coated urea) were used to supply 0, 6, 12, and 18 lb. S/acre in a starter fertilizer. When the mixtures were used, each component supplied 50% of the S applied. In addition to a small amount of N, both broadcast and starter treatments received adequate amounts of P_2O_5 and K_2O in the starter. Adequate N was used at both sites.

Corn was planted in early May at recommended plant populations. Recommended herbicides and insecticides were used at both locations.

Whole plant samples were collected 3 weeks after emergence and the ear leaf at silking was also sampled. These plant samples were analyzed for N and S. Yields were recorded in October.

Results and Discussion:

Application of S had no effect on yield at the Lincoln County site. Yields at the Antelope County site were increased by both broadcast and starter applications of S (Tables 2 and 3). At this site, the use of 6 lb. S/acre in a starter or a broadcast application of 12 lb. S/acre was sufficient to produce maximum yield.

The source of S used in the starter had no effect on yield (Table 4). Lack of a significant difference among sources can be explained by the absence of excessive rains in May and June in 1978. Without excessive rainfall, leaching of $SO_4^=$ would not be a problem and performance for all sources would be expected to be equal.

This study will be repeated in 1979.

Table 1. Properties of soils used at the experimental sites. 1978.

Property	Depth	County: Antelope	County: Lincoln
	in.		
pH	0-6	6.3	6.3
organic matter, %	0-6	.68	.70
phosphorus, (Bray), ppm	0-6	22	17
potassium, ppm	0-6	143	153
zinc, ppm	0-6	6.2	-
sulfate-S, ppm	0-6	3.0	<3.0
sulfate-S, ppm	6-12	4.0	<3.0
sulfate-S, ppm	12-24	4.3	<3.0
sulfate-S, ppm	24-36	3.7	<3.0
sulfate-S, ppm	36-48	3.6	<3.0
sulfate-S, ppm	48-60	4.7	<3.0
sulfate-S, ppm	60-72	3.8	<3.0
nitrate-N, ppm	0-6	1.5	2.0
nitrate-N, ppm	6-12	1.7	1.0
nitrate-N, ppm	12-24	2.4	1.0
nitrate-N, ppm	24-36	3.2	1.0
nitrate-N, ppm	36-48	3.4	0
nitrate-N, ppm	48-60	3.3	0
nitrate-N, ppm	60-72	6.0	-

Table 2. Effect of broadcast rates of S on corn yield. 1978.

S Rate	County: Antelope	County: Lincoln
lb./acre	- - - - - -bu./acre- - - - - -	
0	178.4 a[1/]	145.8 a
12	188.3 b	135.3 a
24	192.2 b	143.0 a
36	191.5 b	133.3 a

[1/] Treatment means in any one column followed by the same letter are not significantly different at the .05 confidence level.

Table 3. Effect of rate of S applied in a starter fertilizer on corn yield. 1978.

S Rate	County: Antelope	County: Lincoln
lb./acre	bu./acre	bu./acre
0	159.9 a[1/]	143.5 a
6	170.8 b	139.9 a
12	173.3 b	143.2 a
18	174.2 b	142.8 a

[1/] Treatment means in any one column followed by the same letter are not significantly different at the .05 confidence level.

Table 4. Effect of source of S applied in a starter fertilizer on corn yield in 1978.

S Source	County: Antelope	County: Lincoln
	bu./acre	bu./acre
granular gypsum	168.4 a[1/]	140.8 a
Sol-U-Sul	171.6 a	144.3 a
50% granular gypsum; 50% Sol-U-Sul	175.0 a	142.8 a
50% granular gypsum; 50% sulfur-coated urea	176.0 a	139.9 a

[1/] Treatment means in any one column followed by the same letter are not significantly different at the .05 confidence level.

LIME AND BORON FOR CORN

G.W. Rehm and R.A. Wiese

Objective:

In general, the pH of the surface 0-8 in. of sandy soils in north-central Nebraska has decreased with the production of continuous corn under sprinkler irrigation systems. This decrease in soil pH raises questions as to the need for lime for corn production on these irrigated sandy soils. In addition, there is very little information on the requirement for boron for corn production on these soils. Therefore, this study was designed to evaluate the effect of application of lime and boron for corn production on irrigated sandy soils.

Procedure:

This study was initiated in 1975 at sites in Pierce and Holt Counties. Boron was broadcast in early spring at both sites to supply 0, .75, 1.50 and 3.00 lb. B/acre. Lime rates at the Pierce County site were 0, 1.7, and 3.4 ton/acre. The lime rates used at the Holt County site were o, 2.25, and 4.50 ton/acre. The rates of boron were reapplied at the Holt County site in the spring of 1977. Residual effects of the lime applied were measured through 1978. Recommended rates of all other nutrients were supplied in all years at both sites.

In addition to yield, soil samples (0-8 in.) were collected periodically to monitor changes in soil pH as well as levels of B, Zn, Mn, Fe, and Cu in the surface soil.

Results and Discussion:

Soil properties for the Holt County site at the initiation of the study in 1975 are listed in Table 1. In the interest of brevity, results from the Holt County site will be discussed in this report.

Application of boron had no effect on yield from 1975 through 1978 (Table 2). Yields in 1976 showed a significant reduction due to the boron applied in 1975. At present, there is no explanation for this reduction in yield.

Application of lime in 1975 produced yield increases in 1975, 1976, and 1978 (Table 3). The response to lime was linear in 1975. In 1976, the first increment of lime applied in 1975 increased yields but the yield from the use of 4.5 ton/acre was not significantly higher than the yield from the application of 2.25 ton of lime per acre. In 1978, yields were not increased by the application of 2.25 ton of lime/acre in 1975. The application of 4.50 ton per acre in 1975 did increase 1978 yields. Although lime has increased corn yields at this site, with current market prices for corn, the yield increase has not been large enough to offset the cost of lime.

The pH of the surface soil has increased with the application of lime (Table 4). When no lime was applied, there was a slight increase in pH through the summer of 1975. It's important to point out that the pH of the surface soil has not dropped below the initial pH after 3 growing seasons. With the application of 2.25 ton of lime per acre in 1975, the pH rose to 6.0 and has gradually decreased to 5.7 after 3 growing seasons. The 2.25 ton/acre is .75 of the lime requirement for this soil. Soil pH continues to increase with the 4.50 ton/acre applied in 1975. The 4.50 ton/acre is 1.5 times the lime requirement of this soil.

Table 1. Properties of the soil at the experimental site in Holt County at the initiation of the study in 1975.

soil type	O'Neill sandy loam
pH	5.2
pH (Buffer)	6.4
K, ppm	212
P, (Bray), ppm	19
organic matter content, %	2.21
cation exchange capacity, meq/100 gm	7.31
hot water soluble boron, ppm	11.2

Table 2. Effect of the application of boron on the yield of irrigated corn.

Boron Applied	Year			
	1975	1976	1977	1978
lb./acre	- - - - - - - - - - - bu./acre	- - - - - - - - - - -		
0	190 a	200 b	189 a	223 a
.75	189 a	190 a	187 a	221 a
1.50	185 a	193 a	186 a	229 a
3.00	189 a	192 a	190 a	226 a

Table 3. Effect of lime applied in 1975 on the yield of irrigated corn. 1975-1978.

Lime Applied	Year			
	1975	1976	1977	1978
ton/acre	bu./acre			
0	184 a	189 a	186 a	220 a
2.25	188 b	196 b	187 a	222 a
4.50	193 c	196 b	191 a	232 b

Table 4. Soil pH (0-8 in.) as influenced by the rate of lime applied in the early spring of 1975.

Lime Applied	6/75	7/75	11/75	4/76	10/77
ton/acre	-pH-				
0	5.3 a	5.5 a	5.4 a	5.2 a	5.2 a
2.25	5.8 b	5.8 b	6.1 b	6.2 b	5.7 b
4.50	6.1 c	6.2 c	6.3 c	6.4 b	6.5 c

INFLUENCE OF SALT CONTENT OF FERTILIZER AND DISTANCE FROM THE SEED ON EMERGENCE AND YIELD OF CORN

G.W. Rehm and R.A. Wiese

Objective:

The placement of fertilizer either to the side of and below or below the seed at planting can be an important management tool in corn production. The amount of fertilizer that can be applied in this manner is thought to be dependent on the "salt" content of the fertilizer being applied and the moisture content of the soil at planting. Past research has generally rated the "salt index" of several fertilizer materials. Yet, there has been very little field research to evaluate the effect of "salt" content of a fertilizer and distance from the seed on corn emergence and yield.

Procedure:

This study was initiated at the Northeast Experiment Station in 1978. Soil properties are listed in Table 1. Suspension fertilizers were applied to supply 0, 15, 30, and 45 lb. salt per acre. The amount of salt applied was computed from the percentage of N and K_2O in the fertilizer. Placement of the fertilizer was also evaluated. The various rates of salt were placed .5 - .75 in., .75 - 1.5 in., and 3.0 in. from the seed. In all placements, the fertilizer was placed to the side of and below the seed at planting.

In addition, the percentage of "salt" applied as either N or K_2O was evaluated. The percentage chosen were: 1) 100% as N, 0% as K_2O, 2) 50% as N, 50% as K_2O, and 3) 0% as N, 100% as K_2O. All treatments received 120 lb. N/acre as 82-0-0 before planting.

The study was planted in mid-May at a population of 20,000 plants per acre. Recommended herbicides and insecticides were used. Stand counts were recorded 3 weeks after emergence and whole plant weights were recorded at this time. Grain yields were recorded in late October.

Results and Discussion:

A 4 x 3 x 3 complete factorial design with 4 replications was used for this study. Since there were no significant interactions, main effects of the 3 variables used are listed in Tables 2, 3, and 4. The P_2O_5 content of the suspension fertilizers was such that all treatment received 15 lb. P_2O_5/acre.

The moisture content of the soil at planting was high. Under these conditions, the amount of salt applied had no significant effect on plant population, weight of young corn plants and yield (Table 2). When considered over all rates applied, the distance from the seed to the fertilizer did influence the emerged population, the weight of young corn plants and the yield (Table 3). The highest values for all variables measured occurred when the fertilizer was placed at a distance of .5 - .75 in. from the seed. These effects might have been altered if drier soil conditions had prevailed at planting.

The percentage of "salt" applied as either N or K_2O had no effect on emerged plant population, plant weight, and yield (Table 4). This study will be repeated so that the evaluation of the 3 variables can be conducted under a variety of soil moisture conditions at planting.

Table 1. Properties of the soil at the experimental site.

soil texture	silt loam
pH	7.1
NO_3-N (0-8 in.), ppm	3.0
NO_3-N (8-24 in.), ppm	5.0
NO_3-N to 6 ft., lb./acre	55
P (Bray), ppm	17
K, ppm	331
organic matter, %	2.6

Table 2. Influence of rate of "salt" applied on plant population, weight of young corn plants and yield. 1978.

Salt Applied lb./acre	Plant Population plants/acre	Plant Weight gm/plant	Yield bu./acre
0	17,976 a*	4.30 a	131.3 a
15	18,116 a	4.51 a	127.6 a
30	18,140 a	4.74 a	122.9 a
45	17,995 a	4.44 a	124.7 a

*Treatment means in any column followed by the same letter are not significantly different at the .05 confidence level.

Table 3. Influence of distance of fertilizer from the seed on plant population, weight of young corn plants and yield. 1978.

Distance From seed	Plant Population	Plant Weight	Yield
in.	plants/acre	gm/plant	bu./acre
.50 - .75	18,491 a*	4.71 a	133.5 a
.75 - 1.50	17,965 b	4.47 b	121.7 b
3.00	17,714 b	4.31 b	124.0 b

*Treatment means in any one column followed by the same letter are not significantly different at the .05 confidence level.

Table 4. Influence of the percentage of salt applied as N and K_2O on plant population, weight of young corn plants and yield. 1978.

Percentage	Plant Population	Plant Weight	Yield
	plants/acre	gm/plant	bu./acre
100% as N; 0% as K_2O	18,179 a*	4.55 a	126.0 a
50% as N; 50% as K_2O	18,190 a	4.60 a	126.5 a
0% as N; 100% as K_2O	17,802 a	4.34 a	126.6 a

*Treatment means in any one column followed by the same letter are not significantly different at the .05 confidence level.

EVALUATION OF TILLAGE SYSTEMS FOR CORN PRODUCTION ON A SILT LOAM SOIL IN NORTHEAST NEBRASKA

G.W. Rehm

Objective:

Concern over soil erosion and energy costs have stimulated farmers to reconsider the tillage systems used in corn production. Past research in Nebraska as well as research throughout the Corn Belt indicates that tillage system should be matched to soil texture. This long-term study was designed to evaluate 3 tillage systems which may be used for corn production on silt loam soils.

Procedures:

This study was initiated in the fall of 1976 to evaluate 3 common tillage systems (fall chisel plow, spring plow, tillplant). Nitrogen at rates recommended from a soil test was applied each spring as 82-0-0. The suggested rate of P_2O_5 was applied below the seed at planting as 10-34-0. Recommended herbicides and insecticides were used in both 1977 and 1978. The planted population was approximately 17,700 plants per acre each year.

Results and Discussion:

Tillage system had no significant effect on yield in both 1977 and 1978 (Table 1). These results are in general agreement with much of the other tillage research conducted in the western Corn Belt. In general, this research has shown that the use of reduced tillage systems for corn production has not decreased. Since this is intended to be a long-term study, general conclusions would be inappropriate at this time.

Table 1. Effect of tillage system on yield of corn grown on a silt loam soil. Northeast Station.

Tillage System	Year 1977	1978
	- - - - - bu./acre	- - - - -
Tillplant	123.4 a[1/]	114.9 a
Fall Chisel Plow	124.1 a	108.3 a
Spring Plow	133.7 a	107.7 a

[1/] Treatment means in any column followed by the same letter are not significantly different at the .05 confidence level.

EFFECT OF IRRIGATION WELL CAPACITY AND PLANT POPULATION ON PRODUCTION OF IRRIGATED CORN ON A SILT LOAM SOIL

G.W. Rehm

Objective:

Pumping capacities of irrigation wells in northeast Nebraska vary over a wide range. The pumping capacity of some wells is marginal. If there is a limited pumping capacity, the plant population may have to be adjusted in some years to take into consideration the capacity of the irrigation well. This study, designed to be conducted on a long term basis, was established to measure the effect of plant populations and capacity of the irrigation well on the yield of irrigated corn grown on a silt loam soil.

Procedure:

The soil at the experimental site is classified as a Judson silt loam and the properties are listed in Table 1. All treatments received 180 lb. N/acre as 82-0-0 before planting. Corn was planted in mid-May and recommended insecticides and herbicides were used.

Water use was scheduled from evapotranspiration computed from weather data recorded at the Northeast Experiment Station. A total of 7.75 in. of irrigation water was applied during the growing season. Approximately 7 in. of rain was received during the growing season.

Results and Discussion:

The precipitation pattern during the 1978 growing season was such that the application of the 7.75 in. of irrigation water was accomplished with the simulated 400 gpm well capacity. In 1978, the simulated well capacity had no effect on yield (Table 2).

Yields were influenced by plant population. The response was curvilinear with maximum yield recorded at a harvest population of approximately 20,000 plants per acre (Table 3). These results are in general agreement with those recorded in 1977 when maximum yield occurred at a harvest population of approximately 22,000 plants per acre.

Since this study will be conducted on a long term basis, it is inappropriate to draw general conclusions at this time.

Table 1. Properties of the Judson silt loam at the experimental site. 1978.

pH	6.3
pH (Buffer)	6.7
P (Bray), ppm	25
K, ppm	321
NO_3-N, lb./acre to 6 ft.	79
organic matter, %	3.2
Zn, ppm	3.9

Table 2. Effect of simulated well capacity on yield of irrigated corn on an irrigated silt loam soil.

Well Capacity (gpm)	Yield (bu./acre)
400	177.3
600	172.1
800	175.7

Table 3. Effect of plant population on the yield of irrigated corn grown on a silt loam soil.

Planted Population plants/acre	Harvest Population plants/acre	Yield bu./acre
18,300	16,553	163.9
21,200	18,295	171.7
23,900	20,038	180.4
26,500	22,216	179.4
29,300	23,958	181.8
33,100	26,136	172.9

Water Use Efficiency of Corn Genotypes

M. B. Halitligil, W. A. Compton, C. O. Gardner, R. A. Olson

A. *Objective*

It is the objective of this investigation to find the combination of corn genotype, water management practice and N treatment that will effect most efficient utilization of water in corn production.

B. *Procedure*

Field experiments were established on the Agronomy Farm (Stevens Creek) and on the Mead Lab with the following variables:

1) *Irrigation time experiment - Uniform 90# N/a.*
   - a. *Six corn hybrids of varied pedigree*

     N611, N714, N28xMo17, B73xMo17, Pion 3388, Pion 3386
   - b. *Four irrigation regimes (6" supplemental H_2O planned for 'normal' year)*

     I_1 = *6" water applied immediately after ridging*
     I_2 = *3" water after ridging + 3" at tasseling*
     I_3 = *6" water after tasseling*
     I_4 = *1.5" water after ridging, 1.5" at tasseling, 1.5" at early milk, 1.5" at grain filling.*

2) *Irrigation rate experiment,*
   - a. *Three irrigation levels planned*
   - b. *Two N rates*

     90 and 180 lbs N/a as early sidedressing

The plots were hand planted to a uniform stand of 25,000 plants per acre. Irrigation water was measured onto diked basins through water meters. Neutron moisture measurements were taken throughout the growing season for determining consumptive use of water.

C. *Experimental Results*

Rainfall was exceptionally favorable in 1978 affording 20 inches or more of moisture above that stored in the soil at planting at both locations. There was, however, a severe hail storm at the Stevens Creek site on July 14 that removed most of the corn leaves, eliminating most of the projected irrigation rate variable. Sufficient grain yield at season's end was evident to justify harvesting the plots.

The irrigation rate experiment at Mead evidenced higher grain yield by B73xMo17 than all other hybrids (Table 1). The N714 was superior to all others in stover yield. The divided irrigation water application in four increments was more effective for grain production than the heavier, less frequent water treatments as an average for all hybrids, presumably related to N economy. No consistent trend is apparent between water management system and stover yields.

Statistical analyses and consumptive water use values remain to be calculated for these experiments. Accordingly, it is impossible to interpret the apparent differences that exist with the Stevens Creek location. It does appear the hail was most damaging to the B73xMo17 which was the best yielder at the Mead location.

Table 1. Response of six corn hybrids to varied times of irrigation water application

Irrigation Time	N611	N714	N28xMo17	B73xMo17	Pion 3388	Pion 3386	Average
				Corn hybrid yield, bu/a			
				Stevens Creek			
I_1	133	109	118	110	126	123	116
I_2	124	136	122	100	123	130	123
I_3	124	134	109	106	120	133	121
I_4	120	110	118	99	120	144	119
Average	125	122	117	104	122	133	
				Mead Field Lab			
I_1	194 (3.51)*	194 (4.64)	193 (3.55)	204 (3.78)	181 (3.30)	188 (3.73)	192 (3.75)
I_2	197 (3.45)	211 (4.28)	201 (3.71)	215 (3.49)	173 (3.33)	200 (3.61)	200 (3.65)
I_3	195 (3.10)	194 (4.08)	199 (3.63)	210 (3.60)	170 (3.17)	194 (3.27)	194 (3.48)
I_4	212 (3.59)	221 (4.20)	199 (3.40)	223 (3.80)	176 (3.13)	208 (3.08)	207 (3.53)
Average	200 (3.41)	205 (4.30)	198 (3.57)	213 (3.67)	175 (3.23)	198 (3.42)	

* Values in parentheses are tons/a of stover.

Table 2. Response of six corn hybrids to varied irrigation level and rate of N

Irrigation Rate	N rate lb/a	N611	N714	N28xMo17	B73xMo17	Poin 3388	Pion 3386	Average
				Corn hybrid yield, bu/a				
					Stevens Creek			
I_1	90	154	148	136	133	126	122	137
	180	161	158	133	123	143	128	141
I_2	90	138	130	126	102	125	132	126
	180	134	142	117	114	127	135	128
I_3	90	142	160	144	131	136	138	143
	180	145	157	124	123	131	135	136
Average		146	149	130	121	131	132	

Wheat Fertilization Progress Report 1978

G. A. Peterson, D. H. Sander, L. A. Daigger, and G. W. Hergert

This report contains a data summary and a brief statement for each of the soil fertility experiments conducted with winter wheat in 1978 in western Nebraska. The following experiments are included: (1) Phosphorus fertilizer experiments comparing row and broadcast methods of application. (2) Fertilizer interactions with wheat varieties. (3) Fallow system - N source experiment. (4) Comparison of N sources and timing of application for wheat in an ecofallow rotation. (5) Soil test P levels in Rosebud - Canyon soils five years after fertilizer application.

1. Phosphorus fertilizer experiments comparing row and broadcast methods of application.

Many soils in Nebraska are deficient in Phosphorus (P) for wheat. Surveys have shown in southwest Nebraska that about 75% of the soils need P applications. Most wheat producers prefer to broadcast P prior to seeding and incorporate with final tillage. Present fertilizer recommendations for P indicate that seed applied P is twice as effective as broadcast. However, experiments have indicated seed application may be four or five times more effective than broadcast P on some soils while on other soils performance may be equal for the two methods of application. The objective of these experiments was to predict, based on soil characteristics, the relative efficiency of seed placed P compared to preplant broadcast P on wheat both on a one year application and over long term.

Many experimental locations are required to satisfy the objective. These locations were selected to obtain a range of soil pH and soil test P levels. The study will take several years to complete so that a range of soil test levels will be covered. Fertilizer P (0-46-0) was broadcast in August before final farmer tillage. Seed applications were applied at seeding time with a John Deere drill and standard fertilizer attachment. Nitrogen was spring applied according to a soil test for NO_3-N to a depth of 6 feet. Plant samples were collected at heading for determination of P content.

Results are shown in Table 1a through Table 1k. All study locations showed yield increase due to application of P. Seed application of P was significantly better than broadcast P in seven locations. Seed and broadcast P were equal in effectiveness at four locations. There are not adequate locations to indicate any trends as to how soil pH or soil P level might be related to P application method efficiency.

Table 2 shows data from a long term P experiment. This was the second wheat harvest following the initial P application in August 1975. Rates and methods of application were repeated in August 1977. While seed application was superior to broadcast in 1976, no yield response to P was obtained in 1978 at this location.

2. Fertilizer interactions with wheat varieties.

It has been observed that wheat yield responses to N and P fertilizer applications in western Nebraska have often been small compared to the expected response as assessed by soil test. A hypothesis concerning this "lack" of response was formulated: "Grain yield responses to applied N and P fertilizers are not realized because the increased availability of N and P delays the plant maturity enough that the grain filling period occurs during hotter and dryer climatic conditions which damage potential grain yield. Thus earlier maturing varieties should be able to respond more to fertilization than later maturing varieties."

To test this hypothesis an experiment was designed with five varieties with maturities that encompassed a range of 10 days, three N rates and two P rates. This experiment was conducted at two locations both known to be deficient in N and P. Unfortunately the variety with the longest maturity, Trapper, did not survive and so the range of maturities was less than 5 days.

Grain and straw yield data are given in Table 3. Statistical analysis showed that varieties differed in grain yield, but did not respond differently to N and P fertilizer (Table 4). Obviously the data does not support the hypothesis. However, with the loss of the Trapper variety the hypothesis was not adequately tested. Plant analyses at five growth stages in the wheat life cycle did not indicate any difference in N and P uptake between varieties.

3. Fallow system - N source experiment.

The objective of this experiment was to determine if fallow method would alter the relative effectiveness of N fertilizer sources. Four fertilizer materials, urea, ammonium nitrate, 20% N solution and anhydrous ammonia, were used at rates of 0, 20, 40, 60, 80 lbs N/Acre. All materials were applied in the fall prior to seeding the wheat. All were surface applied with no incorporation before seeding except the anhydrous which was injected on twenty inch spacing at a depth of four inches.

Grain yield results are shown in Table 5. There were no significant differences due to nitrogen sources, rates or fallow method. During the early grain filling period there were visual differences in the N rates. Control plots exhibited N deficiency symptoms; however, these differences were not found at harvest. This lack of response to N fertilization is common in the Panhandle area of Nebraska even when soil tests indicate that responses should occur.

4. Comparison of N sources and timing of application for wheat in an ecofallow rotation.

Goal: Determine effectiveness of different N fertilizer carriers for wheat grown in an ecofallow rotation.

Nitrogen sources used were ammonium nitrate, urea-ammonium nitrate, urea, and anhydrous ammonia. Fertilizer was applied as a fall preplant or a spring top dress. Nitrogen rates were 0, 20, 40, 60, or 80 lbs N/A.

Soil analyses showed:

pH	O.M.	P	K	lbs NO_3-N/A-6'
6.9	1.1%	25 ppm	326 ppm	64

Grain yield, straw weight, and N uptake by grain were determined.

Substantial visual differences in plant height were evident in early June. The significant treatment effects on straw production were N rate, N source, and the N rate x Time of Application interaction (Table 6). Spring NH_3 reduced plant stands and final straw yields. N rate significantly increased straw-yields (Table 6) but this was not translated into grain yields due to drought and hot winds in late June (Table 7). Fall-applied N produced more grain than spring-applied N, however. Spring-applied NH_3 significantly reduced grain yield.

Grain N content was higher for spring-applied N. Spring applied ammonium nitrate produced the highest grain %N (Table 8). The analysis of variance has not been completed.

Nitrogen uptake was significantly affected only by N rate (Table 9).

Conclusions from this two-year study[1/] are:

1. Fall-applied N produced significantly more grain both years than spring-applied N.

2. Ammonium nitrate in 1977 (spring and fall) produced significantly more grain than other sources. All sources performed similarly in 1978.

3. Straw production was the same for fall or spring-applied N both years (excluding spring NH_3).

4. Spring-applied NH_3 significantly decreased straw production both years but did not show a similar effect on grain yield.

5. Spring-applied N produced higher grain %N than fall-applied N.

6. Time of N application had no significant effect on N uptake by the grain either year . In 1977 ammonium nitrate showed significantly higher N uptake than other sources. In 1978 all sources were equal.

5. Soil test P levels in Rosebud-Canyon soils five years after fertilizer application.

Rosebud-Canyon soils are formed in sandy limestone which results in surface soils that range from slightly to highly calcareous. These soils cover over 50 percent of the land surface in several counties of western Nebraska. These soils are generally P deficient according to soil tests. It was hypothesized that because of their calcareous nature, very high rates of P fertilizers may be required for maximum crop growth on these soils. In addition, a limited number of experiments have shown that low P rates are not effective.

[1/] See Soil Science Research Report-1977 for first year data

Nine experiments were established in the fall of 1972 and ten more in the fall of 1973 to study the problem of limited yield response to N fertilizer. These experiments had four P rates (25, 50, 100 500 kg P/ha) and five N rates (0, 30, 60, 90, 120 kg N/ha) in a split plot treatment arrangement. The P was broadcast in August of the establishment year and incorporated with farmer tillage prior to seeding. Yields were measured and plant samples collected the first two crop years after establishment.[2/] The soils have been sampled in March or April every year since 1974.

Figure 1 depicts the typical response in $NaHCO_3$ extractable P over time. In this example one can observe that rate of P application greatly influenced the extractable P levels at the 18 month sampling. By the 66 month sampling, however, all rates were within 10 ppm of each other. Only the 100 and 500 kg/ha rates remained above the initial soil test level. Figure 2 is a summary of the data from all experiments for the 500 kg/ha P rate. Exponential equations were used to relate extractable P to time of sampling. It can be observed that changes in extractable P were related to $CaCO_3$ level as well as time. However, increases in $CaCO_3$ content above 0.1% did not affect the relationship of extractable P to time of sampling.

Sampling of these locations will continue for one more year. Other experiments, laboratory and greenhouse, are planned to determine if the $NaHCO_3$ P levels are actually reflecting plant availability of the applied P. Fractionation of the soil P in each treatment at each sampling date is also planned to determine what P compounds were present during the reaction of the P fertilizer with the soil. These experiments should lead to a more complete understanding of the reaction of P fertilizer in calcareous soils and improve our ability to predict the P supply capability of a given soil.

One obvious conclusion regarding these soils is that they are a poor place to "store P fertilizers." Minimum physical and time content of soil and fertilizer should be the goal during fertilization of these soils.

2/ See 1976 & 1977 Soil Science Research Reports

Table 1. Effect of P rate and method of application on wheat yield and P content at different locations in southwest Nebraska.

a. Furnas County
Location 3
SW¼ NW¼ Sec 12 T2N R23W

P Rate	Seed wt.	Yield: Grain	Yield: Straw	Yield: Heading	Heading P: Uptake	Heading P: Conc
kg P/ha	g	kg/ha x 10^{-2}			kg	%
0	2.2	27	47	64	12.2	.19
			Row			
8	2.45	35	54	71	13.6	.19
17	2.34	34	56	78	13.4	.18
25	2.35	36	59	71	13.9	.20
33	2.34	35	60	86	13.4	.16
42	2.23	34	58	81	15.1	.19
Mean	2.34	35	57	77	13.9	.18
			Broadcast			
8	2.30	28	49	69	12.7	.18
17	2.35	32	54	77	17.3	.23
25	2.30	35	58	71	15.4	.22
33	2.32	34	56	74	13.6	.19
42	2.30	32	53	76	15.4	.20
Mean	2.31	32	54	73	14.9	.20
Statistics						
Rate		**	**	-	*	*
Method	-	**	**	-	-	*
RatexMethod	-	-	-	-	-	-

Soil Tests	pH	Bray P	Na HCO_3 P
cm		ppm	
0-20	6.7	7	3
20-30	7.1	4	2

**, *, + = significant at 1, 5, and 10 percent level respectively.

- nonsignificant

b. Furnas County
Location 4
NE¼ NW¼ Sec 11 T2N R23W

P Rate	Seed wt.	Yield Grain	Yield Straw	Yield Heading	Heading P Uptake	Heading P Conc
kg P/ha	g/100	kg/ha x 10^{-2}			kg	%
0	2.3	30	51	65	9.4	.14
			Row			
8	2.46	36	61	73	11.6	.16
17	2.47	37	60	80	14.3	.17
25	2.27	37	64	97	16.0	.17
33	2.36	39	67	93	15.3	.17
42	2.37	37	64	80	12.7	.16
Mean	2.39	37	63	85	14.0	.16
			Broadcast			
8	2.35	34	55	81	13.8	.17
17	2.43	34	56	82	12.9	.16
25	2.39	38	64	87	16.3	.19
33	2.33	38	65	82	13.9	.17
42	2.37	39	68	79	14.9	.19
Mean	2.37	37	62	82	14.4	.17
Statistics						
Rate	-	**	**	*	*	-
Method	-	-	-	-	-	-
RatexMethod	-	-	-	-	-	-

Soil Tests cm	pH	Bray P	Na HCO_3 P
		ppm	
0-20	6.5	10	4
20-30	7.0	5	2

**, *, + = significant at 1, 5, and 10 percent level respectively.

\- nonsignificant

c. Red Willow County
Location 7
SE¼ SE¼ Sec 33 T1N R27W

P Rate	Seed wt.	Yield Grain	Yield Straw	Yield Heading	Heading P Uptake	Heading P Conc
kg P/ha	g/100	kg/ha x 10^{-2}			kg	%
0	2.40	14	26			
			Row			
8	2.45	23	38			
17	2.53	27	44			
25	2.65	29	47			
33	2.69	30	49			
42	2.52	29	47			
Mean	2.57	28	45			
			Broadcast			
8	2.54	19	34			
17	2.53	20	36			
25	2.64	25	38			
33	2.69	24	42			
42	2.63	25	43			
Mean	2.61	23	38			
Statistics						
Rate	**	**	**			
Method	-	**	**			
RatexMethod	-	-	-			

Soil Tests cm	pH	Bray P ppm	Na HCO_3 P
0-20	8.0	6	2
20-30	8.2	3	.3

**, *, + = significant at 1, 5, and 10 percent level respectively.

\- nonsignificant

d. Red Willow County
Location 8
SE¼ SE¼ Sec 33 T1N R27W

P Rate	Seed wt.	Yield			Heading P	
		Grain	Straw	Heading	Uptake	Conc
kg P/ha	g/100	kg/ha x 10^{-2}			kg	%
0	2.40	33	52	60	13.6	.23
			Row			
8	2.32	35	55	75	14.9	.20
17	2.29	36	58	78	14.2	.18
25	2.30	37	64	67	12.7	.19
33	2.40	38	61	72	17.3	.25
42	2.43	41	65	75	16.2	.22
Mean	2.35	37	61	73	15.1	.21
			Broadcast			
8	2.34	35	56	61	14.3	.23
17	2.28	31	57	69	15.0	.22
25	2.19	34	58	64	14.6	.23
33	2.25	32	56	68	16.0	.23
42	2.33	34	56	64	11.9	.19
Mean	2.28	33	56	65	14.4	.22
Statistics						
Rate	*	*	**	-	-	-
Method	-	**	**	+	-	-
RatexMethod	-	+	-	-	-	-

Soil Tests cm	pH	Bray P	$NaHCO_3$ P
		ppm	
0-20	6.7	18	6
20-30	7.4	6	2

**, *, + = significant at 1, 5, and 10 percent level respectively.

- nonsignificant

e. Red Willow County
Location 10
SE¼ SW¼ Sec 6 T3N R27W

P Rate	Seed wt.	Yield			Heading P	
		Grain	Straw	Heading	Uptake	Conc
kg P/ha	g/100	kg/ha x 10^{-2}			kg	%
0	2.20	28	53	70	14.0	.20
			Row			
8	2.24	33	57	68	14.5	.21
17	2.30	35	61	73	15.0	.20
25	2.27	32	58	60	10.6	.18
33	2.25	35	63	78	16.8	.22
42	2.27	39	63	78	15.3	.20
Mean	2.26	35	61	71	14.4	.20
			Broadcast			
8	2.23	32	59	76	13.3	.18
17	2.30	34	61	71	15.7	.22
25	2.33	37	62	77	15.7	.20
33	2.34	36	62	84	15.8	.19
42	2.35	38	67	63	14.0	.23
Mean	2.31	36	62	74	14.9	.20
Statistics						
Rate	+	**	**	-	-	+
Method	-	-	-	-	-	-
RatexMethod	+	-	-	-	-	*

Soil Tests cm	pH	Bray P	Na HCO_3 P
		ppm	
0-20	6.8	12	5
20-30	7.2	4	2

**, *, + = significant at 1, 5, and 10 percent level respectively.
- nonsignificant

f. Hitchcock County
Location 12
SW¼ SE¼ Sec 28 T3N R34W

P Rate	Seed wt.	Yield: Grain	Yield: Straw	Yield: Heading	Heading P: Uptake	Heading P: Conc
kg P/ha	g/100	kg/ha x 10^{-2}			kg	%
0	2.18	24	42	39	6.8	.18
			Row			
8	2.28	29	47	46	6.4	.14
17	2.29	30	49	45	7.0	.15
25	2.23	30	48	45	7.9	.18
33	2.27	32	50	58	10.1	.17
42	2.14	30	53	53	9.0	.17
Mean	2.24	30	50	49	8.1	.17
			Broadcast			
8	2.16	25	41	45	7.7	.16
17	2.24	26	43	37	7.1	.19
25	2.26	28	43	47	7.9	.17
33	2.21	27	43	50	9.8	.20
42	2.17	25	41	42	6.7	.16
Mean	2.20	26	42	44	7.9	.18

Statistics

Rate	-	**	-	**	**	-
Method	-	**	**	+	-	-
RatexMethod	-	-	-	-	-	-

Soil Tests cm	pH	Bray P (ppm)	Na HCO_3 P (ppm)
0-20	7.4	6	2
20-30	7.7	4	.1

**, *, + = significant at 1, 5, and 10 percent level respectively.

- nonsignificant

g. Hitchcock County
Location 13
SW¼ NW¼ Sec 28 T3N R34W

P Rate	Seed wt.	Yield Grain	Straw	Heading	Heading P Uptake	Conc
kg P/ha	g/100	kg/ha x 10^{-2}			kg	%
0	2.30	26	41	50	7.8	.16
			Row			
8	2.44	33	50	68	11.7	.17
17	2.41	38	56	73	10.4	.14
25	2.43	38	58	77	14.4	.19
33	2.37	39	58	73	12.9	.17
42	2.49	39	52	73	13.4	.19
Mean	2.43	37	55	73	12.6	.17
			Broadcast			
8	2.32	29	45	55	8.8	.16
17	2.34	28	44	52	7.3	.14
25	2.31	31	48	60	11.0	.18
33	2.34	30	48	59	10.2	.17
42	2.43	34	47	58	13.2	.22
Mean	2.35	30	46	57	10.1	.18
Statistics						
Rate	**	**	**	**	**	**
Method	**	**	**	**	**	-
RatexMethod	-	*	-	-	-	-

Soil Tests cm	pH	Bray P	Na HCO_3 P
		ppm	
0-20	7.5	5	2
20-30	7.6	3	.7

**, *, + = significant at 1, 5, and 10 percent level respectively.

\- nonsignificant

h. Hitchcock County
Location 15
NE¼ NE¼ Sec 7 T3N R34W

P Rate	Seed wt.	Yield			Heading P	
		Grain	Straw	Heading	Uptake	Conc
kg P/ha	g/100	kg/ha x 10^{-2}			kg	%
0	1.66	12	36	40	8.4	.20
			Row			
8	1.70	17	39	45	9.2	.20
17	1.70	16	42	46	9.4	.21
25	1.65	16	45	50	11.1	.23
33	1.71	18	46	49	10.1	.20
42	1.73	18	48	56	11.1	.20
Mean	1.70	17	44	49	10.2	.21
			Broadcast			
8	1.64	13	35	42	8.7	.21
17	1.62	17	46	41	9.5	.23
25	1.66	15	45	46	9.7	.21
33	1.74	17	45	47	10.3	.22
42	1.69	17	48	55	11.6	.21
Mean	1.67	15	44	46	10.0	.21

Statistics

Rate	-	**	**	*	-	-
Method	-	*	-	-	-	-
RatexMethod	-	-	-	-	-	-

Soil Tests cm	pH	Bray P ppm	Na HCO_3 P
0-20	7.4	6	2
20-30	7.6	3	.6

**, *, + = significant at 1, 5, and 10 percent level respectively.

- nonsignificant

i. Hitchcock County
Location 16
NW¼ NW¼ Sec 27 T2N R33W

P Rate	Seed wt.	Yield			Heading P	
		Grain	Straw	Heading	Uptake	Conc
kg P/ha	g/100	kg/ha x 10^{-2}			kg	%
0	2.80	28	39	64	11.4	.18
			Row			
8	2.85	31	40	55	10.0	.18
17	2.86	30	40	65	11.2	.17
25	2.85	31	42	63	12.5	.20
33	2.92	36	44	67	12.1	.18
42	2.90	33	43	68	13.1	.19
Mean	2.87	32	42	64	11.8	.19
			Broadcast			
8	2.83	32	43	64	12.1	.19
17	2.83	30	39	64	10.2	.16
25	2.94	32	43	69	11.8	.17
33	2.90	31	40	63	11.9	.19
42	2.96	32	42	70	12.0	.17
Mean	2.89	31	42	66	11.6	.18
Statistics						
Rate		**	-	-	-	-
Method	-	-	-	-	-	-
RatexMethod	-	+	-	-	-	-

Soil Tests cm	pH	Bray P	Na HCO_3 P
		ppm	
0-20	7.7	7	3
20-30	7.8	3	.9

**, *, + = significant at 1, 5, and 10 percent level respectively.

- nonsignificant

j. Frontier County
Location 17
NW¼ Sec 10 T7N R28W

P Rate	Seed wt.	Yield: Grain	Yield: Straw	Yield: Heading	Heading P Uptake	Heading P Conc
kg P/ha	g/100	kg/ha x 10^{-2}			kg	%
0	2.2	24	54	56	10.2	.18
			Row			
8	2.20	32	63	71	12.1	.17
17	2.04	32	68	81	10.6	.13
25	2.04	33	73	69	11.8	.18
33	2.04	32	74	88	16.4	.18
42	1.95	32	73	82	15.3	.19
Mean	2.05	32	70	78	13.2	.17
			Broadcast			
8	2.13	27	58	59	10.1	.18
17	2.04	27	60	50	9.3	.19
25	2.08	28	63	53	9.3	.18
33	1.99	26	61	68	12.0	.18
42	2.07	28	63	60	10.7	.18
Mean	2.06	27	61	58	10.3	.18
Statistics						
Rate	**	**	**	**	**	+
Method	-	**	**	**	**	+
RatexMethod	-	-	-	-	-	**

Soil Tests (cm)	pH	Bray P (ppm)	Na HCO_3 P (ppm)
0-20	6.5	6	3
20-30	7.1	3	2

**, *, + = significant at 1, 5, and 10 percent level respectively.
- nonsignificant

k. Frontier County
Location 18
SE¼ Sec 24 T7N R28W

P Rate	Seed wt.	Yield Grain	Yield Straw	Yield Heading	Heading P Uptake	Heading P Conc
kg P/ha	g/100	kg/ha x 10^{-2}			kg	%
0	2.4	35	72	73	12.4	.16
			Row			
8	2.29	38	84	98	16.5	.17
17	2.32	41	87	90	16.4	.18
25	2.29	42	88	87	15.5	.18
33	2.27	41	88	91	17.7	.19
42	2.30	40	83	100	19.0	.19
Mean	2.29	40	86	93	17.0	.18
			Broadcast			
8	2.42	38	81	74	13.4	.18
17	2.29	40	84	87	16.8	.19
25	2.28	39	84	92	20.0	.22
33	2.30	41	88	100	23.9	.24
42	2.26	40	87	87	17.1	.19
Mean	2.31	40	85	88	18.2	.20
Statistics						
Rate	-	**	**	*	**	**
Method	-	-	-	-	-	**
RatexMethod	-	-	-	-	*	+

Soil Tests cm	pH	Bray P (ppm)	Na HCO_3 P
0-20	6.8	8	3
20-30	7.2	6	.8

**, *, + = significant at 1, 5, and 10 percent level respectively.
- nonsignificant

Table 2. Effect of reapplication of P rate and method of application on wheat yield and P content following initial P application in 1975. Carter Farm, Hitchcock County

P Rate	Seed wt.	Yield			Heading P	
		Grain	Straw	Heading	Uptake	Conc
kg P/ha	g/100	kg/ha x 10^{-2}			kg	%
0	2.20	38	58	72	17.4	.24
			Row			
8	2.25	38	60	75	17.9	.24
17	2.24	41	62	85	19.0	.22
25	2.18	40	63	80	19.4	.24
33	2.08	37	60	80	18.0	.23
42	2.27	41	62	79	16.7	.21
Mean	2.20	40	61	80	18.3	.23
			Broadcast			
8	2.25	39	60	77	16.7	.22
17	2.18	38	58	84	20.1	.24
25	2.30	41	60	79	19.0	.24
33	2.26	38	60	86	22.3	.26
42	2.26	41	62	82	21.5	.26
Mean	2.25	39	60	82	19.9	.24
Statistics						
Rate	-	-	-	*	-	-
Method	-	-	-	-	-	-
RatexMethod	-	-	-	-	-	-

Soil Tests cm	pH	Bray P	Na HCO_3 P
		ppm	
0-20	6.3	16	8
20-30	7.0	4	.6

**, *, + = significant at 1, 5, and 10 percent level respectively.

- nonsignificant

Table 3. Grain and straw yields in the wheat variety-fertilization experiments.

GRAIN AND STRAW YIELDS

N	P	Variety	LOCATION I (Hitchcock Co.) Grain	LOCATION I (Hitchcock Co.) Straw	LOCATION II (Cheyenne Co.) Grain	LOCATION II (Cheyenne Co.) Straw
			---- kg/ha ----		---- kg/ha ----	
0	0	Centurk	2338	2739	2427	5431
0	10		2094	1947	2807	5033
40	0		2212	2511	3306	6145
40	10		2579	3192	2603	6455
80	0		2257	2991	2429	4847
80	10		2203	2118	2558	6168
0	0	Tam 103	1869	2336	2923	5060
0	10		1999	2193	2171	4362
40	0		2225	2443	2375	5035
40	10		2662	2878	2862	5246
80	0		1854	2316	2046	5615
80	10		2336	2816	1522	5370
0	0	Triumph	1743	2137	2701	5157
0	10		1280	1928	2733	5161
40	0		1819	2454	2715	5375
40	10		2048	2821	2816	6206
80	0		1983	2810	2776	5726
80	10		1858	2302	2459	4862
0	0	Vona	2026	2304	3004	5186
0	10		2028	2723	2801	4699
40	0		2166	2485	2961	5076
40	10		2535	2578	3086	6580
80	0		2187	3201	3381	5962
80	10		2724	3052	2996	6329

Table 4. Analysis of variance for grain and straw yields in the variety-fertilizer interaction experiment.

SOURCE	d.f.	F VALUES			
		Location I		Location II	
		Grain	Yield	Grain	Yield
Block	2	--	--	--	--
Variety	3	**	N.S.	**	N.S.
Triumph vs. Others	1	**	N.S.	N.S.	N.S.
Tam vs. Centurk & Vona	1	N.S.	N.S.	**	*
Centurk vs. Vona	1	N.S.	N.S.	+	N.S.
Nitrogen	2	*	*	N.S.	**
Phosphorus	1	N.S.	N.S.	N.S.	N.S.
Variety x N	6	N.S.	N.S.	N.S.	N.S.
Variety x P	3	N.S.	N.S.	N.S.	N.S.
N x P	2	N.S.	N.S.	N.S.	+
N x P x Variety	6	N.S.	N.S.	N.S.	N.S.
Residual	46				
Total	71				

**, *, + denote significance at the 1, 5 and 10% probability level respectively

Table 5. Grain yields as affected by source and rate of nitrogen and method of fallow.

Source	Rate lbs/A	Method of Fallow: Tillage	Method of Fallow: Chemical
		--------bu/A--------	
None	0	36	39
Urea	20	30	35
	40	36	37
	60	36	28
	80	35	34
		$\bar{x}$ = 34	$\bar{x}$ = 34
Ammonium Nitrate	20	31	35
	40	34	38
	60	36	33
	80	30	31
		$\bar{x}$ = 33	$\bar{x}$ = 34
Solution 28% N	20	34	35
	40	35	34
	60	32	36
	80	33	31
		$\bar{x}$ = 34	$\bar{x}$ = 34
Anhydrous Ammonia	20	38	33
	40	32	31
	60	36	32
	80	36	26
		$\bar{x}$ = 36	$\bar{x}$ = 31

Table 6. Straw yield - cwt/A

Nitrogen lbs/A	Urea Fall	Urea Sprg	NH_3 Fall	NH_3 Sprg	AN Fall	AN Sprg	UAN Fall	UAN Sprg	N rate avg Fall	N rate avg Sprg
0				44					44	
20	52	45	52	43	55	47	49	46	52	45
40	50	54	45	40	46	54	52	46	48	49
60	57	46	63	41	58	51	54	45	58	46
80	56	68	50	58	54	67	49	58	52	63
Source & time avg	54	53	52	45	53	55	51	49		

Condensed AOV

Source of Variation	(N) N Rate	(T) Time	N x T	(S) N Source	N x S	T x S	N x T x S
Probability of F	.407	.393	.022	.012	.626	.136	.807

Table 7. Grain yield - bu/A

Nitrogen lbs/A	Urea Fall	Urea Sprg	NH_3 Fall	NH_3 Sprg	AN Fall	AN Sprg	UAN Fall	UAN Sprg	N rate avg Fall	N rate avg Sprg
0				42					42	
20	45	40	49	37	49	42	47	44	48	41
40	45	48	45	43	37	46	44	43	43	45
60	50	37	48	37	45	39	46	36	47	37
80	46	46	44	45	43	45	43	44	44	45
Source & time avg	47	43	47	40	44	43	45	42		

Condensed AOV

Source of Variation	(N) N Rate	(T) Time	N x T	(S) N Source	N x S	T x S	N x T x S
Probability of F	.419	.006	.003	.764	.852	.270	.782

Table 8. % N in the wheat grain.

Nitrogen lbs/A	Urea Fall	Urea Sprg	NH_3 Fall	NH_3 Sprg	AN Fall	AN Sprg	UAN Fall	UAN Sprg	N rate Avg Fall	N rate Avg Sprg
0				1.64					1.64	
20	1.68	1.73	1.74	2.04	1.68	1.80	1.62	1.93	1.68	1.88
40	1.79	1.81	1.78	1.65	2.01	1.98	1.88	1.72	1.87	1.79
60	1.80	2.11	2.04	1.88	2.18	2.27	1.79	2.07	1.95	2.08
80	2.08	2.38	1.70	2.29	1.96	2.49	2.28	2.10	2.01	2.32
Source & time avg	1.84	2.01	1.82	1.97	1.96	2.14	1.89	1.96		

Condensed AOV

Source of Variation	(N) N Rate	(T) Time	N x T	(S) N Source	N x S	T x S	N x T x S
Probability of F	.01	.01	.10	.05	.05	-	.01

Table 9. N uptake in grain - lbs/A

Nitrogen lbs/A	Urea Fall	Urea Sprg	NH_3 Fall	NH_3 Sprg	AN Fall	AN Sprg	UAN Fall	UAN Sprg	N rate avg Fall	N rate avg Sprg
0					38				38	
20	46	42	52	47	49	45	46	51	48	46
40	49	51	48	42	45	54	50	44	48	48
60	54	47	61	41	58	52	49	45	55	46
80	57	65	44	61	51	68	58	54	53	61
Source & time avg	51	51	51	48	51	55	51	49		

Condensed AOV

Source of Variation	(N) N Rate	(T) Time	N x T	(S) N Source	N x S	T x S	N x T x S
Probability of F	.018	.853	.064	.386	.472	.352	.131

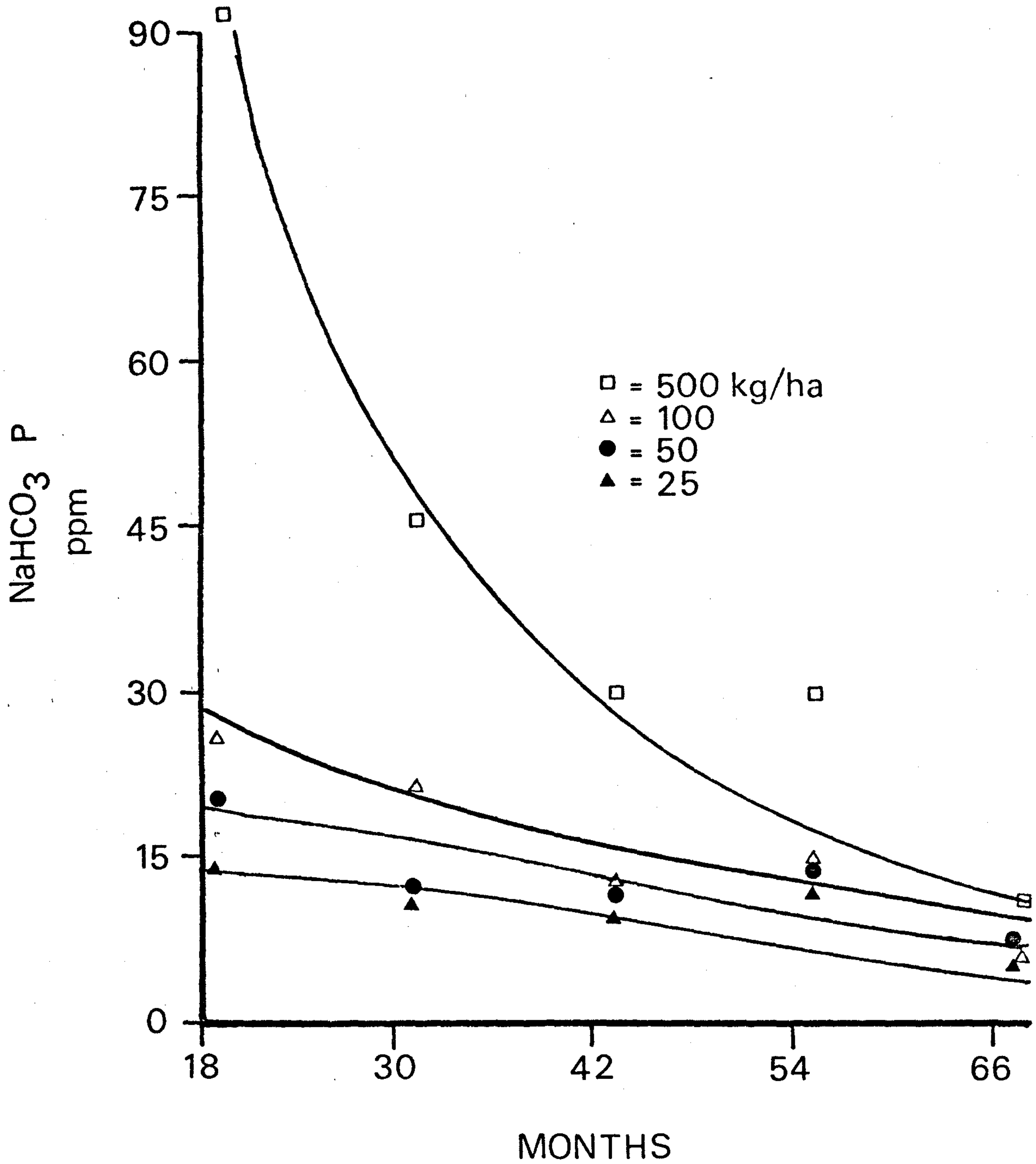

Figure 1. Sodium bicarbonate extractable P over time at the 0.1% $CaCO_3$ level as affected by rate of P fertilizer application.

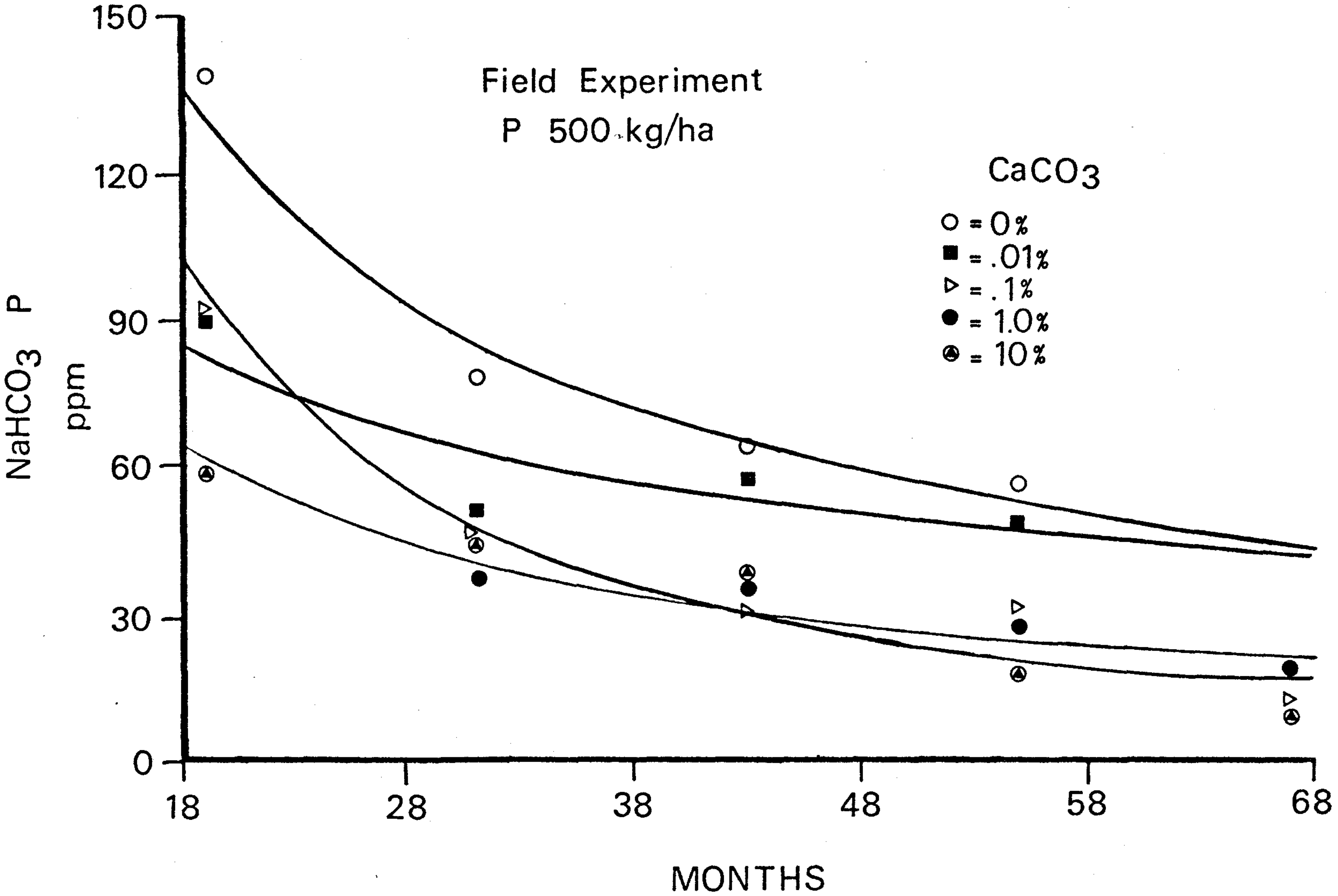

Figure 2. Sodium bicarbonate extractable P over time as related to the calcium carbonate equivalent of the soil at the 500 kg/ha P fertilizer application rate. (Nineteen experiments in Cheyenne County were summarized in this figure)

PHOSPHORUS RATE X PLACEMENT ON WINTER WHEAT IN SOUTHEAST NEBRASKA 1978

E. J. Penas and D. H. Sander

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 Johnson and Seward Counties in the fall of 1977. Sites selected were relatively low in phosphorus and acid in pH. These studies are to parallel studies being conducted in western Nebraska on neutral to alkaline soils.

At each of the selected locations, two other soil fertility experiments were included. Rates of nitrogen top-dressed in the spring were studied. Also a nitrogen by phosphorus study was included.

Discussion: Soil test characteristics are reported in Table 1. The Johnson County site is low in phosphorus and slightly acid. The Seward County site is medium in phosphorus and moderately acid. Both sites are low in nitrogen.

Grain yields were increased by nitrogen and phosphorus at both sites. Grain yields for each of the sites are listed in Table 2.

Since these sites were low in nitrogen, a nitrogen rate study was included. Phosphorus was placed with the seed at the time of seeding at a rate of 46 pounds P_2O_5 (20 P) per acre. Nitrogen as ammonium nitrate was top-dressed in the spring at the rates shown in Table 3. Grain yields were increased significantly by 20 pounds of nitrogen per acre and 60 pounds of nitrogen per acre was sufficient to get maximum yields.

The influence of phosphorus on the growth of wheat was also studied at both locations. Phosphorus applied at various rates with the seed at planting time was compared to the same rates applied broadcast and incorporated prior to seeding. Nitrogen at 60 pounds per acre was top-dressed in the spring. Grain yields for these treatments are given in Table 4.

At Johnson County, phosphorus applied with the seed was about twice as effective as where the phosphorus was broadcast. This is in agreement with current recommendations.

At Seward County, phosphorus with the seed was about four times as effective as where the phosphorus was broadcast. It is not known why the broadcast treatments were not more effective. Yields from broadcast phosphorus were not as high as where the phosphorus was placed with the seed even at the highest rates of phosphorus. Also, a high amount of phosphorus was necessary to get maximum yields; however, 34 pounds of P_2O_5 (15 P) did give yields for near maximum profit when placed with the seed.

Table 1. Soil Test Characteristics of Winter Wheat Test Plot Sites, 1978.

	Johnson Co.	Seward Co.
Soil pH	6.2	5.6
Lime Requirement, tons/ac	2.5	3.0
NO_3-Nitrogen, lbs/ac 6 ft.	53	59
Phosphorus, ppm	6	14
Potassium, ppm	282	362
Organic Matter, %	2.6	2.8

Table 2. Winter Wheat Grain Yields, bu/ac, as influenced by nitrogen & phosphorus, 1978

Treatment	Johnson County	Seward County
None	37	29
60 lbs. N	44	33
46 lbs. P_2O_5 (20 P)	48	37
60 N + 46 P_2O_5 (20 P)	56	44

Table 3. Winter Wheat Grain Yields, bu/ac, as influenced by nitrogen rate, 1978.

Nitrogen, lbs/ac	Johnson County	Seward County
0	42	45
20	47	50
40	49	50
60	50	54
80	--	50

Table 4. Winter Wheat Grain Yields, bu/ac, as influenced by phosphorus rate & placement, 1978.

Phosphorus Rate, lbs/ac		Johnson County		Seward County	
P	P_2O_5	P Bdct	P w/Seed	P Bdct	P w/Seed
0.00	0	41		34	
3.75	9		46		39
7.50	17	44	49	35	43
11.25	26		51		46
15.00	34	47	52	38	48
18.75	43		53		49
22.50	52	50	53	40	50
26.25	60		53		50
30.00	69	52	53	42	49
33.75	77		53		49
37.50	86	52	53	40	49

RELATION OF SOIL PROPERTIES AND OTHER ENVIRONMENTAL FACTORS TO GRAIN YIELD AND QUALITY OF WINTER WHEAT GROWN AT INTERNATIONAL SITES

A.D. Karathanasis, V.A. Johnson, G.A. Peterson, and R.A. Olson

A. Objectives

The objectives of this investigation were to:

1. Investigate by correlation those measurable soil factors that influence the yield and quality of winter wheat varieties grown in international nurseries;
2. Determine status of nutrient elements within nurseries, delineating excessive or limiting nutrients along with nutrient interactions in growth of the wheat.
3. Record differential varietal responses, if any, to specific soil factors over the wide range of soils involved.

B. Procedure

Thirty varieties of winter wheat were established in the International Winter Wheat Performance Nursery of 1975-76 by cooperators in the countries participating. Soil samples were collected to a depth of 6 feet, where possible, by 1-foot increments in the fall and early spring, and were subsequently analyzed for the parameters expressed in the accompanying tables. Relation of the measured soil and environmental factors were related to yield of protein content of the respective genotypes by linear and multiple correlation and regression analysis.

C. Results and Discussion

A wide range in soil, yield, protein and environmental parameters was recorded in the study (Table 1). The thirty varieties of winter wheat

Table 1. Range and means of soil (X), yield (Y), protein (P), and environmental (Z) parameters over the 31 nursery sites.

Parameters	Range	Mean
Y = mean grain yield, g/ha	9.5 - 73.1	39.3
P = mean grain protein, %	11.6 - 18.7	14.7
X_1 = soil pH	5.0 - 8.9	7.6
X_2 = free lime content, %	0.0 - 25.5	5.7
X_3 = organic carbon, %	0.4 - 4.8	1.5
X_4 = total N, %	0.04 - 0.65	0.16
X_5 = NH_4^+-N, ppm	1.2 - 38.4	5.8
X_6 = NO_3^--N, ppm	2.5 - 38.4	13.6
X_7 = mineral N, kg/ha	120 - 1000	380
X_8 = soil P (Olsen), ppm	1.3 = 63.9	13.6
X_9 = soil P (Bray & Kurtz #1), ppm	0.2 - 84.0	22.3
X_{10} = soil K^+, ppm	47 - 577	156
X_{11} = $SO_4^=$-S, ppm	4.1 - 147.6	27.9
X_{12} = Cu (DTPA), ppm	0.6 - 13.2	2.4
X_{13} = Mn (DTPA), ppm	6.7 - 112.8	22.0
X_{14} = Zn (DTPA), ppm	0.3 - 19.8	2.4
X_{15} = Fe (DTPA), ppm	3.0 - 217.7	34.4
Z_1 = rainfall, mm	167 - 851	411
Z_2 = winterkill, %	4 - 63	23
Z_3 = growing season, days	140 - 242	201
Z_4 = elevation, m	7 - 1870	492

grown at 31 international nurseries including 15 in Europe, 9 in Asia and 7 in USA during the 1975-76 growing season revealed significant dependence on many soil parameters studied in expressing maximum grain yield and grain protein. Despite great variability among nurseries in soil type, climate, and soil management, 17-74% of the variation in the grain yield and 20-94% in the grain protein content was explained by the soil variables included in the regression models (Tables 2 & 3). Lowest grain yields were on

Table 2. Regression models for grain yield of some varieties showing the highest R^2 over 26 nurseries.1/

Variety	Grain yield, q/ha	Regression equation	R^2
Priboy	45.2	$Y= 27.2 + 94.6X_4 + 0.7X_5 -1.3X_{14} - 0.009Z_4$	0.60**
Maris Huntsman	41.8	$Y= -51.0 + 213.2X_4 + X_8 + 7.1X_1 - 1.4X_{14}$	0.68**
Kormoran	41.2	$Y= -40.0 + 8.6X_3 + 0.9X_8 + 9.4X_1 - 0.9X_2 - 2.6X_{12}$	0.68**
Maris Templar	40.7	$Y= -39.2 + 0.4Z_3 + 1.1X_8 + 0.2X_{15} - 3.9X_{12}$	0.67**
Lely	41.2	$Y= -25.9 + 93X_4 - 0.4X_2 + 0.3Z_3 + 0.8X_8$	0.74**
Atlas 66	32.9	$Y= 19.1 + 0.8X_8 + 260.4X_4 - 19.8X_3 - 1.2X_{14} + 0.6X_5 - 0.008Z_4$	0.61**
Lerma Rojo 64	26.2	$Y= -124.5 + 9.4X_{12} +17.2X_1 - 0.42X_{11} + 1.2X_8 + 1.2X_5 - 0.02Z_4 - 2.4X_{14} + 0.4X_{13} - 0.3X_{15}$	0.71**
Galiafen	27.1	$Y= -59.2 + 1.3X_8 + 16X_1 - 0.4X_{11} + 0.2X_{14} - 0.2Z_3$	0.64**
Rashid	25.8	$Y= -73.6 + 1.3X_8 + 9.9X_1 + 0.6X_5 - 1.9X_{14} + 0.3X_{13} + 3.7X_{12} - 0.2X_{15}$	0.63**
MEAN GRAIN YIELD OVER 30 VARIEITES	39.9	$Y= -.20.2 + 1.1X_8 + 0.2X_{13} + 0.8X_5 + 0.01Z_4 + 6.5X_1 - 1.2X_{14}$	0.58**

1/ Yield data from nurseries in Norway, Cornell, Nebraska are omitted due to high winterkill factors; W. Germany (Weihensteffen), due to erratic yields; and Japan (soil unique in its characteristics due to allophane content).

Table 3. Regression models for grain protein content for varieties exhibiting the highest coefficient of determination over 29 nurseries. 1/

Variety	Grain protein,%	Regression equation	R^2
Talent	14.6	$P = 19.8 - 0.007Z_1 - 0.05Y + 0.56X_3 - 0.07X_2 - 0.02X_8$	0.70**
Bexostaya 1	14.3	$P = 17.7 - 0.045X_9 - 0.11X_2 - 0.004Z_1$	0.55**
Kitakomi Komugi	13.6	$P = 20.2 - 0.006Z_1 - 0.05Y + 0.07X_3 - 0.56X_1 + 0.004X_{10}$	0.63**
Lely	14.7	$P = 20.5 + 0.14X_6 - 0.06Y - 0.01Z_1 - 0.14X_2 - 0.09X_9 + 0.024X_{15}$	0.55**
Flavio	14.0	$P = 14.6 - 0.044Y + 0.016X_{11} + 0.07X_8$	0.69**
Lerma Rojo 64	15.8	$P = 18.5 + 0.024X_{11} - 0.04X_9 - 1.45X_1 - 0.004Z_1 + 0.055Z_3 + 2.98X_3 + 19.8X_4$	0.76**
Galiafen	14.8	$P = 23.9 = 0.13Y - 0.08X_6 - 0.1Z_3 + 1.21X_3 + 0.14X_5 + 0.24X_8 - 1.63X_{12} + 0.005X_{10} + 0.04X_{13} + 0.003Z_1 - 0.02X_{15}$	0.94**
Rashid	15.3	$P = 17.4 + 0.014X_{11} - 0.08X - 0.004Z_1 + 0.15X_8 + 0.03X_{13} + 0.075X_5 - 0.69X_{12} + 0.003X_{10}$	0.74**
MEAN GRAIN PROTEIN OVER 30 VARIETIES	14.7	$P = 18.0 = 0.044X_8 - 0.13X_2 - 0.004Z_1$	0.48**

1/ Grain protein data were available only from 29 nurseries.

soils with pH lower than 6.0 or on highly calcareous soils. Residual mineral N in the soil profile of most nurseries was more than enough to produce maximum grain yield and protein but P shortage appeared to be the main factor limiting yields of most varieties. Potassium and S level in the soil and Mn and Cu concentrations were significantly related with grain protein and yield, respectively, and appeared to be very important for the nutrition of individual varieties. Winterkill was the main environmental factor depressing yields severely in some nurseries while seasonal rainfall had low significance or rather negative effect on the yield and quality performance.

INFLUENCE OF METHOD OF SEED INOCULATION AND RATE OF NITROGEN ON ESTABLISHMENT OF ALFALFA ON A SANDY SOIL

G.W. Rehm

Objective:

Farmers have come to rely heavily upon the use of pre-inoculated legume seed. There are several methods of inoculating seeds and there was a need to evaluate the effect of various inoculation methods in the field. There is general agreement that large applications of fertilizer nitrogen will hinder nodulation and interfere with fixation of N from the atmosphere. There was some questions regarding the use of low rates of N for establishment of alfalfa on sandy soils. Therefore, this study was initiated to evaluate the effect of several methods of seed inoculation in conjunction with rate of fertilizer N on the establishment of alfalfa on a sandy soil.

Procedure:

This study was conducted in Pierce County on a Thurman loamy fine sand. Dawson alfalfa seed was inoculated with 4 processes (dry, peat, Pelinoc, Cel Pril, and noculized). Seed which was not inoculated was used as a control. Nitrogen as 33-0-0 was applied at rates of 0, 15, 30, and 45 lb./acre. All treatments received, P, K and S to meet the requirements as indicated by soil test. All fertilizer materials were broadcast and incorporated before seeding.

Alfalfa was seeded in mid-August of 1977 without a companion crop. Yields were recorded at 4 times during the growing season. The initial cutting was taken on June 2 with subsequent cuttings taken at 35 day intervals.

Results and Discussion:

Method of seed inoculation had no effect on yield (Table 1). Nodules were observed on the roots of all plants. Although no counts were made, method of inoculation appeared to have no effect on nodule number. Nodules were found in plots where the seed had not been inoculated. This could have been the result of the presence of the necessary bacteria in the soil before planting or contamination of the seed.

Yields were increased by the use of N (Table 2). The use of 15 lb. N/acre had a beneficial effect on yield with higher rates having no beneficial effect on yield.

Table 1. Effect of method of seed inoculation on alfalfa yield.

Method of Inoculation	Yield
	ton D.M./acre
None	4.21 a*
Dry Peat	4.21 a
Pelinoc	4.37 a
Cel Pril	4.28 a
Noculized	4.12 a

*Treatment means followed by the same letter are not significantly different at the .05 confidence level.

Table 2. Effect of rate of fertilizer N on alfalfa yield.

Rate of N	Yield
lb./acre	ton D.M./acre
0	3.97 a*
15	4.39 bc
30	4.17 ab
45	4.41 c

*Treatment means followed by the same letter are not significantly different at the .05 confidence level.

INFLUENCE OF THE FREQUENCY OF FERTILIZER USE WITH AND WITHOUT HERBICIDE ON PRODUCTION OF WARM-SEASON PRAIRIE GRASSES

G.W. Rehm and R.S. Moomaw

Objective:

Many acres of northeast Nebraska are seeded to the warm-season prairie grasses. There are two major problems associated with the production of these grasses. For the most part, these grasses are seeded on soils that have low levels of both nitrogen and phosphorus. In addition, competition from weeds is a serious problem in the management of these grasses. Therefore, this study was conducted to measure the effect of the use of fertilizer with and without herbicide on the production of warm-season prairie grasses.

Procedure:

This study was initiated in Cedar County in 1974 and will be terminated at the end of the 1979 growing season. The experimental site was divided into 3 sections. In the first section, 5 rates of N (0, 30, 60, 90, 120 lb./acre) and 5 rates of P (0, 5, 10, 15, 20 lb./acre) in treatments arranged to fit a central composite design were broadcast to an existing stand of warm-season prairie grasses in late May of each year.

These same fertilizer treatments are applied to a second section. In addition, this section is sprayed with atrazine at a rate of 1 lb. product per acre in early April on alternate years. In the third section, the fertilizer rates are doubled and applied on alternate years. This section also receives an alternate year application of 1 lb. atrazine per acre in early April.

Yields have been recorded in early August each year. Whole plant samples are collected at harvest, ground to pass a 2 mm screen and analyzed for protein N and percentage of IVDMD.

Results and Discussion:

Although yields have been recorded from 1974 through 1978, the yields obtained in 1978 only are listed in Tables 1, 2, and 3. When no herbicide was applied, forage yield increased linearly from the application of both N and P (Table 1). The use of N produced a curvilinear increase in yield in 1978 while the response to P was linear when the warm-season prairie grasses were treated with atrazine on alternate years (Table 2). Forage yields in 1978 did not respond to P applied on an alternate year schedule. The use of N did produce a linear increase in yield (Table 3).

Although the data have not been subjected to complete statistical analysis, it would appear that yields were lower when no herbicide was used. From visual observation it was apparent that foxtail and russian thistle were the dominant weeds. Apparently the weed population was competing with the warm-season grasses for moisture and nutrients and produced a lower yield.

Table 1. The effect of N and P without the use of a herbicide on the yield of warm-season prairie grasses.

		N Applied (lb./acre)				
		0	30	60	90	120
		- - - - - - - - -	ton of dry matter/acre	- - - - - - - - -		
P_2O_5	0	.07	.67	1.05	1.22	1.16
Applied	11.5	.38	1.05	1.50	1.73	1.75
lb./acre	23	.51	1.25	1.77	2.07	2.15
	34.5	.46	1.27	1.86	2.23	2.38
	46	.23	1.11	1.77	2.21	2.44

Table 2. The effect of N and P in addition to the use of a herbicide on the yield of warm-season prairie grasses.

		N Applied (lb./acre)				
		0	30	60	90	120
		- - - - - - - - -	ton of dry matter/acre	- - - - - - - - -		
P_2O_5	0	.13	2.30	3.27	3.05	1.63
Applied	11.5	.60	1.70	2.81	2.73	1.44
lb./acre	23	.78	1.67	2.92	2.97	1.82
	34.5	.38	2.20	3.58	3.77	2.76
	46	.57	3.29	4.81	5.13	4.26

Table 3. Effect of N and P applied on alternate years in addition to the use of a herbicide on the yield of warm-season prairie grasses.

		N Applied (lb./acre)				
		0	60	120	180	240
		- - - - - - - - -	ton of dry matter/acre	- - - - - - - - -		
P_2O_5	0	.35	2.18	3.22	3.45	2.89
Applied	23	.28	2.12	3.17	3.42	2.88
lb./acre	46	.34	2.20	3.27	3.53	3.00
	69	.55	2.43	3.51	3.79	3.28
	92	.90	2.79	3.89	4.19	3.69

FERTILIZER MANAGEMENT FOR FORAGES ESTABLISHED WITH REDUCED TILLAGE TECHNIQUES

G.W. Rehm

Objective:

Pasture improvement is a major problem in northeast Nebraska. Fertilization and weed control will improve production of many abused pastures. There are, however, many acres which have been abused to the extent that the introduction of new species is needed before production can be improved. Erosion is a major hazard if conventional tillage practices are used on the pastures needing improvement. Recent advances in herbicides and seeding equipment have stimulated studies which are designed to develop systems whereby grasses and/or legumes can be seeded into existing pastures with limited tillage. The objective of this study is to evaluate the effect of the application of fertilizer to grasses and/or legumes seeded with reduced tillage techniques.

Procedure:

Studies were initiated in Knox County in late August of 1976. Glyphosate at a rate of 2 lb. a.i./acre was sprayed on existing vegetation approximately 2 weeks before seeding. The John Deere Powr Till Drill was used for seeding at both sites.

Mixtures of smooth bromegrass plus cicer milkvetch and intermediate wheatgrass plus cicer milkvetch were seeded in late August.

Results and Discussion:

Forage yields were not increased significantly by the application of either N or P (Table 1). The lack of significant effects can be attributed to the large amount of variability in the data. This large amount of variability is due to the inconsistent stand obtained with the John Deere Powr Till Drill in 1976.

The N content of the tissue was not influenced by the application of either N or P (Table 2). In this case, lack of significant treatment effects can be attributed to differences in the percentages of grasses and legumes in stand brought about by the use of N and P. Without applied N, there was a higher percentage of cicer milkvetch which probably increased the protein content of the forage. With added N, there was a higher percentage of grass in the mixture. Although fertilizer N may have increased the N content of the grasses, the N content of the forage mixture was equal to the N content of the mixture receiving no N where the legume component was a major factor in the mixture.

Table 1. Effect of rate of N and P on yield of grass-legume mixtures seeded with reduced tillage techniques. Knox County, 1978.

Smooth Bromegrass + Cicer Milkvetch:

P Applied	N Applied (lb./acre)			
	0	40	80	120
lb./acre	ton D.M./acre			
0	.76	1.45	1.09	1.78
20	1.30	1.29	1.13	1.40
40	.55	.73	1.79	1.33

Intermediate Wheatgrass + Cicer Milkvetch:

P Applied	N Applied (lb./acre)			
	0	40	80	120
lb./acre	ton D.M./acre			
0	.69	1.25	1.12	1.69
20	1.21	.76	1.36	1.32
40	.76	.92	1.76	1.35

Table 2. Effect of rate of N and P on the nitrogen content of grass-legume forage mixtures seeded with reduced tillage techniques. Knox County, 1978.

Smooth Bromegrass + Cicer Milkvetch:

P Applied	N Applied (lb./acre)			
	0	40	80	120
lb./acre	% N			
0	1.81	2.33	2.27	2.10
20	2.36	2.40	1.87	2.04
40	2.15	1.96	1.77	2.19

Intermediate Wheatgrass + Cicer Milkvetch:

P Applied	N Applied (lb./acre)			
	0	40	80	120
lb./acre	% N			
0	1.41	1.71	1.83	1.80
20	1.37	1.52	1.38	1.27
40	1.41	1.61	1.47	1.53

OPTIMUM ECONOMIC USE OF FERTILIZERS THROUGH EFFECTIVE SOIL TESTING[1/]

G.W. Rehm, R.A. Olson, L.A. Daigger, K.D. Frank and P.H. Grabouski

Objective:

There is general agreement that there is no substitute for the use of soil testing as a basis for making recommendations for fertilizer use. It's also widely recognized that many farmers have lost confidence in soil testing. In many cases, this lack of confidence has evolved from situations in which a farmer has collected a suitable soil sample from a given field, divided the sample, sent subsamples to various soil testing laboratories, and received widely divergent fertilizer recommendations. This experience of several farmers emphasizes the need to install some uniformity in the philosophies used in making fertilizer recommendations from the results of an analysis of a soil sample.

With this basic problem in mind, this study was designed with the objectives of: 1) evaluating the effect of the fertilizer recommendations from several soil testing laboratories on crop production, and 2) to compare, under controlled conditions, fertilizer recommendations from the University of Nebraska with fertilizer recommendations from commercial soil testing laboratories to determine if the recommendations from the University of Nebraska are adequate to produce optimum economic yields.

Procedure:

This study was initiated at the Mead Field Laboratory in 1973. In 1974, this study was expanded to sites at the North Platte Experiment Station, South Central Experiment Station and Northeast Experiment Station. Corn was the test crop at the above locations. This study was also conducted with wheat in Cheyenne County as well as potatoes and sugar beets. The results of these trials are published in Agronomy Department Reports No. 26 and 18 respectively.

At each site in the year of establishment, a representative soil sample from the plot area was thoroughly mixed and split into 5 samples. One sample was mailed to the Soil Testing Laboratory of the University of Nebraska. One sample was mailed to each of 4 commercial laboratories providing services in Nebraska. Each laboratory received a request for fertilizer recommendations to grow a given crop at a specified reasonable yield goal. This approach was used in order to reflect the normal service and normal fertilizer recommendations provided to any grower who would request soil test analyses and a suggested fertilizer program. This procedure eliminates dealer-producer contact which might alter the suggested fertilizer program in specific situations.

All nutrients suggested by the laboratory were assumed to be needed and were applied. All fertilizers were broadcast and incorporated prior to planting. Yields were recorded and cost of the various fertilizer recommendations

[1/] This article is a brief summary of Agronomy Department Report 29 by the soil fertility staff at UN-L covering experiments conducted at the South Central Station, the North Platte Station, the Northeast Station, the High Plains Lab and the Mead Field Lab during 1973-1977. Copies of Agronomy Report #29 can be obtained from the Department of Agronomy, University of Nebraska, Lincoln, Nebraska.

were computed. Typical prices of the various fertilizers from throughout Nebraska were used to compute fertilizer costs at each site. Subsequent to the initial year at each location, each laboratory received only soil samples from plots to which fertilizer had been applied according to their recommendations.

Results and Discussion:

This report contains a summary of fertilizer recommendations from the various laboratories in 1978 as well as yields and the costs of the fertilizer programs from 1974 through 1978. Additional data is contained in Agronomy Department Report No. 29.

There was a wide variance in the fertilizer recommendations made for the 1978 corn plots (Tables 1, 3, 5, 7). This variation is consistent with the wide differences in fertilizer recommendations made from 1974 through 1977. This variance in fertilizer recommendations is reflected in the cost of the fertilizer applied (Tables 2, 4, 6, 8).

From 1974 through 1977, the fertilizer applied had no significant effect on yield at all locations. In 1978, yields at the North Platte and Northeast Station sites were affected by the fertilizer program used. At North Platte, lowest yields were produced by the recommendations from Laboratory C. Lowest yields at the Northeast Station were produced by recommendations from Laboratory B. Highest yields resulted from recommendations from Laboratories D and E. Recommendations from Laboratories A and C produced yields which were intermediate.

Table 1. Fertilizer recommendations from five soil testing laboratories for corn production at the Mead Field Laboratory. 1978.[1/]

Nutrient	A	B	Laboratory C	D	E (UN-L)
			lb./acre		
Nitrogen	190	210	250	190	130
Phosphorus (P_2O_5)	70	65	40	75	40
Potassium (K_2O)	75	45	40	-	-
Magnesium (MgO)	-	-	-	-	-
Sulfur	18	-	60	-	-
Zinc	-	-	5	-	-
Iron	-	1	-	-	-
Manganese	-	.2	-	-	-
Copper	-	-	1.0	-	-
Boron	-	-	.5	1	-
Lime	-	-	-	-	-

1/ Yield goal for irrigated corn was 170 bu./acre

Table 2. Corn yields and fertilizer costs at Mead resulting from fertilizer recommendations received from 5 soil testing laboratories (1974-1978).

Yield:

Year	A	B	C	D	E (UN-L)
			Laboratory		
			bu./acre		
1974	139	131	131	137	133*
1975	162	157	153	160	158*
1976	143	143	129	143	137*
1977	148	142	136	142	145*
1978	178	168	183	170	179*
Total:	770	741	732	752	752

Fertilizer Cost:

Year	A	B	C	D	E (UN-L)
			$/acre		
1974	$ 96.00	$ 69.00	$ 90.00	$ 57.00	$ 39.00
1975	95.00	74.00	83.00	46.00	46.00
1976	51.15	31.75	60.85	34.80	31.60
1977	37.80	55.05	67.85	50.50	22.80
1978	38.60	34.74	50.58	30.72	19.05
Total:	$318.55	$264.54	$352.28	$219.02	$158.45

*Differences in yield are not the result of fertilizer applied; differences are due to natural variation in the field.

Table 3. Fertilizer recommendations from five soil testing laboratories for corn production at the North Platte Station. 1978[1/].

Nutrient	Laboratory A	Laboratory B	Laboratory C	Laboratory D	Laboratory E (UN-L)
	lb./acre				
Nitrogen	215	210	250	190	185
Phosphorus (P_2O_5)	140	105	50	73	-
Potassium (K_2O)	-	20	-	-	-
Magnesium (MgO)	-	20	-	-	-
Sulfur	-	10	70	-	-
Zinc	-	2	8	-	-
Iron	-	-	-	-	-
Manganese	-	3	-	-	-
Copper	-	-	1.5	-	-
Boron	-	-	.5	-	-
Lime	-	-	-	-	-

[1/]Yield goal for irrigated corn was 170 bu./acre

Table 4. Corn yields and fertilizer costs at North Platte resulting from fertilizer recommendations received from 5 soil testing laboratories (1974-1978).

Yield:

Year	A	B	C	D	E (UN-L)
			bu./acre		
1974	167	168	155	155	159*
1975	216	208	210	217	222*
1976	148	130	133	128	132*
1977	173	180	177	176	172*
1978	160 a	156 a	149 b	160 a	157 a[1/]
Total:	864	842	824	836	842

Fertilizer Cost:

Year	A	B	C	D	E (UN-L)
			$/acre		
1974	$ 53.40	$ 66.25	$ 81.65	$ 39.30	$ 28.90
1975	82.80	44.90	72.25	45.60	34.20
1976	57.82	64.85	74.67	38.86	29.00
1977	31.40	52.78	50.45	21.60	21.60
1978	44.36	52.26	54.60	30.37	17.21
Total:	$269.78	$281.04	$333.62	$175.73	$130.91

*From 1974-1977, differences in yield were not due to the fertilizer applied. The differences are due to natural variation in yields in the field.

[1/] In 1978, yields followed by the same letter are not significantly different at the .05 confidence level.

Table 5. Fertilizer recommendations from five soil testing laboratories for corn production at the South Central Station. 1978[1/].

Nutrient	Laboratory A	Laboratory B	Laboratory C	Laboratory D	Laboratory E (UN-L)
	lb./acre				
Nitrogen	250	220	250	240	220
Phosphorus (P_2O_5)	135	40	-	-	-
Potassium (K_2O)	60	15	-	-	-
Magnesium (MgO)	-	15	5	-	-
Sulfur	26	15	70	-	-
Zinc	-	-	5	-	-
Iron	-	-	-	-	-
Manganese	-	2	-	-	-
Copper	-	-	1	-	-
Boron	1	.5	.5	-	-
Lime	-	-	-	-	-

[1/]Yield goal for irrigated corn was 170 bu./acre in 1974 and 1975 and 250 bu./acre for 1976, 1977, and 1978.

Table 6. Corn yields and fertilizer costs at the South Central Station resulting from fertilizer recommendations received from 5 soil testing laboratories (1974-1978).

Year	Laboratory A	Laboratory B	Laboratory C	Laboratory D	Laboratory E (UN-L)
Yield:			bu./acre		
1974	186	189	187	189	184*
1975	203	206	196	201	194*
1976	188	186	186	196	199*
1977	154	155	156	154	166*
1978	197	203	189	199	199*
Total:	928	939	914	939	942
Fertilizer Cost:			$/acre		
1974	$ 81.65	$ 71.65	$ 79.20	$ 46.40	$ 37.65
1975	96.12	70.55	93.50	43.40	55.20
1976	71.19	49.61	65.70	26.36	36.30
1977	45.60	65.15	68.45	49.20	4.80
1978	60.20	40.43	46.89	23.88	24.36
Total:	$354.76	$297.39	$353.74	$189.24	$158.31

*Differences in yields are not due to the fertilizer applied. The differences are due to natural variation in yields in the field.

Table 7. Fertilizer recommendations from five soil testing laboratories for corn production at the Northeast Station. 1978[1/]

Nutrient	Laboratory A	B	C	D	E (UN-L)
	- - - - - - - - - -	lb./acre	- - - - - - - - - -		
Nitrogen	75	10	40	130	80
Phosphorus (P_2O_5)	45	40	-	108	40
Potassium (K_2O)	30	15	-	34	-
Magnesium (MgO)	-	-	-	-	-
Sulfur	-	-	30	-	-
Zinc	-	3	3	-	-
Iron	-	-	-	-	-
Manganese	-	-	-	-	-
Copper	-	-	.5	-	-
Boron	-	-	.5	-	-
Lime (ton)	1.0	-	-	4.0	2.5

[1/]Yield goal for dryland corn was 90 bu./acre

Table 8. Corn yields and fertilizer costs at the Northeast Station resulting from fertilizer recommendations received from 5 soil testing laboratories (1974-1978).

Yield:

Year	Laboratory A	Laboratory B	Laboratory C	Laboratory D	Laboratory E (UN-L)
	bu./acre				
1974	No Yield Because Of Drought				
1975	59	60	56	52	59*
1976	9	11	14	10	15*
1977	144	145	149	144	142*
1978	120 ab	113 a	117 ab	123 b	124 b[1/]
Total:	332	329	336	329	340

Fertilizer Cost:

Year	A	B	C	D	E (UN-L)
1974	$ 37.59	$ 27.95	$ 49.05	$ 29.00	$ 11.90
1975	15.90	18.00	20.05	19.80	16.20
1976	29.70	29.20	49.00	12.00	10.80
1977	17.40	20.75	14.30	24.03	2.00
1978	17.30	9.14	13.37	33.70	14.40
Total:	$117.89	$105.04	$145.77	$118.53	$ 55.30

*Differences in yields from 1975-1977 are not due to the fertilizer applied. The differences are due to natural variation in yield in the field.

[1/] In 1978, yields followed by the same letter are not significantly different at the .05 confidence level.

Crop and soil response to applied P and K in a long term buildup/depletion study

R. A. Olson, G. Rehm and L. Daigger

A. Objective

The objective of this project is to determine the rate of depletion or accumulation of plant available P and K in soils with intensive crop production and varied levels of fertilizer application as part of a country-wide investigation sponsored by TVA.

B. Procedure

This experiment is conducted on irrigated corn at the Mead Field Lab, on non-irrigated corn at the Northeast Station, and on winter wheat at the High Plains Lab. Soils represented are Sharpsburg sicl at Mead, Moody-Nora sil at the Northeast Station, and Keith sil and Rosebud fsal at the High Plains Lab. The P and K fertilizer treatments are broadcast and incorporated before planting with subsequent uniform N treatments.

C. Results and Discussion

Results for 1978 and averages to date for the three locations are presented in Tables 1, 2 and 3. Excellent yields were obtained at the Mead site in 1978 with some response to applied P. The six-year average likewise suggests response up to the 20 lb P rate with advantage for yearly application over the same total amount applied in less frequent increments. The average effect of row application has been less advantageous than broadcast P, and applied K has afforded no yield benefit on this soil of high K level.

Soil test values for P are increasing on this soil with all rates employed. After the fifth year, the annual 20 lb rate had almost doubled the soil available P while the equivalent of 30 lbs annually had essentially tripled the soil test value, this despite average annual grain yields in excess of 160 bu/a which removes in the order of 30 lb P/a. The soil exchangeable K values, however, have not been influenced significantly by fertilizer treatment during the six years of this experiment. But there is indication of an increasing K status across all treatments including the control, perhaps related to the uniform N fertilization of the site.

Whereas the Sharpsburg soil is slightly acid throughout the profile, the Moody-Nora sil of the Northeast Station is slightly acid in the surface and alkaline in reaction in the subsoil with a lime accumulation zone. Here a rather consistent yield response has been obtained from the 20 lb P/a rate. It is apparent with this soil as well that the available soil P level is increasing with all rates employed, nearly doubling with the 20 lb P rate and tripling with the 30 lb rate. These, too, are very good yields for non-irrigated corn in northeastern Nebraska and the rate of soil P buildup is quite surprising with these nominal application rates.

Applied K has not influenced grain yield at the Northeast Station site with the relatively high soil K levels involved. Nor has there been perceptible influence of the crops harvested or applied K on the level of soil exchangeable K.

The experimental results on winter wheat at the High Plains Lab, although somewhat erratic, again suggest response to approximately 20 lbs P/a at both locations. Soil available P has increased perceptibly on both soils from applied P, more than doubling on the Rosebud soil at the higher P rates. Fertilizer K has not influenced yield or perceptibly influenced soil test K on these soils of extremely high K level.

Table 1. Response of irrigated corn to applied P and K fertilizers in a long-term P and K buildup/depletion study on Sharpsburg sicl, Mead Field Lab, Nebraska, 1973-78.

Treatment* P	Treatment* K	Application Schedule	Grain yield 1978	Grain yield 6-year ave.	Soil test P ** (Surface) 1973	1975	1977	1978	Soil test K ** (Surface) 1973	1975	1977	1978
			bu/A			ppm P				ppm K		
0	0	Control	163	161	15	12	14	14	320	350	320	355
10	0	Every year@	172	163	15	15	18	23	311	301	347	330
20	0	Every year@	187	168	16	16	24	33	310	323	337	353
30	0	Every year@	173	167	19	27	34	40	300	286	334	326
20	0	Every other year	175	160	16	20	30	19	300	321	391	328
30	0	Every 3rd year@	177	165	25	12	21	17	288	297	360	313
60	0	Every other year	183	161	22	41	51	30	283	307	402	317
60	0	Every 6th year@	172	158	30	14	19	15	288	285	377	306
20	25	Every year@	175	169	16	16	30	30	296	316	389	345
20	50	Every year@	185	159	14	20	24	27	296	304	326	340
10	25	Every year - row@	178	156	11	14	18	22	268	285	420	341
LSD (.05)			16									

* Uniform N application made to all plots for optimum yield (200 lbs N/A in 1978); P and K treatments broadcast before final tillage (except for indicated row application); grain yield on 15.5% moisture basis. An @ indicates application in 1978.

** Soil P by Bray and Kurtz No. 1 extraction; soil K is exchangeable from NH_4Ac extraction.

Table 2. Response of non-irrigated corn to applied P and K fertilizers in a long-term P and K buildup/decline study on Moody-Nora sil, Northeast Station, Nebraska, 1973-78.

Treatment*		Application	Grain yield**		Soil test P*** (surface)				Soil test K*** (surface)			
P	K	Schedule	1978	5-year ave.	1973	1975	1977	1978	1973	1975	1977	1978
			bu/A		ppm P				ppm K			
0	0	Control	125 a	106	10	10	9	7 a	223	185	195	192 a
10	0	Every year@	136 ab	114	9	11	13	10 ab	220	179	179	197 a
20	0	Every year@	147 b	117	12	12	16	14 bc	228	177	187	200 a
30	0	Every year@	144 b	114	22	20	27	20 cd	234	175	108	211 a
20	0	Every other year	132 ab	109	9	11	12	7 ab	218	179	196	200 a
30	0	Every 3rd year@	132 ab	111	17	9	12	8 ab	224	178	190	205 a
60	0	Every other year	146 b	113	11	13	22	25 d	213	173	202	197 a
60	0	Every 6th year@	138 ab	113	11	12	11	10 ab	202	166	189	208 a
20	25	Every year@	143 b	113	10	12	16	12 ab	220	181	204	203 a
20	50	Every year@	135 ab	110	11	14	19	13 ab	238	210	218	228 a

* Uniform N application made to all plots for optimum yield (80 lbs N/A in 1978); P and K treatments broadcast before final tillage; grain yield on 15.5% moisture basis. An @ indicates application in 1978.

** No yield in 1974 due to drouth.

*** Soil P by Bray and Kurtz No. 1 extraction; soil K is exchangeable K from NH_4Ac extraction.

Table 3. Response of winter wheat to applied P and K in the long-term P and K soil buildup/depletion study on the High Plains Ag Lab, Nebraska, 1975-78.

Treatment* P	Treatment* K	Application Schedule	Grain yield ** Keith sil 1977	Keith sil 2-yr ave	Rosebud fsal 1977	Rosebud fsal 2-yr ave	Soil test P*** (surface) 1977 Keith	Rosebud	Soil test K*** (surface) 1977 Keith	Rosebud
			--------------bu/A-------------				ppm P		ppm K	
0	0	Control	63	57	49	45	22	8	525	447
10	0	Every year@	71	59	52	47	18	10	496	431
20	0	Every year@	60	53	55	50	16	12	487	527
30	0	Every year@	70	62	56	48	29	18	547	403
20	0	Every other year@	70	61	52	45	19	11	455	452
30	0	Every 3rd year	70	60	50	42	26	18	520	480
60	0	Every other year	66	60	55	48	33	36	565	454
60	0	Every 6th year	67	59	60	50	34	15	513	516
20	25	Every year@	71	61	55	48	23	16	507	529
20	50	Every year@	74	63	51	44	32	13	612	495
LSD (.05)			9		9					

* Uniform N application to all plots for optimum yield; P and K treatments broadcast before final tillage; grain yield on 14% moisture basis; an @ indicates application in 1978.

** Grain produced only in alternate years with land summer fallowed during the interim.

*** Soil P by Bray and Kurtz No. 1 extraction; soil K is exchangeable K from NH_4Ac extraction.

NITRATE RECOVERY IN STEAM DISTILLATION

C. Clausen, B.R. Bock, G. A. Peterson and R.A. Olson

A. Objective:

In the thesis work of Dr. Bock a problem was recognized in the recovery of known quantities of NO_3^--N in acid solution by the steam distillation procedure of Bremner and Keeney. It was the objective of this investigation to seek out the factors responsible and, if possible, propose alternatives that would overcome the problem.

B. Procedure:

Designated quantities of NH_4NO_3 were added to distilling flasks as varied amounts of acid or $MgCl_2$ were employed, hypothesis being that it was the level of Mg^{++} in solution responsible for inhibiting the action of the Devarda alloy in NO_3^--N reduction. The NH_4^+ of the NH_4NO_3 served as the benchmark for the quantity of NO_3^--N to be expected since no problem has been encountered with NH_4^+ measurement by the method. A final series of distillations evaluated the impact of varied exchangeable soil Mg^{++} on NO_3^--N recovery.

C. Experimental Results:

In the acid series of Table 1 it will be noted that Mg^{++} in the final distillation solution increased with each increment of the M_2SO_4 and that NO_3^--N recovery declined to 85% with 5 ml of 0.10 N acid added and to 75% with 5 ml of 0.25 N acid. In Table 2 we find decreasing NO_3^--N recovery from added quantities of $MgCl_2$ reaching the minimum measured of 76% with 5 ml of 0.25 N $MgCl_2$ that left a Mg^{++} concentration of 110 ppm in the distilling solution. Bremner and Keeney had reported that 240 ppm Mg^{++} was the critical concentration above which errors would occur. When KOH was used in place of MgO for bringing pH to the desired 10.1 level for releasing NH_4^+ and thereby achieving a Mg^{++} free system, no loss in NO_3^--N recovery was registered (Table 3).

Perhaps of greatest significance in the measurements made in this study is the depressing effect that exchangeable soil Mg^{++} has on NO_3^--N recovery. The soil with only 4 me. exchangeable Mg^{++}/100g of Table 4 permitted only 88% recovery of the known NO_3^--N in the first 30 ml of distillate. With increase in exchangeable soil Mg^{++} up to 9 and 11 ml/100g recovery was further reduced to 75% in the first 30 ml. The Mg^{++} concentration in the distilling solution recorded in this table gives evidence of the interaction occurring between the Devarda reducer and the Mg in the system. It is quite apparent that the problem is associated with an inactivation of the reducer by the Mg^{++} present. Increasing the amount of Devarda's reagent employed in a further series of measurements did not improve the situation and rather further accentuated the problem.

A further series of NO_3^--N determinations on 160 soil samples by the steam distillation procedure was compared with results by the Phenoldis u 1-fonic acid procedure. Values by the former method were consistently less by an average 20% than obtained by the latter method. These results demonstrate quite conclusively that Mg^{++} presents a more serious problem in the direct measurement of NO_3^--N by steam distillation procedure than the originators of the method projected. It is especially the Mg^{++} present in soil or that initially solubilized from the applied MgO when the solution containing the NO_3^--N is acid in reaction that inhibits the reducing action of the Devarda alloy. The heart of the problem thus appears to be basically in the choice of a reducing agent.

Table 1. Influence of varied concentration of H_2SO_4 added to the distilling flask on NO_3^--N recovery and concentration of Mg^{++} in the distilling solution.

Sample Descrip.	Rep.	NH_4 ppm	NO_3^- 1st 40 ml ppm	1st 40 ml % of total	2nd 40 ml ppm	3rd 40 ml ppm	4th 40 ml ppm	5th 40 ml ppm	Mg^{+2} conc. in dist. sol. ppm
H_2O 5 ml	1	115.8	110.0	93.9	7.1	---	---	---	1.65
	2	113.1	112.0	97.8	2.5	---	---	---	1.94
.05N Acid 5 ml	1	116.1	114.8	95.9	4.9	---	---	---	2.14
	2	121.1	115.8	94.0	7.4	---	---	---	2.14
.10N Acid 5 ml	1	119.8	100.6	82.6	18.7	2.5	---	---	4.03
	2	120.4	110.0	87.7	9.4	.6	---	---	6.37
.15N Acid 5 ml	1	118.1	92.9	74.6	24.4	6.0	1.2	---	19.61
	2	122.2	96.8	78.4	22.6	3.2	.8	---	18.97
.20N Acid 5 ml	1	121.8	86.8	70.6	26.4	7.7	2.1	---	33.17
	2	120.6	*101.0	81.8	17.1	3.8	1.5	---	21.82
.25N Acid 5 ml	1	120.0	89.7	72.6	26.9	5.6	1.3	---	35.03
	2	121.4	96.4	78.5	20.5	4.7	1.2	---	27.00

* distilled more than 40 ml.

Table 2. Influence of applied $MgCl_2$ to the distillation flask on recovery of NO_3^--N.

Sample Descrip.	Rep.	NH_4 ppm	NO_3^- 1st 40 ml ppm	1st 40 ml % of total	2nd 40 ml ppm	3rd 40 ml ppm	4th 40 ml ppm	5th 40 ml ppm	Mg^{+2} conc. in dist. sol ppm
H_2O $MgCl_2$ 5 ml	1	95.4	91.2	97.4	2.4	---	---	---	3.92
	2	93.4	90.5	96.1	3.7	---	---	---	1.06
.05 $MgCl_2$ 5 ml	1	94.9	88.5	89.1	8.1	2.7	---	---	15.22
	2	95.8	87.5	88.4	9.3	2.2	---	---	15.22
.10 $MgCl_2$ 5 ml	1	94.9	84.8	87.6	10.3	1.7	---	---	48.17
	2	95.4	81.7	83.1	14.2	2.4	---	---	44.26
.15 $MgCl_2$ 5 ml	1	97.8	80.7	78.6	16.6	4.2	1.2	---	63.25
	2	96.6	79.5	81.1	13.9	3.4	1.2	---	82.81
.20 $MgCl_2$ 5 ml	1	94.6	75.8	76.6	18.3	3.4	1.5	---	101.71
	2	97.3	76.0	78.3	17.1	3.4	0.5	---	85.18
.25 $MgCl_2$ 5 ml	1	96.6	74.6	76.0	17.4	4.9	1.2	---	98.15
	2	94.4	71.6	76.5	16.9	3.9	1.2	---	124.83

Table 3. Recovery of NO_3^--N when KOH was substituted for MgO in raising pH of distilling solution to 10.1.

Sample descrip.	Rep.	NH_4^+ ppm	NO_3^- 1st 40 ml ppm	1st 40 ml % of total	2nd 40 ml ppm	3rd 40 ml ppm
H_2O 5 ml	1	106.9	106.5	97.4	2.8	---
	2	110.4	108.4	98.2	2.0	---
.05N Acid 5 ml	1	112.0	110.0	96.1	4.4	---
	2	113.6	110.6	98.4	1.8	---
.10N Acid 5 ml	1	112.4	111.0	96.7	3.8	---
	2	112.8	111.4	98.1	2.2	---
.15N Acid 5 ml	1	118.4	118.1	99.2	0.9	---
	2	122.3	118.2	98.6	1.7	---
.20N Acid 5 ml	1	119.8	111.0	98.5	1.7	---
	2	120.3	113.0	97.7	2.7	---
.25N Acid 5 ml	1	121.8	110.8	97.2	3.2	---
	2	122.0	111.0	97.4	2.9	---

Table 4. Recovery of NO_3^--N as influenced by the quantity of exchangeable Mg^{++} in the soil and the influence of Devarda reagent on Mg solubilization.

			NO_3^-					
Approx. me Mg^+/100g	Sample Description	NH_4^+ ppm	1st 30 ml ppm	1st 30 ml % of total	2 30 ml ppm	3rd 30 ml ppm	4th 30 ml ppm	Mg^{+2} conc. in dist.sol. ppm
4 me/100g	Crete Ap 0-9 Dev.	80.1	62.6	82.6	10.4	1.8	0.6	8.1
"	" No Dev.	80.4	2.5	---	0.9	0.7	0.3	56.8
7 me/100g	Crete B1 9-12 Dev.	77.3	63.8	85.2	8.6	1.6	0.6	12.5
"	" No Dev.	78.6	0.4	---	0.7	0.4	0.6	61.0
9 me/100g	Crete B21t 12-21 Dev.	73.1	54.0	75.9	12.8	3.1	0.9	15.0
"	" No Dev.	74.2	0.3	---	0.4	---	---	70.2
11 me/100g	Wym. B22t 27-48 Dev.	74.2	52.8	75.2	14.1	2.9	0.4	19.8
"	" No Dev.	75.3	---	---	---	---	---	71.6