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Soil Science Research Report - 1980

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DEPARTMENT OF AGRONOMY
UNIVERSITY OF NEBRASKA-LINCOLN
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SOIL SCIENCE RESEARCH REPORT - 1980

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
Delno Knudsen, Soil Fertility
David T. Lewis, Soil Classification
Mary A. Lueking, Instructor
Dennis McCallister, Soil Chemistry
Lloyd N. Mielke, USDA-SEA - Soil Physics
Robert A. Olson, Soil Fertility
Gary A. Peterson, Soil Fertility
James Power, USDA-SEA - Soil Fertility
Michael P. Russelle, Soil Fertility
Donald H. Sander, Soil Fertility
James S. Schepers, USDA-SEA - Soil Physics
Joseph Skopp, 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 (Retired)
Charles R. Fenster, Soil Management

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

Phillip 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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IMPROVING NITROGEN FERTILIZER RECOMMENDATIONS ON CORN

E.J. Penas, G.W. Rehm and G.W. Hergert

Objectives:

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

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

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

Procedure: This study included 10 experimental plots selected in Districts II, III and V. Data were collected from 9 sites. One experiment was discarded due to poor crop stand. Two experiments with nitrogen rates and carriers on corn were conducted in District IV and are being reported separately by the researchers involved. At two sites, experiments were conducted in two fields side-by-side where one field had been corn the previous year and the other soybeans.

Soil samples were collected to a depth of 6 feet at each site except Sandhills Ag Lab (5 ft). These samples were analyzed for pH, phosphorus, potassium, zinc and organic matter for the surface sample and for nitrate- and ammonium-nitrogen throughout the total soil depth. These data are reported in the accompanying tables.

Nitrogen was applied preplant or shortly after planting as ammonium nitrate. Rates in 40 pound increments at the irrigated sites and in 20 pound increments at the non-irrigated sites were used.

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

Results and Discussion: Corn yields were reduced in 1980 because of high temperature and lack of moisture. Two non-irrigated sites contained 142 and 151 pounds of nitrate nitrogen in the soil and this was adequate for the 90-100 bushels per acre which was produced. One other non-irrigated plot contained 81 pounds of nitrogen, had been in soybeans the previous year, and this was sufficient for the 108 bushel yield level produced. The other two non-irrigated sites were low in soil nitrogen and corn yields were increased by applied nitrogen.

The soil nitrogen level in the four irrigated sites was between 50 and 100 pounds of nitrogen and at three of the sites yields were increased by nitrogen. A rate of 160 to 200 pounds of nitrogen per acre was required for top yields. The one site that had the lowest level of nitrogen in the soil showed a marked growth response early in the growing season to applied nitrogen; however, there was no significant yield increase from the applied treatments. The cooperating farmer applied 50 pounds of nitrogen per acre through the pivot. This 50 pounds along with the soil nitrogen, nitrogen applied as a herbicide carrier and nitrogen in the ground water (149 pounds total per acre) was sufficient to eleminate any significant yield increase from the applied treatments.

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

NITROGEN RATES ON CORN, 1980
SOIL TEST DATA

County & Cooperator	Soil pH	Nitrogen, lbs/ac 6 ft.	Phosphorus, ppm	Potassium, ppm	Zinc, ppm	Organic Matter, %
Butler						
Kobza	6.8	51	25 Hi	127 Hi	3.9 Hi	0.9
Burt						
Fleischman Soybeans	5.8	142	18 Med	384 VHi	4.5 Hi	3.7
Corn	5.9	72	9 Low	242 VHi	6.1 Hi	3.1
Saunders						
Hanson	5.8	70	26 Hi	406 VHi	3.8 Hi	3.1
Washington						
Anderson Corn	5.6	151	26 Hi	263 VHi	5.1 Hi	2.6
Soybeans	5.6	81	32 Hi	326 VHi	5.8 Hi	2.6
NE Station						
NSI	7.5	30	10 Low	347 VHi	5.0 Hi	2.9
N P Station	7.8	103	24 Med	522 VHi	10.2 Hi	1.8
Sandhills Ag Lab	6.7	96/5 ft	24 Med	169 Hi	9.0 Hi	1.6

NITROGEN RATES ON CORN, 1980
GRAIN YIELDS

County: Cooperator: Previous Crop:	Burt Fleischman Soybeans	Burt Fleischman Corn	Washington Andersen Corn	Washington Andersen Soybeans	NE Station NS-I Oats
Nitrogen Rate, lbs/ac	Grain Yield, bushels per acre				
0	94	60	96	103	38
20	93	63	93	108	43
40	94	66	90	104	48
60	95	69	95	108	53
80	95	72	99	112	57
100	94	76	88	107	57
120	91	79	93	106	54
140	85	82	103	112	--
Response	Negative	yes	no	no	yes
Soil NO_3-N, lbs/ac 6 ft.	142	72	151	81	30
Stater N, lbs/ac	--	--	9	9	

County: Cooperator:	Butler Kobza	Saunders Hanson	NP Station	SAL
Nitrogen Rate, lbs/ac	Grain Yield, bushels per acre			
0	129	88	115	92
40	145	115	133	112
80	139	131	147	127
120	141	139	157	137
160	136	142	164	141
200	150	142	167	141
240	140	141	166	135
280	136	143	---	---
Response	no	yes	yes	yes
Soil NO_3-N, lbs/ac 6 ft.	51	70	103	96/5 ft
Starter N, lbs/ac	28	0	0	15
N in water	20 + 50 lbs/ac	0	10	8

Title: Anhydrous Ammonia and N-Serve for Irrigated Corn

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

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

Procedure: Anhydrous ammonia with or without N-Serve was used in nitrogen rate studies on two soils. A furrow irrigated Cozad silt loam at the North Platte Station was used to comapre fall and spring applied NH_3 with and without 0.5 lb/A N-Serve/A. Plots received N rates in 1978 and 1979. No N was applied in 1980 so residual nitrate effects could be measured. Spring applied NH_3 with and without N-Serve was used on a sprinkler irrigated Valentine sand at the University of Nebraska Sandhills Agricultural Laboratory near Tryon, Nebraska.

Nitrogen rates for the Cozad silt loam were 0, 40, 80, 120, 160, 200, and 240 lbs N/A and were replicated three times. N rates of 0, 45, 90, 135, and 180 lbs N/A were used on the Valentine sand and were replicated four times.

Grain yields from the Cozad silt loam are shown in Table 1. The only significant effect on yield was N rates i.e. effect of residual N from previous N rates.

Table 1. Grain yields for the Cozad silt loam.

Nitrogen rate	Fall-applied NH_3		Spring-Applied NH_3	
	N-Serve	W/O	N-Serve	W/O
lbs/A	----------bu/A----------			
0	72		68	
40	71	72	74	79
80	93	88	87	83
120	92	83	86	86
160	98	91	93	87
200	94	99	86	91
240	99	115	94	96

CV = 11.3%

Grain yields on the Valentine sand are shown in Table 2. Nitrogen rate significantly increased yields but no effect of N-Serve was shown. Plots were irrigated according to crop water use (ET) and changes in soil water content. Little early season leaching occurred from rainfall. No large rains occurred in May and early June.

Table 2. Grain yields for the Valentine sand.

Nitrogen rate	N-Serve	without N-Serve
lbs/A	----------------bu/A----------------	
0	83	
45	109	127
90	146	147
135	149	139
180	162	157

CV = 8.7%

NITROGEN MANAGEMENT FOR IRRIGATED CORN AND GRAIN SORGHUM

R. A. Olson

Objectives:

1. Compare corn and grain sorghum for production as irrigated crops on Sharpsburg sicl.

2. Determine optimum N management for the two crops grown under identical conditions as to time, rate and kind of N applied.

3. Compare the two crops in response to P at the varied N levels.

Procedure:

High yielding hybrids or varieties of the two crops are grown in split plot arrangement with identical tillage and irrigation practices applied. Nitrogen rates of 0, 80, 160 and 240 lbs N/a as 28% UAN are injected at planting or as a summer sidedressing when plants are approximately 18" tall. A sidedress application of anhydrous ammonia at the three same rates is also made.

Results and Discussion:

Grain yields were lower than the norm for this experiment in 1980, presumably due to the extreme heat and desiccation of the crop during the pollination stage. The much lower than average grain/stover ratio give further indication of the stress conditions under which the 1980 crop developed (Tables 1 and 2).

Otherwise, this 12-year study reveals grain sorghum to be a more efficient scavenger for soil N than corn under low N availability conditions, but corn responds to higher N application rates making it the better irrigated crop so long as the N can be provided. Anhydrous ammonia has given essentially the same results with 80 lbs N/a as UAN with 160 lbs N when both were sidedressed (both well incorporated). Sidedressing at most economic rate has averaged about 9-10 bu/a better than planting time application of N for corn, 5-6 bu better for grain sorghum.

Several years' trial of interseeding rye or legume with irrigated corn within this experiment has given quite indeterminate results to date, the legume having been beneficial in some years others not. Rye has been seeded at ridging time in plots receiving a high rate of N while alfalfa seeding was done at the same time on control plots. The major associated problem has been that of maintaining stands of the green manure crops late in the season after irrigation ceased with little or no fall rainfall received. Earlier seeding of both will be effected in 1981 in attempting to overcome this shortcoming.

Table 1. Corn response to N and P fertilizer as influenced by time, rate and method of N application, 1980 and average grain yields for 1969-80.

Treatment	N Rate	Grain Yield 0 P	Grain Yield 20 P	Grain Yield Avg 1980	Grain Yield Avg 1969-80	Stover Yield 1980 0 P	Stover Yield 1980 20 P	Stover Yield 1980 Avg	Grain/Stover 0 P	Grain/Stover 20 P	Grain/Stover Avg 1980	Grain/Stover Avg 1969-80
	lb/acre	bu/acre	($15.5\%\ H_2O$)			lb DM/acre						
Control	0	66	55	61		5967	5365	5666	0.54	0.50	0.52	
	0	52	63	57		5344	5601	5454	0.49	0.57	0.53	
	Avg	59	59	59	92	5656	5483	5567	0.52	0.53	0.52	0.96
32% N solution at planting	80	113	92	102	125	7147	8022	7585	0.77	0.56	0.67	
	160	123	134	129	139	7856	8198	8027	0.75	0.80	0.77	
	240	121	122	121	141	8140	7844	7992	0.71	0.74	0.72	
	Avg	119	116	117		7714	8022	7868	0.74	0.70	0.72	1.14
32% N solution sidedressed	80	119	139	129	135	8024	7569	7797	0.72	0.89	0.81	
	160	131	130	131	147	7826	7917	7871	0.80	0.78	0.79	
	240	146	127	137	144	7335	6969	7152	0.99	0.87	0.93	
	Avg	132	132	132		7728	7485	7607	0.84	0.85	0.84	1.24
NH_3 sidedressed	80	131	147	139	144	6631	7152	6892	0.95	0.98	0.96	
	160	148	140	144	146	7466	8521	7993	0.94	0.79	0.87	
	240	147	139	143	149	6977	6833	6905	1.00	0.97	0.98	
	Avg	142	142	142		7025	7502	7263	0.96	0.91	0.94	1.31
Overall average for N and P	0	59	59	59	92	5656	5483	5567	0.52	0.53	0.52	0.96
	80	121	126	124	135	7267	7581	7424	0.81	0.81	0.81	1.22
	160	134	135	134	144	7716	8212	7964	0.83	0.79	0.81	1.22
	240	138	129	134	145	7484	7215	7350	0.90	0.86	0.88	1.26

Table 2. Grain sorghum response to N and P fertilizer as influenced by time, rate and method of N application, 1980 and average grain yields for 1969-80.

Treatment	N Rate	Grain Yield 0 P	Grain Yield 20 P	Grain Yield Avg 1980	Grain Yield Avg 1969-80	Stover Yield 1980 0 P	Stover Yield 1980 20 P	Stover Yield 1980 Avg	Grain/Stover 1980 0 P	Grain/Stover 1980 20 P	Grain/Stover 1980 Avg
	lb/acre	bu/acre	(15.5% H_2O)			lb DM/acre					
Control	0	72	66	69		4848	4905	4876	0.73	0.67	0.70
	0	67	66	66		4884	4838	4861	0.67	0.66	0.69
	Avg	70	66	68	102	4866	4872	4869	0.70	0.67	0.69
32% N solution at planting	80	110	111	110	122	5215	5268	5241	1.02	1.03	1.03
	160	115	115	115	126	5735	6126	5931	0.97	0.91	0.94
	240	118	106	112	125	5700	5369	5535	1.00	0.96	0.98
	Avg	115	111	113		5550	5588	5569	1.00	0.97	0.98
32% N solution sidedressed	80	119	119	119	127	5719	6088	5903	1.00	0.95	0.97
	160	121	104	113	127	5371	5911	5641	1.12	0.85	0.99
	240	115	115	115	126	5667	5545	5606	0.98	1.00	0.99
	Avg	118	113	116		5586	5848	5717	1.03	0.93	0.98
NH_3 sidedressed	80	114	115	114	128	5725	5946	5835	0.96	0.93	0.94
	160	116	122	119	128	5294	5604	5449	1.06	1.05	1.05
	240	112	104	108	128	5333	5155	5244	1.03	0.98	1.00
	Avg	114	113	114		5451	5568	5509	1.01	0.99	1.00
Overall average	0	70	66	68	102	4866	4872	4869	0.70	0.67	0.69
	80	114	115	114	126	5553	5767	5660	0.99	0.97	0.98
	160	117	114	116	127	5467	5880	5674	1.05	0.94	0.99
	240	115	108	112	126	5567	5356	5462	1.00	0.98	0.99

EFFECT OF DIFFERENT METHODS OF P APPLICATION

ON IRRIGATED CORN PRODUCTION

D. H. Sander, K. D. Frank, R. A. Olson

Objective:

To determine the effect of different methods of P application on corn production especially ammonia and ammonium polyphate when applied separated and together compared to row and broadcast treatments.

Procedure:

Two locations with soils testing low in available P were selected--one in Greeley County and at the Mead Station. Treatments were as follows:

1. Knife together
2. Knife separate
3. Broadcast
4. Row (at planting)
5. Surface rows (dribble)
6. Same as (1) with N-Serve

All plots were disked after application and both locations planted on May 8 with PV76S hybrid at a population of 28,600 plants/acre in 30 inch rows. Furadan at a rate of 8.7 lbs/A was used for root worm control. Weeds were, controlled with Lasso-atrazine or Cultivation. All plots received a total of 200 lbs N/A as ammonia and nitrogen from the APP. Early plant samples were collected at the seventh leaf stage. Ear leaves were collected at early silk. Irrigation was by center pivot in Greeley County and gravity at Mead. Soil test for phosphorus as measured by Bray No. 1 was 7 ppm at Mead and 5 ppm in Greeley County. Soil is Colby silt loam at Greeley County and a Sharpsburg silty clay loam at Mead.

Results and Discussion:

Results are shown in Tables 1, 2 and 3. Most surprising is the lack of significant grain yield increases due to application of P. Therefore no differences in methods of P application could be detected in either grain yields or grain moisture content. However applied P did increase small plant P content at both locations. Row applicated increased P content of small plants at Greeley County but did not affect ear leaf content. Both row application and knife separate treatment significantly increased P content of small plants but these treatments seemed to be lower in ear leaf content than other treatments. There was a trend for row application to have depressed grain yield but was not significant. Weather in 1980 probably influenced results. Yields were generally lower than normal especially at Mead. This may have affected the results and reduced yield response to P application.

Table 1. Effect of P rate and method of P application on corn yield, early P, leaf P content and grain moisture. Greeley County, 1980.

Rate	Grain: Yield	Grain: Moisture	P Content: Small Plant	P Content: Ear Leaf
lbs/ha	bu/A	%	g	% P
0	122	15.3	3.39	.196
10	115	15.6	3.22	.201
20	125	15.5	3.71	.210
30	127	15.4	3.91	.219
Method 2/ of P application:				
1) Knife together	124	15.6	2.99	.210
2) Knife separate	122	15.6	3.61	.209
3) Broadcast	123	15.3	3.51	.222
4) Row (at planting)	123	15.3	5.97	.203
5) Surface row (dribble)	117	15.4	2.81	.205
6) Same as 1) with N-Serve	122	15.6	2.79	.210

1/ Seven leaf stage
2/ Refers to method by which NH_3 and 10-34-0 was applied.
Knife spacing = 30 inches
All plots received 200 # N/A
All plots were disked after application

Table 2. Effect of P rate and method of P application on corn yield, early P content, ear leaf P content, and grain moisture. Mead, 1980.

P Rate	Grain: Yield	Grain: Moisture	P Content: Small Plant	P Content: Ear Leaf
	bu/A	%	g	% P
0	137	10.9	10.04	.267
10	140	11.2	10.48	.276
20	147	11.3	12.93	.280
30	148	10.8	12.44	.280
Method 2/ of P application:				
1) Knife together	144	11.6	9.49	.284
2) Knife separate	153	11.0	13.75	.270
3) Broadcast	148	10.9	10.79	.288
4) Row (at planting)	135	11.6	17.11	.266
5) Surface row (dribble)	144	10.9	9.95	.270
6) Same as 1) with N-Serve	146	10.8	10.61	.293

1/ Seven leaf stage
2/ Refers to method by which NH_3 and 10-34-0 was applied.
Knife spacing = 30 inches
All plots received 200 # N/A
All plots were disked after application

Table 3. Analysis of variance

Source of Variation	Grain Yield	Grain Moisture	P Content Small Plant	P Content Ear Leaf
		Greeley County		
Treatment	NS	NS	**	NS
Check vs treatments	NS	NS	NS	NS
P rate	NS	NS	NS	*
Method	NS	NS	**	NS
Rate x method	NS	NS	NS	NS
		Mead		
Treatment	NS	NS	**	++
Check vs treatment	NS	NS	NS	NS
P rate	NS	NS	**	NS
Method	NS	NS	**	**
Rate x method	NS	NS	**	NS

IMPROVING THE EFFICIENCY OF FERTILIZER N USE BY IRRIGATED CORN

M. P. Russelle and R. A. Olson

Objectives:

1. Study the physiology of N utilization by irrigated corn in relation to crop and fertilizer N management practices employed.

2. Measure uptake and utilization of ^{15}N tagged fertilizer as influenced by time and rate of N applied and crop planting date.

Procedure:

Corn was planted at one of three planting dates, early, intermediate and late, to a uniform stand of 25,000 plants per acre. ^{15}N depleted $(NH_4)_2SO_4$ was applied at rates of 80 and 160 lbs N/a at planting or at the 4-, 8- or 16-leaf stage for tracing plant N source. Rainfall and sprinkler irrigation water increments were measured with receptacles placed about the experimental area and neutron access tubes in individual plots measured soil moisture extraction.

Results and Discussion:

Grain yield in 1979 increased with delayed N application to the first and second plantings but required earlier application with late planting. Highest fertilizer use efficiency in the crop of around 70% accompanied 80 lbs N applied at the 4- and 8-leaf stages with the intermediate planting date as well as the late planting with its lower yield levels. Little variation occurred in FUE with the 160 lb rate which exceeded substantially that required for maximum yield. Delayed application was again beneficial in 1980 but with best results achieved from 8- and 16-leaf application time, both distinctly better than planting or 4-leaf treatment time (note Table 1). Poorest yields were obtained with the intermediate planting date probably associated with the extremely warm and dry weather conditions that affected pollination for that particular planting date.

It is hoped on the completion of these studies that more precise recommendations can be given for N fertilizer management in the production of irrigated corn on medium to fine textured soils in Nebraska.

Table 1. Grain yield and N use efficiency by irrigated corn on Sharpsburg sicl

Planting time	N rate	N time	1979 corn Grain yield	1979 corn FUE[1/]	1980 Grain yield
			bu/a	%	bu/a
Early	0	Check	173	--	108
	80	pl	183	65	149
		4 leaf	203	64	164
		8 leaf	188	63	178
		16 leaf	209	59	184
	160	pl	194	42	170
		4 leaf	196	41	156
		8 leaf	209	48	192
		16 leaf	198	30	194
Mid	0	Check	176	--	72
	80	pl	204	56	127
		4 leaf	207	68	146
		8 leaf	197	69	169
		16 leaf	211	60	163
	160	pl	189	49	160
		4 leaf	208	49	153
		8 leaf	202	41	166
		16 leaf	215	38	173
Late	0	Check	169	--	107
	80	pl	176	64	169
		4 leaf	188	70	184
		8 leaf	176	68	179
		16 leaf	163	51	175
	160	pl	183	51	182
		4 leaf	186	49	171
		8 leaf	182	44	189
		16 leaf	178	36	190

1/ lb fertilizer N in grain + stover ÷ lb fertilizer N applied x 100

INFLUENCE OF RATES OF K AND MG FOR CORN PRODUCTION

ON IRRIGATED SANDY SOILS

G.W. Rehm

Objective:

Current K recommendations for corn production made by University of Nebraska personnel are considered to be conservative by the fertilizer industry and by several farmers. As a result, these recommendations are viewed with skepticism. The large majority of soils in Nebraska are well supplied with K. Some soils from the Sandhills and bordering areas have K levels which are currently considered to be in the medium or low range. The K requirements for production of irrigated corn on these sandy soils need to be researched and defined. The objective of this study is to measure the effect of the application of both K and Mg on the production of irrigated corn on sandy soils.

Procedure:

This study was initiated in 1979 and continued in 1980. Two sites were selected for study in 1980. At one site (Holcomb), treatments were reapplied to the plots established in 1979. A second site was selected for study but an early infestation of Goss's wilt eliminated collection of useful data from this site. The soil at the Holcomb site is classified as a Valentine loamy fine sand and soil properties are listed in Table 1.

Nine rates of K (0, 30, 60, 90, 120, 150, 180, 210, 240 lb./acre) supplied as 0-0-60 and nine rates of Mg (0, 5, 10, 15, 20, 25, 30, 35, 40 lb./acre) supplied as $MgSO_4 \cdot 7\ H_2O$ with treatments selected to fit a central composite factorial design were broadcast in mid-April. All treatments received 100 lb. P_2O_5/acre as 0-46-0, 10 lb. Zn/acre as $ZnSO_4$ and 53 lb. S/acre as a combination of $MgSO_4 \cdot 7\ H_2O$, granular gypsum and $ZnSO_4$. All fertilizer materials were incorporated with a disk before planting. Adequate N (a combination of 33-0-0, 82-0-0, and 28-0-0 with the irrigation water) was used on all treatments.

Whole plant samples were collected at the 16-20 in. growth stage. Ear leaf samples were collected at silking. These plant samples were dried, ground to pass a 2 mm screen and analyzed for K and Mg. Yields were recorded in mid-October.

Results and Discussion:

The data from the Holcomb site are consistent for each of the two years. There was no response to either K (Table 2) or Mg (Table 3.). Based on the exchangeable K content of the soil, some response to fertilizer K would be expected. Past research in other states has shown that crops grown on soils with similar K values will respond to the application of fertilizer K.

In this study, the irrigation water is supplying small amounts of K (Table 4). Since the organic matter content is less than 1.5%, the amount of K supplied from the source should be relatively low. The data collected in both 1979 and 1980 indicate that this soil is supplying adequate amounts of K for production of irrigated corn. The data do not indicate a source for this K but it is highly probable that it is released from the weathering of soil minerals.

Based on the amount of Mg supplied by the irrigation water as well as the Mg content of the soil, the lack of a response to applied Mg could be anticipated.

This study will be repeated in 1981.

Table 1. Soil properties of the experimental site. Holt County.

Depth	pH	NO_3-N	Soil Test Bray-P	K	Zn	O.M.	CEC	Exchangeable Ca	Mg	K
in.	ppm					%	m.e./100 g.			
0-6	5.7	.6	8.4	79	1.9	1.51	2.64	1.86	.45	.18
6-12	6.1	1.0	-	62	-	-	1.87	1.27	.30	.10
12-24	6.2	1.1	-	41	-	-	1.26	1.15	.27	.07
24-36	6.3	1.1	-	35	-	-	.62	1.00	.22	.06
36-48	6.5	1.0	-	27	-	-	1.04	.99	.20	.05
48-60	6.5	1.0	-	38	-	-	1.32	1.25	.28	.06
60-72	6.6	.9	-	43	-	-	1.68	1.45	.34	.08

Table 2. Effect of rate of applied K on yield and early growth of irrigated corn grown on sandy soils. Holt County.

K Applied	Early growth 1979	1980	Yield 1979	1980
lb./acre	gm/plant		bu./acre	
0	15.6	8.9	178.9	170.7
30	15.0	8.9	181.0	161.1
60	14.6	9.3	182.5	163.6
90	14.4	8.9	183.4	162.7
120	14.4	8.5	183.7	162.4
150	14.6	7.5	183.4	164.4
180	14.6	6.9	182.5	162.1
210	15.5	7.4	181.0	160.9
240	16.3	7.6	179.0	158.8

Table 3. Effect of rate of applied Mg on yield and early growth of irrigated corn grown on sandy soils. Holt County.

Mg Applied	Early growth		Yield	
	1979	1980	1979	1980
lb./acre	gm/plant		bu./acre	
0	14.3	7.7	181.0	162.3
5	14.7	8.2	181.3	165.1
10	15.1	7.6	181.4	159.5
15	15.3	7.9	181.6	162.2
20	15.4	8.9	181.7	165.8
25	15.4	8.5	181.9	164.9
30	15.3	8.6	182.0	166.2
35	15.1	8.0	182.1	157.0
40	14.8	8.5	182.2	164.9

Table 4. Nutrient content of the irrigation water at the Holcomb location. Holt County.

Nutrient	Concentration
	ppm
N	1.1
P	.07
K	3.0
S	.2
Mg	4.0
B	.02

APPLICATION OF SULFUR FOR IRRIGATED CORN ON SANDY SOILS

G.W. Rehm

Objective:

Prior research has shown that the application of S fertilizer will increase the yield of irrigated corn grown on some sandy soils. Although these studies provided a general range of rates of fertilizer 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 anion 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 a slow release material was needed. The two objectives of this study were: 1) to evaluate the effect of rate of S either broadcast or applied in the row at planting (starter) on yield of corn grown on an irrigated sandy soil and 2) to evaluate a slow release fertilizer materials that might be suitable for use in the production of irrigated corn on sandy soils.

Procedure:

This study was initiated in 1978 and continued in 1980. The soil at the site selected in 1980 is classified as a Valentine loamy fine sand. Soil properties are listed in Table 1. Sulfur was either broadcast and incorporated or applied as a starter at rates of 0, 6, 12, 18 lb./acre. For the broadcast treatments, the needed S was applied as either granular gympsum (SO_4-S) or Sol-U-Sul (elemental sulfur). The S in the row applied fertilizer was supplied as: 1) granular gypsum, 2) Sol-U-Sul, 3) a mixture of granular gypsum and Sol-U-Sul with each supplying 50% of the S needed, and 4) a mixture of granular gypsum and sulfur coated urea with each supplying 50% of the needed S. All treatments received 15 lb. N, 46 lb. P_2O_5 and 10 lb. K_2O per acre in the starter fertilizer. Zinc was broadcast at a rate of 5 lb./acre. Adequate N was supplied as 28-0-0 with the irrigation water.

Whole plant samples were collected approximately three weeks after emergence, dried and weighed. The ear leaf at silking was also collected. All plant samples will be analyzed for N and S. Grain yields were measured in October and corrected to 15.5% moisture.

Results and Discussion:

At the time of this writing analysis of plant samples for N and S had not been completed. Therefore, only plant weight and yield will be reported here.

Considering the broadcast treatments, neither the source of S nor the rate applied had a significant effect on either the weight of young plants or yields (Table 2 and 3). For the starter treatments, both source and rate of applied S had a significant effect on the weight of young corn plants (Tables 4 and 5). Grain yield, however, was not significantly increased by either S source or rate of S applied. Since there were no significant interactions main effects for both broadcast and starter treatments are listed separately. There was no significant relationship between the weight of the young corn plants and grain yield (r = -.032).

Table 1. Properties of the soil at the experimental site - Pierce County, 1980.

Property	Depth (in.) 0-6	6-12	12-24	24-36	36-48	48-60	60-72
pH	6.1	-	-	-	-	-	-
P(Bray), ppm	37	-	-	-	-	-	-
$K(NH_4C_2H_3O_2)$, ppm	193	-	-	-	-	-	-
Zn(HCl), ppm	2.8	-	-	-	-	-	-
O.M., %	1.40	.75	.30	.20	.20	.10	.20
SO_4-S, ppm	11.3	8.7	9.2	5.4	7.0	7.5	6.9
NO_3-N, ppm	.6	1.1	1.0	2.3	3.1	6.4	7.8

Table 2. Effect of sulfur source broadcast on weight of young plants and corn yield. Pierce County, 1980.

Sulfur Source	Plant Weight	Yield
	gm/plant	bu./acre
granular gypsum	4.7a*	141.7a
elemental sulfur	4.4a	141.7a

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

Table 3. Effect of rate of sulfur broadcast on weight of young plants and corn yield. Pierce County, 1980.

S Applied	Plant Weight	Yield
lb./acre	gm./plant	bu./acre
0	4.4a*	136.0a
6	4.3a	149.0a
12	4.8a	138.8a
18	4.5a	143.0a
CV: %	12.5	7.3

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

The yield data collected in 1980 support earlier research which showed that S was not needed for corn production on all sandy soils. Using current sulfur recommendations of the University of Nebraska, corn grown on a soil with an organic matter content in excess of 1.0% and a SO_4-S content in excess of 8 ppm would not be expected to respond to S fertilization. The organic matter content of the soil at this site was 1.4%. The SO_4-S content of the surface 6 in was 11.3 ppm with relatively high levels of SO_4-S throughout the soil profile. The data collected in 1980 indicate that this Valentine sand was able to supply adequate amounts of S for corn production.

Table 4. Influence of sulfur source applied in a starter at planting on the weight of young plants and corn yield. Pierce County, 1980.

Sulfur Source	Plant Weight	Yield
	gm/plant	bu./acre
granular gypsum	4.1ab*	154.1a
Sol-U-Sul	3.9b	150.0a
50% granular gypsum/50% Sol-U-Sul	4.2ab	148.6a
50% granular gypson/50% SCU	4.5a	148.8a

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

Table 5. Influence of rate of S applied in a starter at planting on the weight of young plants and corn yield. Pierce County, 1980.

Sulfur Applied		Plant Weight	Yield
lb./acre		gm/plant	bu./acre
0		3.8a*	153.7a
6		4.2ab	148.0a
12		4.4b	151.4a
18		4.4b	148.3a
	CV: %	12.7	7.2

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

EFFECT OF DIFFERENT PLANTING SYSTEMS AND ROW APPLIED P ON CORN YIELDS

P. W. Harlan, E. J. Penas, D. H. Sander

Objective:

To compare a no-till systems of planting corn to conventional plow and disk systems with and without row applied P.

Procedure:

The experiment was a completely randomized design with three planting systems, disk, plow, and no-till, with and without 13 P applied in the row at planting. Plots were 1164 feet long and six 30 inch rows wide. All six rows were combine harvested. Pioneer 3541 was planted April 30 at 29,000 plants per acre. Fertilizer was 11-33-0 suspension. Three quarts of Lasso plus 1 quart of Atrozine was applied broadcast at planting. Dyfonate 20G was applied at a rate of 6.5 lbs/A. All plots were planted with a John Deere "Maxi-Merge" planter with the conservation tillage attachment. Plots were irrigated by center pivot. Soil was an eroded Before-Nora-Crofton Complex with a soil test as follows:

pH = 6.5
Bray No. 1 P = 11 ppm
K = 432 ppm
Zn (Hcl) = 6.8 ppm
OM = 2.8%

Results:

Results are shown in Table 1. There were no apparent differences in yield or grain moisture from any of the treatments. Yields were generally low because of poor pollination and intense corn borer infestation.

Table 1.

Effect of different corn planting methods on corn grain yields and grain moisture, Platte County 1980. Combine yields.

Planting Method	Corn grain yield and moisture						
	Rep 1		Rep 2		Rep 3		
	Yield	Moist.	Yield	Moist.	Yield	Moist.	Mean
	bu/A	%	bu/A	%	bu/A	%	
Disk Starter	87	14.0	110	13.8	113	14.0	103
No Starter	90	14.0	99	13.9	109	14.1	99
Plow Starter	93	14.0	93	13.8	99	13.7	95
No Starter	86	14.0	93	13.8	105	13.9	95
No-till Starter	99	13.9	98	13.9	108	13.6	102
No Starter	98	14.1	92	13.9	114	14.0	101

	Mean		Mean
Starter	100	Disk	101
No Starter	98	Plow	95
		No-till	102

Soil - Eroded Before - Nora-Crofton Complex
Irrigated by center pivot
Planted April 30 in 30 inch rows to Pioneer 3541 at 29,900 plants/acre
Starter = 30#P_2O_5/acre as 11-33-0 suspension
Herbicide = 3 qts. Lasso + 1 qt. atrazine/A at planting
Insecticide 6.5# Dyfonate 20G/A at planting
Planted with John Deere Maxi-Merge with conservation tillage attachment

INFLUENCE OF CLAY CONTENT, pH, AND DISTANCE FROM THE SEED

OF A SUSPENSION FERTILIZER ON CORN PRODUCTION

G.W. Rehm

Objective:

Several farmers have experienced problems associated with placement of fluid fertilizer too close to the seed at planting. Yet, the use of fertilizer applied in the row at planting provides the farmer with a management tool that can substantially reduce costs. A review of the literature shows that very little field research has been conducted to evaluate the possible damaging effects of fertilizer placed too close to the seed.

Procedure:

This study was initiated at the Northeast Experiment Staton in 1980. Three variables were studied. These were 1) pH of the fluid fertilizer (6.5 or 7.2), 2) clay content (0, .1, .5, 1%), and 3) distance of fluid fertilizer from the seed (0-.5 in., .75-1.0 in., 3.0 in.). The analysis of the fertilizer was 7-21-7 applied at 300 lb./acre.

The Accra-Plant runner was used to place the fertilizer 0-.5 in. from the seed. A special attachment was bolted to the planter shoe to place the fertilizer .75-1.0 in. from the seed. The conventional double disk opener was used to achieve a distance of 3.0 in. between fertilizer and seed.

Corn was planted on May 9 at a population of 18,300 plants per acre. Stand counts were taken 6 weeks after planting. Whole plant samples were collected at this time, dried and weighed. Grain yields were measured in October.

Results and Discussion:

All treatments of the 3-factor factorial were used in a completely randomized block design with four replications. Statistical analysis of the data showed no significant interactions. Therefore, main effects are shown in the accompanying tables.

Except for the effect of distance between fertilizer and seed on the weight of young corn plants (Table 3), the factors evaluated in this study had no significant effect on any of the variables measured. In addition, there was no significant relationship between either yield and plant weight (r = -.153) or yield and the emerged stand (r = .086).

Table 1. Effect of pH of the fluid fertilizer on the stand, weight of young corn plants, and corn yield. Northeast Station, 1980.

Fertilizer pH	Emerged Stand	Plant Weight	Yield
	plants/acre	g/plant	bu./acre
acid	17,714 a	14.4 a	78.0 a
alkaline	17,969 a	14.7 a	79.8 a

Table 2. Effect of clay content of the fluid fertilizer on the stand, weight of young corn plants and corn yield. Northeast Station, 1980.

Clay Content	Emerged Stand	Plant Weight	Yield
%	plants/acre	g/plant	bu./acre
0	17,860 a	14.4 a	74.9 a
.1	17,932 a	14.0 a	85.3 a
.5	17,860 a	14.6 a	78.4 a
1.0	17,714 a	15.0 a	77.0 a

Table 3. Effect of distance between fertilizer and seed on the stand, weight of young plants and corn yield. Northeast Station, 1980.

Distance	Emerged Stand	Plant Weight	Yield
in.	plants/acre	g/plant	bu./acre
0 - .5	17,914 a	14.7 a	78.4 a
.75 - 1.0	18,023 a	15.3 a	76.0 a
3.0	17,587 a	13.5 b	82.3 a

Title: Nitrate Distribution Under Irrigated Corn

Personnel: Phil H. Grabouski and Gary W. Hergert, UNL-North Platte Station

Procedure: An experiment including N rates of 0, 100, 200, and 300 lbs N/A was initiated in 1974 and has continued on the same plots. The soil is a Cozad silt loam, furrow irrigated. Grain yields are shown in Table 1.

Table 1. Grain yields - North Platte N Rate Study.

lbs N/A	1974	1975	1976	1977	1978	1979	1980	Avg
	----	----	----	bu/A	----	----	----	----
Check	134	122	34	121	63	105	120	100
100	170	213	126	167	149	143	164	160
200	173	224	135	171	168	160	172	172
300	160	218	130	181	157	171	180	172

Soils samples were taken from the soil surface to the water table (12 feet) in the spring of 1980 from each replicate of a treatment. Average nitrate N content with depth is shown in Figure 1.

The 200 lbs N/A usually maximizes yield and residual nitrate levels from 0 to 6 feet were not much different for the 100 and 200 lb N rates. In many years yields are nearly maximized with the 100 lb N rates. The effects of the additional 100 lbs of N in the 200 compared to the 100 lbs N rate are shown as a larger residual nitrate level between 6 feet and the water table. The effect of the 300 lbs N rate is striking. Assuming a bulk density of 1.33 for all depths the following amounts of residual nitrate-N would be in the soil:

Pounds of residual nitrate-N in a Cozad silt loam

	------	lbs N/A	------	------
Depth	Check	100	200	300
0 to 6 feet	38	86	84	189
6 to 12 feet	41	84	138	304
Total	79	170	222	493

One interesting factor to note from the sampling is from the 300 lb N rate. Most of the residual nitrate is below 2 feet. This has interesting implications for use of residual nitrate-N test on furrow irrigated fields when samples are only taken to a 2 foot depth. Current research on calibrating the deep nitrate test for irrigated corn can hopefully provide some answers.

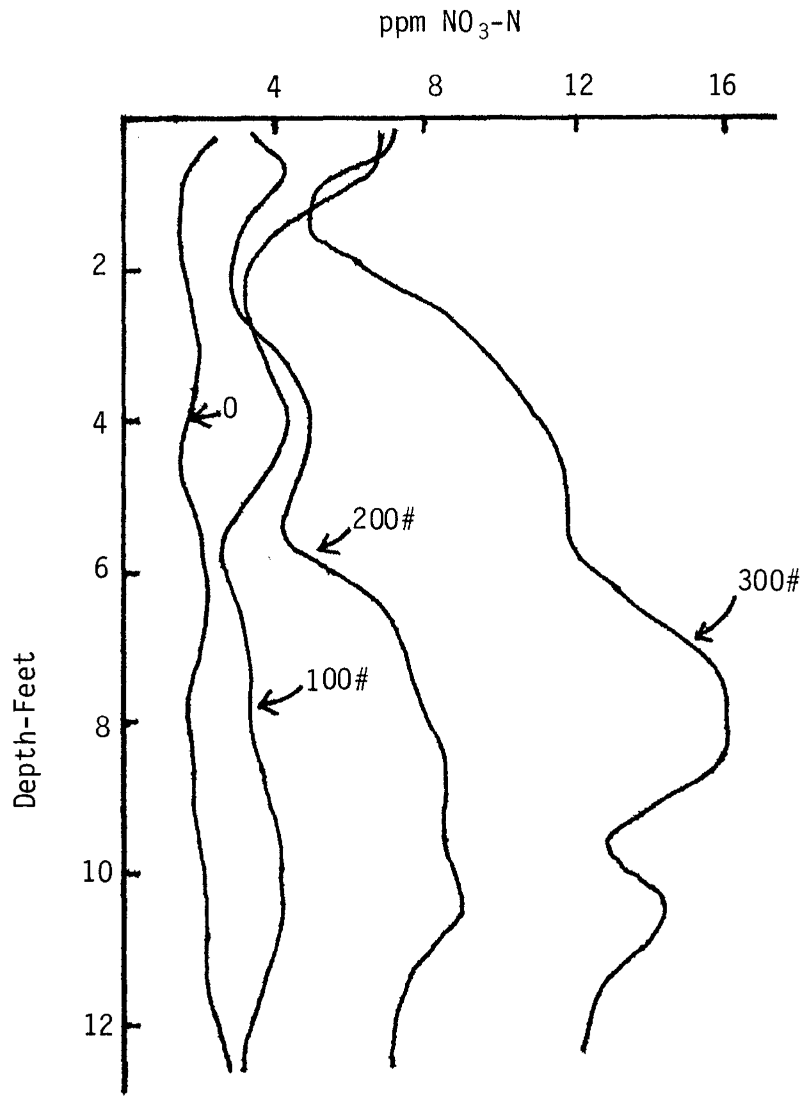

Figure 1. Nitrate-N distribution with depth from different N rates.

EVALUATION OF LIME FOR CORN PRODUCTION ON IRRIGATED SANDY SOILS

G.W. Rehm

Objective:

The importance of lime for crop production on acid soils of other states has been well documented. The pH of the irrigated sandy soils in the Sandhills and bordering areas usually drops into the acid range with repeated production of irrigated corn. There is some question regarding the value of lime for corn production on these irrigated sandy soils. The objective of this study is to evaluate the effect of several rates of lime on yield of corn grown on irrigated sandy soils.

Procedure:

This study was initiated at three sites in 1979 and continued in 1980. The properties of the soils are listed in Table 1. Finely ground agricultural lime was applied and disked in before planting in the spring of 1979. Adequate rates of N, P, K, S and Zn are applied each year at all sites.

Grain yields are measured each fall and soil samples (0-8 in.) are collected to monitor changes in soil pH.

Results and Discussion:

Although this study was initiated in 1979, severe hail prevented harvest from the Nelson and Ericson sites. As a result, yields were recorded from all sites in 1980, only. The application of lime increased yields, in 1980, at one of the three sites (Figure 1). The yield response to lime was linear at the Kunz location while lime had no significant effect on yield at the Nelson and Ericson locations.

At the present time, the data do not provide a method whereby a response to lime could be predicted. The initial pH of the surface 6 in. at the Kunz location was 5.9 while an initial pH of 5.5 was measured for the surface 6 in. at the Ericson and Nelson locations.

It should be pointed out that judgements regarding the use of lime for corn on sandy soils cannot be based on data from 1 or 2 years. This study will be continued in 1981.

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

Property	Depth (in.)	Site Ericson	Nelson	Kunz
pH	0 - 6	5.5	5.5	5.9
	6 - 12	6.0	5.1	6.1
	12 - 24	6.4	6.1	6.4
	24 - 36	6.5	6.5	6.5
	36 - 48	6.5	6.7	6.6
	48 - 60	6.6	6.6	6.6
	60 - 72	6.5	6.6	6.7
NO_3-N, ppm	0 - 6	1.4	2.7	1.7
	6 - 12	.6	3.5	1.7
	12 - 24	.8	1.5	1.2
	24 - 36	3.0	1.7	2.3
	36 - 48	4.4	3.0	2.2
	48 - 60	7.1	2.7	2.3
	60 - 72	5.2	2.7	3.2
P(Bray), ppm	0 - 6	21	38	5
$K(NH_4C_2H_3O_2)$, ppm	0 - 6	158	263	147
Zn(HCl), ppm	0 - 6	3.2	9.5	1.9
O.M., %	0 - 6	1.1	1.3	2.1
CEC, me/100 g.	0 - 6	6.51	5.25	8.51
texture	0 - 6	loamy fine sand	loamy fine sand	sandy loam

Table 2. Nutrient content of irrigation water used at the experimental sites.

Nutrient	Site Ericson	Nelson	Kunz
	- - - - - - - -	lb./acre ft.	- - - - - -
lime	214	205	196
N	45	23	8
P	.47	.36	.19
K	11	7	21
S	4	.1	.1
Mg	18	14	13
B	.03	.02	.02

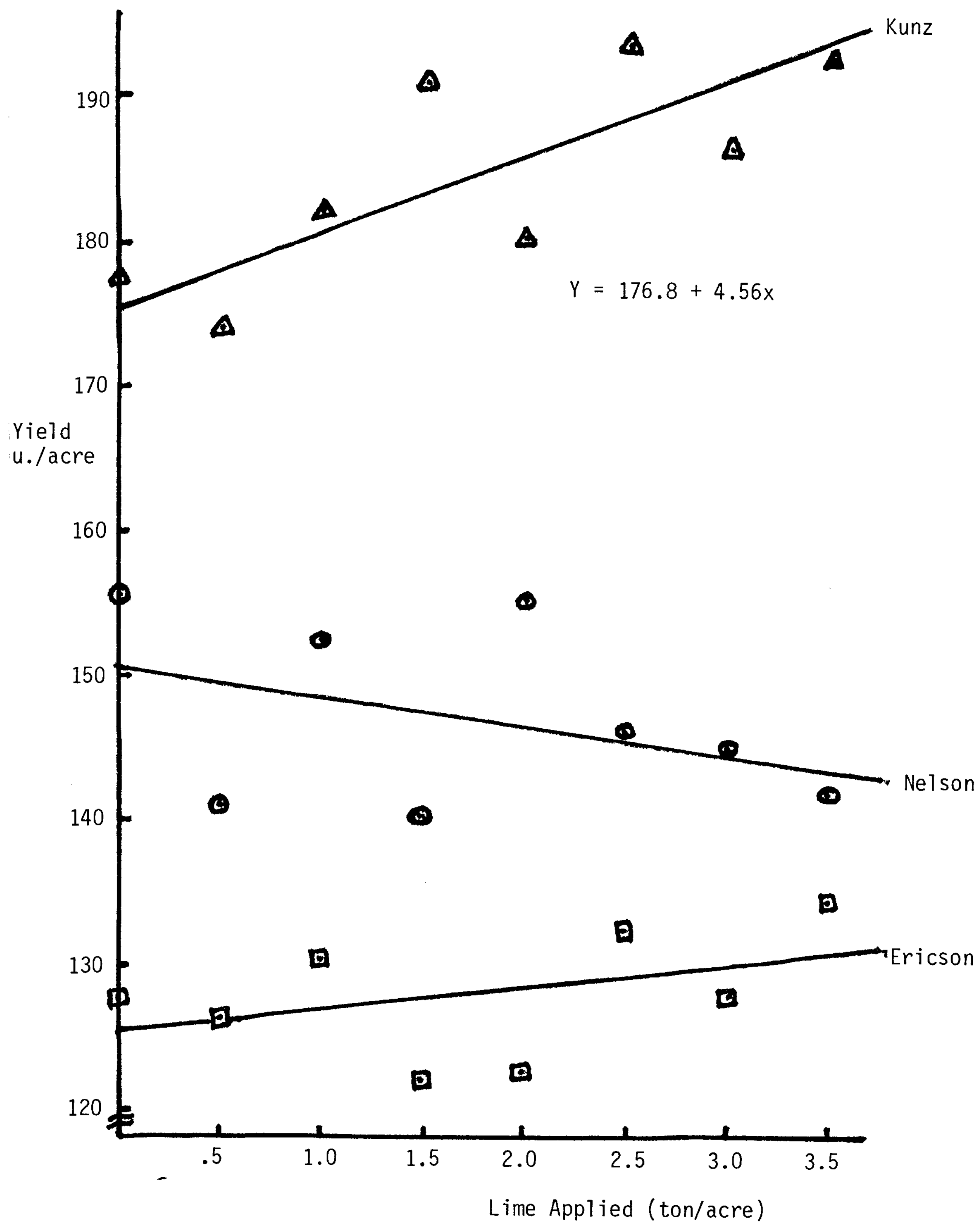

Figure 1. Influence of rate of lime on yield of corn grown on irrigated sandy soils. 1980.

SOURCE AND RATE OF SULFUR FOR CORN PRODUCTION ON SILT LOAM SOILS

G.W. Rehm

Objective:

The importance of sulfur (S) for crop production in Nebraska has been recognized since 1952. Results from prior research have shown that S is needed for sandy soils, only. Yet, there are still many questions about the use of sulfur for corn production on the silt loam and silty clay loam soils of northeastern and eastern Nebraska. Therefore, the objective of this study is to evaluate the rate and source of S for production of corn on silt loam soils.

Procedure:

This study was initiated at the Northeast Experiment Station in 1980. The soil is classified as a Nora silt loam. Soil properties are listed in Table 1. Two sulfur sources (granular gypsum, elemental sulfur) were used. These sources were broadcast to supply 0, 10, 20, 30 and 40 lb. sulfur per acre. The N was applied as 82-0-0 before planting. All treatments received 100 lb. 10-34-0/acre as a starter fertilizer. Grain yields were measured in mid-October.

Results and Discussion:

Neither the source or rate of sulfur applied had a significant effect on yield (Table 2). The corn receiving S as granular gypsum averaged 77.0 bu./acre while the corn receiving S as elemental S averaged 75.4 bu./acre. The data from this study is consistent with data collected from similar studies in past years in which fertilizer S did not increase production of corn grown on silt loam and silty clay loam soils.

Table 1. Properties of the soils at the experimental site. Northeast Experiment Station.

Property	Depth (in.) 0-6	6-12	12-24	24-36	36-48	48-60	60-72
pH	7.7	-	-	-	-	-	-
NO_3-N	5.6	3.9	3.5	3.6	3.3	4.9	5.0
P (Bray #1), ppm	7.7	-	-	-	-	-	-
K ($NH_4C_2H_3O_2$), ppm	218	-	-	-	-	-	-
Zn (HCl), ppm	6.0	-	-	-	-	-	-
organic matter, %	2.1	1.7	.9	.5	.5	.3	.3
SO_4-S, ppm	9.5	8.2	10.4	9.0	10.5	10.6	9.3

Table 2. Effect of source and rate of sulfur on production of corn on a silt loam soil, Northeast Experiment Station.

S Source	Rate of S (lb./acre) 0	10	20	30	40
	bu./acre				
granular gypsum	76.6	76.0	79.5	70.0	82.7
elemental S	68.7	82.2	77.4	73.6	75.0

INFLUENCE OF BORON ON BARREN STALKS AND GRAIN YIELD

K. D. Frank

Objectives:

To evaluate the effect of boron applied broadcast and disked in on irrigated corn yield, barren stalks, and plant uptake of boron.

Procedure:

The experiment was located on a shallow coarse-textured soil in northern Kearney County. In previous years, numerous barren stalks were present. Irrigation water at the plot location showed no boron (Table 1). Thus, a coarse-textured soil low in organic matter and no boron in the irrigation water should have provided an ideal location to obtain a boron response.

Fertilizer treatments (Table 3) were broadcast and disked in by the farmer cooperator. Each plot consisted of five 36-inch rows 50 feet long.

All plots received 200 pounds/acre of 7-21-7 + 2% zinc as starter, 200 pounds N as solution through the pivot, and 2 pounds of magnesium through the pivot on July 18, 1978. Approximately 16 inches of water was applied during the season. Some hail damage was received on July 20, 1978. The plots were hand-harvested on September 18, 1978.

Results:

Grain yield and barren stalks were not influenced by treatments (Tables 4 and 6).

The addition of boron to the soil significantly increased the boron content of the plants (Tables 5 and 7). However, plants from the non-boron treatments contained adequate boron. This substantiates the validity of the boron test (Table 1) which indicated adequate boron in the soil.

Under the conditions of this experiment, the addition of sulfur did not increase yield over the check plot even though soil and water analysis results were in the range where a sulfur response would be expected.

Table 1. Soil test information for the plot area.

	Measurement	Nutrient Availability Range
pH	5.7	
Buffer pH	6.7	1.5 tons lime/A needed
Phosphorus	38 ppm	High
Potassium	125 ppm	High
Zinc	7.9 ppm	High
Organic Matter	1.3%	
Sulfur	2.5 ppm	Deficient
Boron	1.3 ppm	Adequate

Table 2. Nutrient content of irrigation water at the plot location.

Nutrient	ppm	Concentration Pounds/Acre Foot Water
Calcium	23	124 (Lime)
Magnesium	3	9 (Mg)
Potassium	3	9 (K)
Nitrate-N	9.7	26 (NO_3-N)
Phosphate	0.19	0.5 (P)
Sulfate	1.8	5 (S)
Boron	0	0

Table 3. Treatment number & rate of nutrients applied in addition to constant application of nitrogen, phosphorus, potassium, zinc, & magnesium[1/].

Treatment Number	Symbol	Nutrients Pounds/Acre					
		P_2O_5	K_2O	MgO	Sulfur	Boron	Copper
1	Check	0	0	0	0	0	0
2	S	0	0	0	40	0	0
3	S,Cu	0	0	0	40	0	5
4	S,B	0	0	0	40	3	0
5	S,B,Cu	0	0	0	40	3	5
6	P,K,S,B,Cu	20	40	33	40	3	5

[1/] All plots received 200 #/A 7-21-7 + 2% zinc, 200 # N as 28% solution through the pivot, and 2 pounds magnesium through the pivot.

Table 4. Mean grain yield, plants per acre, and barren plants per acre as influenced by treatments.

Treatment Symbol	Yield Bu/A	Population (Plants/Acre)	Barren (Plants/Acre)
Check	144	26,136	2,541
S	144	25,047	1,452
S,Cu	147	25,047	1,815
S,B	144	26,136	3,267
S,B,Cu	149	25,047	1,089
P,K,Mg,S,B,Cu	157	26,499	2,178

Table 5. Mean nutrient content of ear leaf at silking as influenced by treatment.

Treatment Symbol	Nutrient Content		
	% Nitrogen	% Sulfur	ppm Boron
Check	2.96	0.208	17.5
S	2.88	0.215	16.7
S,Cu	2.95	0.236	14.9
S,B	2.87	0.187	30.7
S,B,Cu	2.85	0.216	24.6
P,K,Mg,S,B,Cu	2.91	0.187	25.1
Sufficient Range	2.2 - 3.0	0.2 - 0.3	10 - 20

Table 6. Analysis of variance for grain yield and barren stalks.

Source	df	F Values1/	
		Yield	Barren Plants
Total	23		
Rep	3	+	N.S.
Treatments	5	N.S.	N.S.
Error	15		

1/ + denotes significance at the 1, 5, and 10% probability level, respectively.

Table 7. Analysis of variance for percent nitrogen, boron, and sulfur in the ear leaf at silking.

Source	df	F Values		
		% N	% B	% S
Total	23			
Replication	3	N.S.	N.S.	N.S.
Treatments	5	N.S.	**	*
1 Vs 2	1	-	-	N.S.
1,2,3 vs 4,5,6	1	-	**	-
Error	15			

1/ *,** denotes significance at the 1, 5, and 10% probability level, respectively.

Title: Effects of Different Iron Products on Reducing Iron Chlorosis in Corn

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

Objective: Evaluate several iron products for correcting chlorosis on high pH soils in western Nebraska.

Procedure: Two locations were selected for the experiments. Materials used included:

Product	Company
Ironsul	Duval Corporation
Eagle Iron	Eagle Picher Industries
Iron KeMin	Georgia Pacific Corporation
Urea Phosphate + Fe	Tennessee Valley Authority

Twenty treatments were used with the above materials. Treatments were applied to single rows and replicated four times. Because of extreme variability (CV >35%) no significant treatment effects were noted. Several check rows were left in each replicate. Checks ranged from 35 bu/A to 100 bu/A within one replicate. With this high degree of variability, testing product effectiveness seems rather doubtful. After some searching of statistical literature it was decided that an experimental design could be constructed that would handle highly variable sites.

The experimental design is simply a paired row design. Another way of thinking of this design is the combination of the old uniformity trial (LeClerg, Leonard, and Clark, 1962) and a normal treatment design. An example is shown in Figure 1.

Treatments are first randomized within each block or replicate. A treatment unit consists of two rows (in this case) or two sub units. One of the rows is a check the other is a treatment. The treatment is randomly assigned to one of the two treatment units. Every treatment has a check neighbor which can serve as a true covariate. An example of how an analysis of covariance can help with interpretation on a highly variable site is given.

Five treatments A, B, C, D, and E were selected. It was assumed that treatment response was as follows: A-130% of check; B-125% of check, C-110% of check, D-105% of check, and E = check. Yields are shown in Figure 1.

The standard analysis of variance using only values from treatments A, B, C, D, and E showed no effect of treatments.

Analysis of Variance

Source	d.f.	SS.	F	Prob. >F
Total	19	4316.6		
Block	3	2318.6	7.9	0.01
Treatment	4	821.3	2.1	0.14
Error	12	1176.7		
			CV = 11%	

The analysis of covariance using the paired check as the covariate gave the following:

Source	F	Prob. >F	
Block	1.4	0.30	
Treatment	103.3	0.01	
Check covariate	337.1	0.01	CV = 2%

Duncan's multiple range test of the unadjusted and adjusted data clearly show the effect of using the covariate to improve data analysis and interpretation (Table 1).

Table 1. Unadjusted and adjusted yields from the experiment.

Treatment	Yield	Least Squares Yield from ANOCOVAR
A	97 a*	102 a*
B	98 a	99 b
C	89 a	87 c
D	83 a	83 d
E	84 a	79 e

*Yields followed by the same letter are not significantly different at the 5% level of probability.

The primary disadvantage of the paired treatments design for analysis of covariance is the automatic doubling of experiment size. The primary advantage is collection of data that can be interpreted with some degree of confidence. The high variability of my 1980 data was a failure in terms of treatment comparisons and thus a loss of 1 year's data. The failure, however, did prompt some research which resulted in the previously discussed design. Hopefully the application of these findings can be used by others to avoid the problems encountered in the 1980 iron choloris work at North Platte.

Block I	Treatment	A	CK	C	CK	B	CK	E	CK	D	CK
	Yield	118	85	93	85	101	81	92	90	115	110
Block II	Treatment	E	CK	D	CK	CK	A	CK	B	CK	C
	Yield	95	92	84	80	78	102	84	105	100	110
Block III	Treatment	CK	C	CK	B	E	CK	D	CK	CK	A
	Yield	80	88	75	93	73	70	73	70	72	94
Block IV	Treatment	CK	B	E	CK	C	CK	A	CK	D	CK
	Yield	75	94	77	79	66	60	81	62	60	58

Figure 1. Experimental design for paired plot technique.

FERTILIZER NEEDS FOR WHEAT IN NEBRASKA

D. H. Sander, G. A. Peterson, and C. R. Fenster

In 1980, eight experimental wheat fertilizer experiments were harvested involving seed applied versus broadcast P. Five of these experiments were one year studies and three were long term studies where P has been reapplied either for the second (locations 78-17 and 78-14) or third time (76-Carter). Three experimental sites were lost due to hail (80-9, 80-18, long term 78-7). Wheat yields were generally excellent with yields up to 70 bu/acre. Stands were excellent except for Furnas 80-4 location, where germination was poor due to dry soil at seeding.

Wheat grain yield response to applied P was significant on the Frontier, Furnas, and Hitchcock 80-20 locations (Table 1). Superiority of row or seed application was especially apparent at the Furnas County location but stands were poor and variability high. Phosphorus may have affected winter survival at this location. The apparent equal performance of seed applied and broadcast at the Hitchcock 80-20 location is surprising. The decrease in yield of seed applied compared to broadcast at the Red Willow 80-11 site is the first we have obtained in three years and 23 experiments. Available P in this soil is also one of the highest we have studied. The lower yields associated with the seed applied P appears to be the result of increased P uptake.

The long term Scharf location continues to show a strong superiority of row over broadcast, but the Goodenburger location may show signs of P carryover from the previous application. At Carter location, wheat yields were increased with P application with no difference due to method. This soil tests high in P and yield responses have been marginal with past crops.

Wheat grain yields were increased with applied N only at the Furnas County 80-4 site. Nitrogen recommendations for this soil was probably low. However, nitrogen was recommended on both the Hitchcock 80-20 and 80-21 sites where grain yields were not affected by applied N. Residual nitrate-N was relatively high at all experimental sites which reduces predictability.

For the third year, the N source x rate x tillage study at Sidney failed to show differences in N source performance. Response to N application has been a problem each year on these Rosebud soils. Nitrogen application had no effect on grain yields on either stubble mulch or chemical fallow although there is a trend for straw yields to be increased on chemical fallow with N application. Applied N increased grain protein. Grain protein was highest where ammonia was applied.

The effect of placing 10-34-0 with ammonia on wheat yields was studied at three locations in 1980. Phosphorus increased grain yield at all three locations. Ammonia and 10-34-0 placed separately (ammonia knifed between 12 inch spacings of 10-34-0) or together performed equally or possibly better than seed applied P. Broadcast 10-34-0 performed well at the Furnas County site.

Table 1. Effect of method and rate of P application on wheat yields in southwest Nebraska in 1980

Furnas County
Location 80-4
NE¼, Sec 32, T3N, R22W

P Rate	Yield: Grain	Yield: Straw	Heading: Yield	Heading: P Conc.	Heading: P Yield
kg P/ha	kg/ha x10^{-2}			%	kg/ha
0	19.6	29.8	22.6	.158	3.5
		Seed Applied			
8	26.5	42.8	28.2	.148	4.1
17	24.1	34.9	20.1	.179	3.3
25	28.6	43.6	34.0	.157	5.1
33	27.7	41.5	41.2	.156	7.0
42	24.9	36.8	36.8	.160	5.9
Mean	26.4	39.9	32.0	.160	5.0
		Broadcast			
8	19.6	32.6	20.2	.161	3.2
17	20.3	29.4	23.8	.153	3.7
25	20.0	29.8	18.4	.172	3.1
33	16.9	26.4	19.1	.194	3.6
42	21.8	31.7	22.8	.168	3.8
Mean	19.7	30.0	20.8	.167	3.5
Analysis of Variance 1/					
Rate	++	*	+	NS	*
Linear	*	NS	*	NS	**
Quadratic	+	++	NS	NS	NS
Method	**	**	**	NS	**
Rate x Method	+	+	**	+	*
C.V.	15.9	15.9	32.8	17.0	28.8

Soil Test

Depth	pH	Bray P	$NaNCO_3$
cm		ppm	
0-10	6.2	10	7
10-20	6.4	4	3
20-30	6.8	3	4

Table 1. Continued

Red Willow County
Location 80-11
SE¼, Sec 7, T2N, R27W

P Rate	Yield Grain	Yield Straw	Heading Yield	Heading P Conc.	Heading P Yield
kg P/ha	kg/ha x10^{-2}			%	kg/ha
0	39.3	75.4	47.8	.115	5.6
		Seed Applied			
8	39.3	81.5	56.6	.121	6.8
17	38.6	80.3	58.6	.1314	7.8
25	34.4	77.1	55.6	.139	7.7
33	36.0	76.1	52.8	.133	6.8
42	35.5	72.6	63.2	.139	8.8
Mean	36.8	77.5	57.4	.133	7.6
		Broadcast			
8	39.3	84.9	55.0	.118	6.6
17	41.8	74.7	53.0	.114	6.0
25	37.3	72.0	52.9	.130	7.0
33	42.0	80.5	55.6	.141	7.8
42	40.7	82.0	57.1	.131	6.1
Mean	40.2	78.8	54.7	.127	7.0
Analysis of Variance 1/					
Rate	++	NS	+	*	*
Linear	+	NS	*	**	**
Quadratic	NS	NS	NS	NS	NS
Method	**	NS	NS	NS	+
Rate x Method	NS	NS	NS	NS	NS
C.V.	8.5	11.4	17.0	13.6	21.4

Soil Test

Depth	pH	Bray P	$NaNCO_3$
0-10	6.0	26	15
10-20	5.9	17	10
20-30	6.5	8	8

1/ Rate statistic includes check plots while method does not.

Table 2. Effect of method and rate of P application overtime on wheat yield in southwest Nebraska. 1980.

Frontier County
Location, Scharf Farm 78-17
SW¼, Sec 10, T7N, R28W

P Rate	Yield: Grain	Yield: Straw	Heading: Yield	Heading: P Conc.	Heading: P. Yield
kg P/ha	kg/ha $x10^{-2}$			%	kg/ha
0	32.0	38.3	22.3	.135	2.9
		Seed Applied			
8	39.0	56.7	29.9	.126	3.6
17	34.2	48.4	39.5	.118	4.6
25	40.0	56.3	47.6	.131	6.4
33	40.3	59.3	42.4	.131	5.6
42	41.6	563	32.0	.156	5.1
Mean	39.0	55.4	38.3	.132	5.1
		Broadcast			
8	31.3	37.1	26.6	.149	3.9
17	34.9	41.2	23.4	.150	3.5
25	34.2	41.8	31.4	.152	4.7
33	35.1	42.4	33.8	.149	5.2
42	38.5	46.2	33.4	.145	4.6
Mean	34.8	41.8	29.8	.149	4.6
Analysis of Variance1/					
Rate	**	**	**	NS	**
Linear	**	**	**	*	**
Quadratic	NS	++	**	NS	*
Method	**	**	**	**	++
Rate x Method	++	*	+	++	NS
C.V.	9.7	10.9	27.0	11.6	29.4

Soil Test 1977

Depth	pH	Bray P	$NANCO_3$
cm		ppm	
0-10	6.2	3	-
10-20	6.8	10	-
20-30	7.1	3	-

Table 2. Continued

Hitchcock County
Location - Goodenburger Farm 78-14
SE¼, NW¼, Sec 20, T3N, R34W

P Rate	Yield Grain	Yield Straw	Heading Yield	Heading P Conc.	Heading P Yield
kg P/ha	kg/ha $x10^{-2}$			%	kg/ha
0	28.4	41.6	25.2	.089	2.2
		Seed Applied			
8	31.0	44.4	30.2	.086	2.6
17	35.0	54.6	30.3	.089	2.7
25	35.8	49.4	32.3	.082	2.5
33	39.1	62.0	34.3	.089	3.1
42	38.5	59.5	40.6	.089	3.6
Mean	35.9	54.0	33.6	.087	2.9
		Broadcast			
8	31.7	45.8	28.5	.089	2.5
17	30.7	42.8	26.5	.093	2.4
25	37.4	55.7	30.6	.101	3.3
33	38.9	56.7	32.5	.097	3.2
42	40.9	60.4	34.6	.112	4.0
Mean	35.9	52.3	30.6	.099	3.1
Analysis of Variance 1/					
Rate	**	**	**	NS	*
Linear	**	**	**	NS	**
Quadratic	NS	NS	NS	NS	NS
Method	NS	NS	+	+	NS
Rate x Method	NS	+	NS	NS	NS
C.V.	12.0	16.2	23.3	26.9	34.7

Soil Test

Depth	pH	Bray P	$NaNCO_3$
cm		ppm	
0-10	8.0	9	-
10-20	8.2	1	-
20-30	8.2	2	-

Table 2. Continued

Hitchcock County
Location - Carter Farm 76

P Rate	Yield: Grain	Yield: Straw	Heading: Yield	Heading: P Conc.	Heading: P Yield
kg P/ha	kg/ha $x10^{-2}$			%	kg/ha
0	39.3	75.4	43.3	.144	6.2
		Seed Applied			
8	44.0	84.7	45.3	.153	7.0
17	38.5	85.9	53.0	.180	9.5
25	47.3	94.1	55.0	.167	9.1
33	38.5	77.2	45.5	.173	7.8
42	43.0	80.1	49.0	.184	9.0
Mean	42.3	84.4	49.6	.171	8.5
		Broadcast			
8	42.4	77.0	48.6	.149	7.2
17	39.3	71.5	41.4	.184	7.6
25	42.9	77.1	47.2	.166	7.6
33	40.2	80.0	45.0	.183	8.3
42	42.9	74.1	48.2	.181	8.8
Mean	41.5	75.9	46.1	.172	7.9
Analysis of Variance[1/]					
Rate	**	+	+	**	**
Linear	NS	NS	*	**	**
Quadratic	NS	*	NS	+	++
Method	NS	**	**	NS	++
Rate x Method	NS	+	**	NS	++
C.V.	9.4	10.8	32.8	12.3	17.0

Soil Test

Depth	pH	Bray P	$NaNCO_3$
cm		ppm	
0-10	6.7	11	-
10-20	7.0	5	-
20-30	7.2	6	-

Table 3. Effect of applied N on wheat yields and protein content on soils with varying residual nitrates.[1/]

Furnas County
Location 80-4
NE¼, Sec 32, T3N, R22W

N Rate	Grain Yield	Straw Yield	Grain Yield
kg/ha	kg/ha x 10^{-2}		%
0	22.7	68.7	13.8
33	25.9	66.5	15.0
66	26.0	66.4	13.7
99	30.5	78.6	15.1
132	31.2	84.0	14.9
Mean	27.3	72.9	14.5

1/ Residual NO_3-N, 180 cm = 13.8 kg/ha   Recommended N = 33 kg/ha

Table 3. Continued

Hitchcock County
Location 80-20
SW¼, Sec 36, T3N, R35W

N Rate	Grain Yield	Straw Yield	Grain Yield
kg/ha	kg/ha x 10^{-2}		
0	40.3	114.2	13.5
33	41.9	116.9	14.3
66	44.7	124.0	14.2
99	43.0	118.6	14.8
132	42.5	118.6	14.4

1/ Residual nitrate, 180 cm = 109 hg/ha   Recommended N = 44 kg/ha

Analysis of Variance			
N Rate	NS	NS	*
Linear	NS	NS	**
Quadratic	NS	NS	NS
C.V.	8.9	10.0	3.6

Table 3. Continued

Hitchcock County
Location 80-21
S½, SW¼, Sec 20, T3N, R32W

N Rate	Grain Yield	Straw Yield	Grain Protein
kg/ha	kg/ha x 10^{-2}		%
0	39.7	119.7	14.1
33	36.6	113.8	15.7
66	36.3	110.8	12.7
99	38.1	99.7	14.2
132	34.9	106.4	15.5
Mean	37.1	110.1	14.4

1/ Residual nitrate, 180 cm = 98 kg/ha Recommended N = 44 kg/ha

Analysis of Variance			
N Rate	NS	NS	NS
Linear	NS	NS	NS
Quadratic	NS	NS	NS
C.V.	14.8	16.6	15.3

Table 3. Continued

Frontier County
Location 80-24
SW½, Sec 26, T8N, R28W

N Rate	Grain Yield	Straw Yield	Grain Protein
kg/ha	kg/ha x 10^{-2}		%
0	46.5	108.9	14.0
33	47.1	110.4	14.2
66	43.3	101.2	14.7
99	47.8	109.1	13.7
132	41.7	96.4	14.5

1/ Residual nitrate, 180 cm = 183 kg/ha Recommended N = 0

Analysis of Variance			
N Rate	++	++	+
Linear	++	+	NS
Quadratic	NS	NS	NS
C.V.	6.3	6.7	3.5

Table 4. Effect of rate and source of applied N on wheat yields and grain protein content as affected by two systems of fallow. High Plains Agriculture Laboratory, Sidney, Nebraska. 1980.

N Source	Rate		Total Plant Yield	Grain Yield	Plant[1/] N	Grain Protein
	kg/ha		kg/ha x 10^{-2}	kg/ha x10^{-2}	%	%
			Chemical Fallow			
	0		48.0	21.2	1.18	10.0
NH_4NO_3	20	22	54.8	22.2	1.18	11.1
	40	44	41.7	17.9	1.34	11.7
	60	66	45.5	15.8	1.35	13.2
	80	88	53.3	19.4	1.52	13.3
	Mean		48.4	18.8	1.35	12.3
Urea	20	22	46.1	19.7	1.18	10.6
	40	44	53.1	21.3	1.37	11.8
	60	66	48.8	19.1	1.50	12.6
	80	88	58.4	19.8	1.38	13.1
	Mean		51.6	20.0	1.36	12.0
N Soln	20	22	51.5	20.6	1.11	11.3
	40	44	47.3	17.5	1.30	11.8
	60	66	56.2	19.4	1.35	13.5
	80	88	56.8	19.2	1.67	13.5
	Mean		53.0	19.2	1.36	12.5
NH_3	20	22	50.2	20.1	1.32	12.0
	40	44	52.5	22.3	1.46	11.5
	60	66	50.8	16.8	1.40	14.7
	80	88	46.9	15.8	1.58	14.5
	Mean		50.1	18.8	1.44	13.2

1/ Plant at Flowering

Table 4. Continued

N Source	Rate		Total Plant Yield	Grain Yield	Plant N [1/]	Grain Protein
			kg/ha x10^2	kg/ha x10^2	%	%
			Stubble Mulch			
	0		44.5	21.0	1.22	11.2
NH_4NO_3	20	22	48.4	21.7	1.35	12.1
	40	44	45.6	20.8	1.32	12.7
	60	66	52.5	21.0	1.43	13.1
	80	88	41.4	17.9	1.51	14.3
	Mean		47.0	20.4	1.40	13.1
Urea	20	22	47.0	20.8	1.21	11.8
	40	44	36.2	17.7	1.42	12.1
	60	66	52.2	22.6	1.50	12.9
	80	88	47.8	20.7	1.44	14.2
	Mean		45.8	20.5	1.39	12.8
N Soln	20	22	33.4	16.9	1.34	11.0
	40	44	39.4	17.6	1.40	12.7
	60	66	42.1	18.0	1.61	13.8
	80	88	56.3	20.7	1.67	14.2
	Mean		42.8	18.3	1.51	12.9
NH_3	20	22	46.1	21.2	1.37	12.1
	40	44	50.6	21.0	1.42	12.9
	60	66	36.3	15.7	1.56	14.7
	80	88	54.2	20.1	1.56	14.6
	Mean		46.8	19.5	1.48	13.1
Means						
Tillage						
	Chemical		56.2	19.4	1.35	12.2
	Stubble Mulch		47.3	19.8	1.42	12.9
N Sources						
	NH_4NO_3		47.9	19.6	1.38	12.7
	Urea		48.7	20.2	1.38	12.4
	N Soln		47.9	18.7	1.43	12.7
	NH_3		48.4	19.1	1.46	13.4
N Rates	0		46.2	21.1	1.20	10.6
	20		47.2	20.4	1.26	11.5
	40		45.8	19.5	1.38	12.1
	60		48.0	18.5	1.46	13.5
	80		51.9	19.2	1.54	14.0

Table 4. Continued

Analysis of Variance	Total Plant	Grain Yield	Plant N	Grain Protein
Tillage[1/]	NS	NS	NS	*
Treatments	NS	NS	**	**
0 N vs Treatment	NS	NS	**	**
N Rate	NS	NS	**	**
N Source	NS	NS	NS	*
N Rate x N Source	NS	NS	NS	NS
Tillage x Treatment	NS	NS	NS	NS
C.V.	19.2	17.8	12.3	8.25
R^2	.58	.37	.61	.75

1/ Tillage and treatment companions include 0 N treated plots while N rate and N source do not.

Table 5. Effect of preplant bands of ammonia and polyphosphate on wheat yields on three locations in Nebraska. 1980

Treatment[1/]	Grain Yield Pawnee Co.	Seward Co.	Furnas Co. 80-4
		bu/A	
Ammonia alone	39	21	29[2/]
Broadcast	39	28	39
Dribble	43	31	
Seed applied	42	46**	45
Knife Together	48**	50**	39
Knife Separate	50**	49**	
Knife Together w/N-Serve	47*	48**	48

* Yield significantly higher than where no P applied at .05 level

** Yield significantly higher than where no P applied at .01 level

1/ Ammonia applied at 70 lbs N/acre and 10-34-0 at 15 lbs P/acre.

2/ Yield without P on adjacent experiment.

	Soil Tests		
pH	6.5	6.0	6.3
Bray P, ppm	5	6	6
K, ppm	108	238	-
O.M.T	2.0	1.5	-

Table 6.

Hitchcock County
Location 80-20
SW¼, Sec 36, T3N, R35W

P Rate	Yield: Grain	Yield: Straw	Heading: Yield	Heading: P Conc.	Heading: P Yield
kg P/Hg	kg/Ha $x10^{-2}$			%	kg/ha
0	42.8	66.2	41.0	.121	5.0
		Seed Applied			
8	44.0	75.8	50.8	.131	6.6
17	43.7	70.6	40.0	.116	4.6
25	46.2	79.2	47.2	.116	5.5
33	46.4	77.6	46.6	.111	5.3
42	48.0	82.0	41.8	.142	5.8
Mean	45.7	77.0	45.3	.123	5.6
		Broadcast			
8	46.4	71.6	41.3	.122	4.9
17	44.4	71.6	38.4	.137	5.2
25	46.7	76.6	40.9	.137	5.5
33	47.1	75.8	41.4	.139	5.7
42	45.2	73.5	46.4	.146	6.7
Mean	46.0	73.8	41.7	.137	5.6
Analysis of Variance					
Rate	**	**	+	+	*
Linear	**	**	NS	*	*
Quadratic	NS	++	NS	NS	NS
Method	NS	*	*	*	NS
Rate x Method	NS	NS	+	NS	++
C.V.	6.0	6.8	14.1	15.5	18.6

Soil Test

Depth	pH	Bray P	$NaNCO_3$
0-10	7.3	8	6
10-20	7.6	4	2
20-30	7.8	3	0

Table 7.

Hitchcock County
Location 80-21
S½, SW¼, Sec 20, T3N, R32W

P Rate	Yield: Grain	Yield: Straw	Heading: Yield	Heading: P Conc.	Heading: P Yield
kg P/Ha	kg/Ha x10^{-2}			%	kg/ha
0	36.4	59.7	40.4	.137	5.5
		Seed Applied			
8	36.1	67.0	45.8	.128	5.8
17	35.4	71.4	39.1	.132	5.1
25	38.3	75.0	44.8	.136	6.2
33	38.1	75.4	45.2	.134	6.0
42	36.8	72.0	41.0	.151	6.2
Mean	36.9	72.2	43.2	.136	5.9
		Broadcast			
8	34.4	54.3	33.0	.126	4.2
17	36.5	60.3	36.2	.116	4.2
25	36.6	61.9	41.9	.136	5.5
33	36.0	58.6	43.2	.121	5.2
42	37.9	70.4	42.1	.146	6.1
Mean	36.3	61.1	39.2	.129	5.1
Analysis of Variance					
Rate	NS	*	NS	++	++
Linear	NS	**	NS	+	++
Quadratic	NS	NS	NS	*	++
Method	NS	**	+	NS	*
Rate x Method	NS	NS	NS	NS	NS
C.V.	9.7	13.1	18.3	14.3	21.9

Soil Test

Depth	pH	Bray P	$NaHCO_3$
cm		ppm	
0-10	6.9	16	9
10-20	7.0	6	6
20-30	7.3	3	4

Table 8.

Frontier County
Location 80-24
SW¼, Sec 26, T8N, R28W

P Rate	Yield: Grain	Yield: Straw	Heading: Yield	Heading: P Conc.	Heading: P Yield
kg P/Ha	kg/ha X10^{-2}			%	kg/ha
0	39.3	51.6	39.3	.132	5.1
		Seed Applied			
7	44.1	61.6	39.5	.127	4.9
17	42.9	59.4	42.6	.145	6.1
25	46.1	63.6	44.4	.178	7.8
33	43.4	60.4	43.4	.155	6.8
42	42.7	54.0	43.2	.155	6.7
Mean	43.8	59.8	42.6	.152	6.5
		Broadcast			
7	38.8	51.0	38.4	.145	5.6
17	40.1	53.6	40.4	.127	5.1
25	40.3	51.4	40.6	.135	5.3
33	41.6	56.4	39.8	.145	5.7
42	41.3	52.3	34.9	.152	5.3
Mean	40.4	52.9	38.8	.141	5.4
Analysis of Variance					
Rate	++	*	NS	+	+
Linear	*	NS	NS	*	*
Quadratic	++	**	NS	NS	NS
Method	**	**	++	+	+
Rate x Method	NS	++	NS	+	+
C.V.	7.2	9.0	16.8	18.2	22.4

Soil Test

Depth	pH	Bray P	$NaHCO_3$
cm		ppm	ppm
0-10	6.1	28	14
10-20	6.3	9	6
20-30	6.8	4	2

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

E.J. Penas and D.H. Sander

Objectives:

1. 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.

2. To determine the effect of rates of nitrogen on grain yield for purposes of calibrating a soil test for nitrogen.

Procedure: Experimental plots were established in farmers' fields in Gage and Nance Counties in the fall of 1979. The basis for site selection was a low level of soil phosphorus and an acid soil pH. These studies parallel studies being conducted in Western Nebraska on neutral to alkaline soils. The soil test characteristics are presented in Table 1.

Results and Discussion: Table 2 shows the influence of nitrogen and phosphorus on wheat yields. The site in Gage County was very deficient in nitrogen. Nitrogen increased grain yield; however, the effect was too late to allow a response to phosphorus. Nitrogen was applied in April but no rain was received until mid-May. At Nance County, grain yields were increased by phosphorus; however, there was no effect from nitrogen. Soil nitrogen was high at Nance County.

Table 3 shows the influence of nitrogen on winter wheat grain yields. These nitrogen rates were topdressed in April. Phosphorus at 46 pounds P_2O_5 (20 P) per acre was placed with the seed at planting time. At Gage County, 60 pounds of nitrogen was required for top yields.

The influence of rate and placement of phosphorus is shown in Table 4. At Nance County both methods of phosphorus application resulted in increased grain yield; however, phosphorus applied with the seed was most effective. The most profitable rate of phosphorus with the seed was 36 pounds P_2O_5 per acre with a yield of 72 bushels per acre. Where phosphorus was broadcast, 75 pounds P_2O_5 per acre was the most profitable rate with a 68 bushel per acre yield.

Table 1. Soil Tests Characteristics of Winter Wheat Test Plot Sites, 1980.

	Gage Co.	Nance Co.
Soil pH	6.2	5.9
Buffer pH	6.6	6.5
NO_3-Nitrogen, lbs/ac 6 ft.	38	145
Phosphorus, ppm	10	8
Potassium, ppm	211	324
Organic Matter, %	1.9	2.7

Table 2. Winter Wheat Grain Yields, bu/ac, as influenced by nitrogen and phosphorus, 1980.

Treatment	Gage County	Nance County
None	39.7	65.4
40 lbs. N	--	62.2
60 lbs. N	48.7	--
46 lbs. P_2O_5	38.9	72.6
40 N & 46 P_2O_5	--	68.7
60 N & 46 P_2O_5	51.5	--

Table 3. Winter Wheat Grain Yields, bu/ac, as influenced by nitrogen rate, 1980.

Nitrogen, lbs/ac	Gage County	Nance County
0	41.0	69.6
20	44.4	69.6
40	47.4	70.9
60	50.5	67.9
80	50.1	69.6
100	51.0	67.5

Table 4. Winter Wheat Grain Yields, bu/ac, as influenced by phosphorus, rate & placement, 1980.

Phosphorus Rate,	Gage County		Nance County	
P_2O_5, lbs/ac	P Bdct	P w/seed	P Bdct	P w/seed
0	51.3		62.3	
9		49.6		66.4
17	47.3	50.6	62.8	69.1
26		50.9		70.9
34	50.1	48.9	64.3	72.0
43		52.4		72.6
52	47.2	51.3	66.1	72.8
60		51.8		72.9
69	49.4	51.1	67.9	73.0
86	49.3	55.5	69.2	74.0
103	47.9		69.6	
120	50.6		68.5	
134	50.6		65.5	

DUAL PLACEMENT OF NITROGEN AND PHOSPHORUS ON WHEAT

E.J. Penas and D.H. Sander

Objective: To determine the most effective methods of applying phosphorus for winter wheat when using a liquid formulation of fertilizer.

Procedure: Two studies were established in the fall of 1979. Plots were located in Pawnee and Seward Counties. The accompanying table shows the soil test characteristics of both sites. Both locations were low in phosphorus and were slightly acid in soil pH.

Each plot area received 70 pounds of nitrogen per acre as ammonia plus 10 pounds of nitrogen from the 10-34-0 that was applied, except the ammonia only plots which received all 80 pounds of nitrogen as ammonia.

Phosphorus was applied at a constant rate of 34 pounds P_2O_5 (15# P) per acre as 100 pounds of 10-34-0. A double rate of phosphorus with the seed (200 pounds 10-34-0 per acre) was included as another treatment in Seward County.

The method of phosphorus application was the main variable being studied. The 10-34-0 was applied prior to seeding with ammonia and ammonia plus N-Serve in 12 inch bands using double tube knives, applied in 12 inch band separate from the ammonia, dribbled in 12 inch bands on the soil surface and incorporated prior to seeding, broadcast on the soil surface and incorporated, and applied with the seed at planting time.

Results and Discussion: The table shows the grain yields at both locations. At the Pawnee County site, wheat yields were increased only where the 10-34-0 was knifed into the soil. The application of the phosphorus in bands with ammonia, in bands separate from the ammonia, or in bands with ammonia plus N-Serve all gave the same yield. Broadcast, dribble and seed application of 10-34-0 did not increase yields significantly in the Pawnee County test.

At Seward County all methods of phosphorus application except broadcast increased wheat yields significantly. The knife applications and with the seed were the most effective and were significantly more effective than the dribble treatment. Doubling the rate with the seed was the most effective treatment which gave a 39 bushel yield increase.

DUAL PLACEMENT OF NITROGEN AND PHOSPHORUS ON WHEAT
1980

	Grain Yields, bu./ac.	
Location:	Pawnee	Seward
Treatment 1/		
Ammonia alone	39.0	21.1
10-34-0 Broadcast and Ammonia	39.3	28.1
10-34-0 Dribbled and Ammonia	43.4	30.7*
10-34-0 with Seed and Ammonia	42.1	45.7**
10-34-0 with seed (double rate) and Ammonia		59.8***
10-34-0 and Ammonia knifed separately	50.1**	48.8**
10-34-0 and Ammonia knifed together	47.7*	49.7**
10-34-0 and Ammonia with N-Serve knifed together	47.4*	47.9**

1/ Ammonia @ 70# N/ac and 10-34-0 @ 15# P (34# P_2O_5)/ac.

* yield significantly higher (.05) than where no phosphorus applied.

** yield significantly higher (0.1) than where no phosphorus applied

*** yield significantly higher (0.1) where double rate (200 pounds 10-34-0) applied as compared to lower rate with seed.

Soil Test Information	Pawnee	Seward
Soil pH	6.5	6.0
Buffer pH	--	6.6
Phosphorus, ppm	5	6
Potassium, ppm	108	238
Organic Matter, %	2.0	1.5

RATE AND PLACEMENT OF PHOSPHATE FERTILIZER

FOR SOYBEAN PRODUCTION

G.W. Rehm and R.A. Wiese

Objective:

In recent years, considerable research has been focused on the use and management of fertilizer for corn production. Less attention has been given to fertilizer use for soybeans in Nebraska. In northeast and eastern Nebraska, the number of acres planted to soybeans has increased substantially in recent years. This trend will probably continue. Many of the fields planted to soybeans have phosphorus levels which are low or very low. Therefore, effective and efficient use of phosphate fertilizers should be one of the first considerations in a fertilizer program for soybeans in eastern Nebraska. The objective of this study is to measure the effect of rate and placement of phosphate fertilizer for soybean production on the irrigated silt loam soils of northeast and eastern Nebraska.

Procedure:

This study was initiated in 1979 and continued in 1980. Soil properties are listed in Table 1. Five rates of P (0, 10, 20, 30, 40 lb./acre) were either broadcast and incorporated with a disk before planting or applied in a band to the side of and below the seed at planting. Appropriate herbicides at the recommended rates were used at all sites. Amsoy 71 soybeans were seeded at a rate of 10 seeds/ft. of row in 30 in rows. All sites were irrigated as needed throughout the season.

Leaf samples were collected at the early bloom stage, dried, and analyzed for P. Yields were measured in early October.

Results and Discussion:

In 1980, the rate and placement of fertilizer P influenced soybean yields at 1 of the 4 locations (Table 2). Both rate and placement of fertilizer P influenced yield at the Dixon County site but there was no significant rate X placement interaction. When averaged over all rates, yields were higher, when the phosphate was broadcast rather than applied in the row at planting.

The response at the Dixon County site would be expected since the soil P level is very low. All other sites had a P level of 9.6 ppm or higher in the surface soil.

The uppermost fully developed trifoliate leaves were sampled prior to pod set and analyzed for P. The P content of the leaves increased with rate of applied P at the Pierce and Dixon County sites (Table 3). Placement of fertilizer P had no effect on the P content of the leaves at the Pierce County site while broadcast application of fertilizer P produced a higher concentration of P in the plant tissue at the Dixon County site. There was no significant rate X placement interaction. It should be noted that the P content of plant tissue from all treatments is within the generally accepted sufficiency range for P content of soybean leaves.

The P content of the soybean leaves sampled before pod set was related to soybean yield at the Dixon County site only ($r = .747^{**}$).

This study will be continued in 1981 in an effort to define more accurately the soil P level at which a response of soybeans to P fertilization can be expected.

Table 1. Properties of soils at experimental sites in 1980.

	Depth (in.)						
Property	0-6	6-12	12-24	24-36	36-48	48-60	60-72
Pierce County:							
pH	5.9	-	-	-	-	-	-
NO_3-N, ppm	3.4	-	-	-	-	-	-
K ($NH_4C_2H_3O_2$) ppm	301	-	-	-	-	-	-
Zn (HCl), ppm	4.2	-	-	-	-	-	-
organic matter, %	2.8	-	-	-	-	-	-
P (Bray), ppm	9.6	4.7	3.7	5.7	19.0	24.7	21.4
P ($NaHCO_3$), ppm	5.4	2.1	1.7	2.7	12.7	15.7	10.8
Knox County:							
pH	6.5	-	-	-	-	-	-
NO_3-N, ppm	10.3	-	-	-	-	-	-
K ($NH_4C_2H_3O_2$) ppm	208	-	-	-	-	-	-
Zn (HCl), ppm	5.1	-	-	-	-	-	-
organic matter, %	2.5	-	-	-	-	-	-
P (Bray), ppm	19.7	3.3	2.4	1.7	2.7	3.3	-
P ($NaHCO_3$), ppm	9.3	2.8	2.5	3.2	2.5	2.3	-
Dixon County:							
pH	7.6	-	-	-	-	-	-
NO_3-N, ppm	4.3	-	-	-	-	-	-
K ($NH_4C_2H_3O_2$), ppm	215	-	-	-	-	-	-
Zn (HCl), ppm	6.4	-	-	-	-	-	-
organic matter, %	1.8	-	-	-	-	-	-
P (Bray), ppm	3.1	1.2	1.0	1.4	1.8	1.9	2.0
P ($NaHCO_3$), ppm	10.7	.9	1.1	1.2	1.1	1.1	1.2
Cedar County:							
pH	6.2	-	-	-	-	-	-
NO_3-N, ppm	20.4	-	-	-	-	-	-
K ($NH_4C_2H_3O_2$), ppm	278	-	-	-	-	-	-
Zn (HCl), ppm	7.2	-	-	-	-	-	-
organic matter, %	3.3	-	-	-	-	-	-
P (Bray), ppm	12.7	3.9	6.4	6.4	9.4	10.1	9.8
P ($NaHCO_3$), ppm	6.7	2.7	4.5	6.6	9.5	9.2	7.9

Table 2. Effect of rate and placement of fertilizer P on yield of soybeans.

County	Placement	P Applied (lb./acre) 0	10	20	30	40
		bu./acre				
Pierce	Broadcast	31.7	31.4	32.8	33.8	33.9
	Starter	31.7	31.4	32.6	33.0	32.4
Knox	Broadcast	45.0	41.5	43.7	42.3	48.7
	Starter	41.4	41.2	42.8	42.2	41.5
Dixon	Broadcast	35.4	38.6	41.1	41.5	43.5
	Starter	34.2	35.4	34.9	36.6	35.9
Cedar	Broadcast	43.7	38.3	43.1	38.2	39.1
	Starter	41.8	43.2	40.5	40.1	43.6

Table 3. Effect of rate and placement of fertilizer P on the P content of soybean leaves.

County	Placement	P Applied (lb./acre) 0	10	20	30	40
		% P				
Pierce	Broadcast	.299	.309	.333	.347	.346
	Starter	.332	.327	.335	.346	.334
Knox	Broadcast	.286	.302	.305	.313	.298
	Starter	.310	.297	.303	.305	.309
Dixon	Broadcast	.295	.324	.341	.323	.365
	Starter	.273	.298	.304	.301	.323
Cedar	Broadcast	.334	.339	.338	.352	.350
	Starter	.327	.340	.345	.368	.371

Effect of Various Products in Reducing Chlorosis in Soybeans

Richard A. Wiese

Chlorosis in soybeans is common on high pH soils. Growers avoid growing soybeans in such fields because their experience has been that yield reductions are certain to occur wherever soybeans remain chlorotic for a period of time in excess of 30 days. Farmer interest is in favor of producing soybeans on more acres, some of which are characterized by high soil pH.

Objective:

To evaluate selected products for their ability to reduce chlorosis in soybeans.

Procedure:

This study was conducted in Dodge County in the vicinity of North Bend. Soil properties, listed in table one, is a site where soybeans are certain to be chlorotic in all years. Various products were placed in the row with soybeans (Peterson variety) planted at 1.5 inch spacing in the row. Selection of products were largely experimental and followed a best judgement for potential success in reducing chlorosis. The treatments were arranged in a randomized block design for statistical analysis. Chlorosis ratings were made weekly and grain yield was measured.

Results and Discussion:

Products tested, rates of product applied, soybean yield, and chlorosis rating are given in table 2. The products, with the exception of Fe-HEDDHA, were used at single rates in order to ascertain an ability to reduce chlorosis. Further study adjusting rate of product will be necessary to identify a most suitable rate. In previous research Fe-HEDDHA, at 17 lbs per acre kept soybeans green throughout the growing season. In this experiment rates were reduced to as low as 1.8 lbs per acre, at which a significant yield increase was not obtained.

Soybean yields ranged from 23.1 to 49.6 bushels per acre for the check and the highest treatment respectively. The potential for reducing chlorosis and significantly increasing yields is clear.

There is a relationship between chlorosis rating and yield. A chlorosis rating of one represented a normal green soybean and a chlorosis rating of 4 represented an acute chlorotic condition with necrotic leaves and very stunted plants. There was approximately a 7 bushel decrease with each 0.5 unit increase in chlorosis rating observed each week for six consecutive weeks.

Table 1. Soil Test Characterization of the Field Site

Soil Analyses	Depth of Soil Sample 0-8 inches	8-16 inches	16-24 inches
pH	8.1	8.5	8.6
Excess lime	High	High	Medium
$CaCO_3$ equiv. (%)	1.0	2.7	3.4
Conductivity (mm/cm^3)	.18	.34	.38
Na, exch. (m.e.)	.25	.46	1.36
P (ppm)	16	0.8	0.8
K (ppm)	250	160	199
Organic matter (%)	1.4	---	---

Table 2. Summary of grain yield and chlorosis rating.

Product Tested	Application rate (lbs/A)	Grain Yield (bu/A)	Chlorosis Rating[1/]
Fe-HEDDHA	8.4	49.6	1.47
Fe-HEDDHA	4.2	44.6	1.52
Fe-DPS	20	43.0	1.70
Fe-HEDDHA	17	41.1	1.28
Fe-HEDDHA	1.8	30.2	2.35
Fe-Lignosulfonate	20	28.6	2.60
Acidified-Jarosite	36	28.0	2.58
Check	---	23.1	3.12

$L.S.D._{.05} = 10.0$; C.V. = 15.9%

1/ Average of six observations

RESPONSE OF ALFALFA GROWN ON IRRIGATED SANDY SOIL TO THE APPLICATION OF P AND S

G.W. Rehm

Objective:

Alfalfa is one alternative to the production of continuous corn on the irrigated sandy soils of the Sandhills and bordering areas. Fertilizer requirements for this crop on sandy soils have not been thoroughly researched. This study was conducted for the purpose of measuring the response of alfalfa grown on irrigated sandy soil to the application of fertilizer P and S.

Procedure:

This study is conducted in Pierce County. The study was initiated in 1979 and repeated in 1980. The soil is classified as a Valentine loamy fine sand. Soil properties are listed in Table 1. Rates of P (0, 10, 30, 40, 50, 60 lb. per acre) and S (0, 25, 50, 75, 100, 125, 150 lb. per acre) with treatments selected to fit a central composite factorial design were applied on an annual basis. All plots received 15 lb. N per acre as 33-0-0, 200 lb. K_2O per acre as 0-0-62, and 1½ ton lime per acre before seeding. Except for the lime, these nutrients were applied again in 1980. Four harvests were taken in both 1979 and 1980.

Results and Discussion:

Total yields for the 1980 season are listed in Table 2. In 1980, there was a response to fertilizer P but no response to the application of S. The response to P was curvilinear with maximum yield produced by a P rate of 40 lb. per acre. Based on the P content of the soil, a response to fertilizer P would be expected. The data do not provide an explanation for the lack of a response to fertilizer S. This study will be continued in 1981.

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

Property	Depth (in.) 0-6	6-12	12-24	24-36	36-48	48-60	60-72
pH	6.2	-	-	-	-	-	-
pH(Buffer)	6.9	-	-	-	-	-	-
NO_3-N, ppm	.8	1.1	.7	.8	1.1	1.2	1.1
organic matter, %	.69	.56	.38	.25	.14	.13	.13
SO_4-S, ppm	2.1	4.7	1.8	4.2	1.0	4.5	1.8
P(Bray #1), ppm	6.0	4.0	3.5	4.0	4.5	4.8	4.5
$K(NH_4C_2H_3O_2)$, ppm	89	66	49	42	35	37	38
Zn(HCl), ppm	1.9	-	-	-	-	-	-

Table 2. Response of irrigated alfalfa grown on a sandy soil to the rate of applied P and S, Pierce County, 1980.

S Applied	P Applied (lb./acre) 0	10	20	30	40	50	60	Ave.
lb./acre	- - - - - - - - - - - -			ton dry matter/acre		- - - - - - - - -		
0	3.30	4.18	4.77	5.08	5.11	4.86	4.32	4.52
25	3.25	4.15	4.78	5.12	5.19	4.97	4.47	4.56
50	3.17	4.11	4.77	5.15	5.25	5.07	4.60	4.59
75	3.08	4.05	4.75	5.16	5.29	5.14	4.71	4.60
100	2.97	3.98	4.70	5.15	5.32	5.20	4.81	4.59
125	2.84	3.88	4.64	5.12	5.32	5.24	4.88	4.56
150	2.69	3.76	4.56	5.08	5.31	5.26	4.93	4.51
Ave:	3.04	4.02	4.71	5.12	5.25	5.11	4.67	

EFFECT OF POTASSIUM FERTILIZATION ON PRODUCTION OF ALFALFA GROWN ON AN IRRIGATED SANDY SOIL

G.W. Rehm

Objective:

The potassium levels of some soil samples collected from irrigated fields in the Sandhills and bordering areas are currently considered to be in the medium or low range. Requirements of fertilizer K for alfalfa production on the sandy soils have not been determined. The objective of this study is to measure the effect of fertilizer K on yield, K uptake, and stand persistence of alfalfa grown on an irrigated sandy soil for a period of 5 years.

Procedure:

This study was initiated in Pierce County in 1978. The soil is classified as a Valentine loamy fine sand. Soil properties are listed in Table 1. Four rates of K_2O (0, 80, 160, 320 lb./acre) were broadcast and incorporated before the alfalfa was seeded. Six rates of K_2O (0, 40, 80, 160, 320, 640 lb./acre) were then topdressed to the established stand in the spring of 1979 with a repeat application in the spring of 1980. The K_2O was supplied as 0-0-60. Treatments are arranged to fit a complete factorial design with four replications. All plots received 1.5 ton lime per acre before planting. The yearly fertilizer application includes 15 lb. N/acre as 33-0-0. 120 lb. P_2O_5/acre as 0-46-0 and 100 lb. S/acre as granular gypsum. These fertilizers are applied to all treatments.

Alfalfa was seeded in mid-August of 1978 at a rate of approximately 15 lb. per acre. Four cuttings were harvested in both 1979 and 1980. Whole plant samples are collected from each cutting, analyzed for K and K uptake is then computed.

Results and Discussion:

Total alfalfa production for 1979 and 1980 is summarized in Tables 2 and 3. Rate of applied K_2O (plowdown as well as annual) had no significant effect on total yield. This result is consistent with data collected from individual cuttings collected throughout the year.

The rate of K_2O incorporated before planting had no significant effect on either the K content of the tissue or the amount of K absorbed by the alfalfa (Table 5). In general, K content and uptake was statistically higher only when the annual rate was 640 lb. K_2O/acre.

It should be pointed out that the K content of the alfalfa tissue from all treatments is substantially higher than the value generally considered to be sufficient for alfalfa production. The data gathered in both 1979 and 1980 indicate that the soil is supplying ample K for alfalfa production. This is true even though the ammonium acetate extractable K falls into the medium to low range as defined by current standards.

Table 1. Properties of the soil at the experimental site

Property	0-6	6-12	12-24	24-36	36-48	48-60	60-72
				Depth (in.)			
pH	6.2	-	-	-	-	-	-
NO_3-N, ppm	.9	1.1	.7	.8	1.1	1.2	1.1
P(Bray), ppm	6	4	3.5	4	4.5	4.8	4.5
K($NH_4C_2H_3O_2$), ppm	89	66	49	42	35	37	38
Zn(HCl)	1.9	-	-	-	-	-	-
O.M., %	.69	.56	.38	.25	.14	.13	.13
SO_4-S, ppm	2.1	4.7	1.8	4.2	1.0	4.5	1.7

Table 2. Effect of rate of K_2O incorporated in the soil before planting on yield of irrigated alfalfa.

	Year and Cutting									
	1979					1980				
K_2O Applied	1	2	3	4	TOTAL	1	2	3	4	TOTAL
lb./acre	ton dry matter/acre									
0	1.62a	1.41a	1.35a	.82a	5.21a	1.32a	1.35a	1.39a	1.03a	5.09a
80	1.66a	1.40a	1.35a	.80a	5.20a	1.26a	1.39a	1.34a	1.06a	5.05a
160	1.52a	1.38a	1.38a	.80a	5.12a	1.40a	1.40a	1.32a	1.07a	5.18a
320	1.62a	1.42a	1.35a	.80a	5.19a	1.35a	1.31a	1.36a	1.10a	5.13a
C (%)	19.90	9.74	8.40	5.75	7.71	20.0a	10.23	9.48	13.33	9.89

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

Table 3. Effect of annual rate of K_2O on yield of irrigated alfalfa.

	Year and Cutting									
	1979					1980				
K_2O Applied	1	2	3	4	TOTAL	1	2	3	4	TOTAL
lb./acre	ton dry matter/acre									
0	1.38a*	1.36a	1.37a	.78a	4.89a	1.34a	1.33a	1.33a	1.03a	5.02a
40	1.67a	1.43a	1.37a	.80a	5.27a	1.40a	1.38a	1.35a	1.08a	5.21a
80	1.56a	1.39a	1.38a	.81a	5.14a	1.28a	1.32a	1.32a	1.01a	4.92a
160	1.61a	1.39a	1.32a	.81a	5.13a	1.34a	1.43a	1.35a	1.06a	5.22a
320	1.66a	1.40a	1.31a	.82a	5.19a	1.27a	1.35a	1.36a	1.08a	5.06a
640	1.75a	1.43a	1.39a	.81a	5.44a	1.34a	1.38a	1.40a	1.12a	5.23a

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

Table 4. Effect of rate of K_2O incorporated in the soil before planting on the K content of alfalfa and K uptake by alfalfa (1979).

	K Content				K Uptake				
K_2O Applied	1	2	3	4	1	2	3	4	TOTAL
lb./acre	- - - - - - - - - % - - - - - -				- - - - - - - - lb./acre - - - - - - - - -				
0	3.74a	3.38a	3.43a	3.49a	122.0a	94.8a	93.0a	57.3a	367.0a
80	3.89a	3.33a	3.46a	3.52a	128.9a	92.1a	92.9a	56.4a	370.3a
160	3.79a	3.30a	3.45a	3.51a	114.6a	91.0a	95.1a	56.2a	356.9a
320	3.83a	3.29a	3.44a	3.48a	124.9a	92.7a	93.0a	55.7a	366.2a

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

Table 5. Effect of annual rate of K_2O on K content of alfalfa and K uptake by alfalfa (1979).

	K Content				K Uptake				
K_2O Applied	1	2	3	4	1	2	3	4	TOTAL
lb./acre	- - - - - - - - % - - - - - - - -				- - - - - - lb./acre - - - - - - - - - -				
0	3.57a*	3.07a	3.20a	3.29a	99.0a	83.5a	88.0a	51.0a	321.4a
40	3.74ab	3.20a	3.22a	3.35a	124.4b	91.0a	88.2a	53.9ab	357.5b
80	3.87b	3.23ab	3.34ab	3.43ab	121.0b	89.8a	91.7ab	55.4bc	358.0b
160	3.78b	3.30ab	3.47b	3.55b	122.1b	90.5a	91.9ab	57.7bc	362.2b
320	3.83b	3.49bc	3.66b	3.57b	126.9bc	97.3bc	95.8b	58.6cd	378.7b
640	4.07c	3.65c	3.78c	3.80c	142.1c	103.7c	105.3c	61.7d	412.9c
CV(%):	7.85	10.85	6.58	7.45	21.22	12.42	10.48	10.18	9.81

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

COMPARISON OF LABORATORY SOIL TEST RECOMMENDATIONS FOR CORN

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

Objectives:

1. Evaluate soil testing recommendations given by soil testing laboratories to Nebraska farmers for corn grown on major soils of the state.
2. Determine if recommendations being given by the UNL soil testing laboratory are adequate for producing most economic crop yields.

Procedure:

This investigation was initiated at the Mead Field Lab in 1973 and on the Northeast, North Platte and South Central stations in 1974 and has continued from those dates with corn as the test crop on the first three stations. The experimental area was planted to soybeans on the South Central Station in 1980 without further treatment for studying residual effects. All locations except the Northeast station were irrigated.

In the first year of the study a representative soil sample of each experimental area was collected, mixed and divided into five samples, one of which being sent to each of the laboratories doing most of the soil testing business in Nebraska. In subsequent years the replicated plot areas assigned to each lab in the first year were sampled separately and resubmitted to that lab for the next crop's recommendation with reasonable yield goal specified. No lab including that of UNL was aware that this was other than a farmer's sample until after recommendations had been made to reflect the normal service provided any grower who might request a suggested fertilizer program.

All suggested nutrients were applied broadcast and incorporated prior to planting. Grain yields were measured and the cost for the recommended nutrients calculated on the basis of average fertilizer costs throughout the state.

Results and Discussion:

Data are presented in tables 1, 2, 3 and 4 summarizing fertilizer recommendations by the five laboratories in 1980 along with grain yields for each year of the study and costs for the fertilizers applied.

Wide variation exists in the kinds, amounts and costs for nutrients on the plots committed to the five labs involved but no difference in positive yield effects (one commercial lab with highest fertilizer recommendations has had significantly lower yield response at the South Central Station than other labs.

Nitrogen efficiencies as measured by grain N harvest have ranged from 50% to 65% at Mead, representing a large potential for ground water pollution with the lower utilization. The very high soil P levels being developed from some of the recommendations likewise can have surface water pollution potentials. Otherwise the substantial number of other nutrients being recommended, many of which never having been found limiting in Nebraska, has both economic and unnecessary resource depletion implications. It is apparent from these investigations that farmers interests are not being served by soil testing in many cases, further that the 'cation balance' and 'maintenance' concepts for fertilizer recommendations are not economically or agronomically sound.

Table 1. Fertilizer recommendations from five soil testing laboratories for corn production at the Mead Field Laboratory in 1980 along with grain yields and fertilizer costs for the period 1973-80 (yield objective, 170 bu/a).

Nutrient	Laboratory A	B	C	D	E (UNL)	
	-----	-----	lb/acre	-----	-----	
Nitrogen	225	230	220	185	200	
Phosphorus (P_2O_5)	75	65	100	83	40	
Potassium (K_2O)	30	95	70	--	--	
Magnesium (Mg))	--	--	--	--	--	
Sulfur	10	20	100	25	--	
Zinc	--	--	3	--	--	
Iron	--	--	--	--	--	
Manganese	--	2	--	--	--	
Copper	--	½	½	--	--	
Boron	1	--	½	--	--	
Lime	--	--	--	--	--	
	Grain Yields, bu/a, 1973-80					Check Yield
1973	152	148	153	148	160	32
1974	139	131	131	137	133	33
1975	162	157	153	160	158	49
1976	143	143	129	143	137	77
1977	148	142	136	142	145	72
1978	178	168	183	170	179	108
1979	200	187	191	197	186	79
1980	129	126	122	118	136	52
Total 8-year yield	1251a 1/	1202a	1198a	1215a	1234a	
	Fertilizer Costs, $/a, 1973-80					
1973	$91.80	$70.65	$78.40	$56.90	$37.30	
1974	91.80	70.65	78.40	56.90	37.30	
1975	93.80	73.90	85.65	45.60	43.40	
1976	49.95	31.75	60.85	34.80	31.60	
1977	36.70	51.03	67.85	50.50	22.80	
1978	38.60	34.74	50.58	30.72	19.05	
1979	51.16	50.75	77.65	48.60	42.70	
1980	71.10	82.65	115.85	67.36	48.80	
Total 8-year cost	$524.91	$466.12	$615.23	$398.38	$282.95	

1/ Yields followed by the same letter are not significantly different at the 5% level of probability.

Table 2. Fertilizer recommendations from five soil testing laboratories for corn production at the Northeast Station in 1980 along with grain yields and fertilizer costs for the period 1974-80 (yield objective, 90 bu/a).

Nutrient	Laboratory A	B	C	D	E (UNL)
	Nutrients recommended in 1980, lbs/a				
Nitrogen	70	100	80	110	90
Phosphorus (P_2O_5)	45	20	30	68	--
Potassium (K_2O)	30	10	40	0	--
Magnesium (MgO)	--	--	--	--	--
Sulfur	--	10	50	15	--
Zinc	--	--	3	--	--
Iron	--	--	--	--	--
Manganese	--	--	--	--	--
Copper	--	½	--	½	--
Boron	--	--	½	--	--
Lime	--	--	--	--	--
	Grain Yields, bu/a, 1974-80				
1974	No yield because of drouth				
1975	59	60	56	52	59
1976	9	11	14	10	15
1977	144	145	149	144	142
1978	120	113	117	123	124
1979	151	148	148	147	145
1980	98	99	104	98	100
Total 8-year yield	581a[1/]	576a	588a	574a	585a
	Fertilizer costs, $/a, 1974-80				
1974	$37.95	$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	12.14	13.37	33.70	14.40
1979	27.18	24.60	17.20	27.43	12.00
1980	30.60	29.85	48.40	47.36	16.20
Total 8-year cost	$176.03	$162.49	$211.37	$193.32	$ 83.50

1/ Yields followed by the same letter are not significantly different at the 5% level of probability.

Table 3. Fertilizer recommendations from five soil testing laboratories for corn production at the North Platte Station in 1980 along with grain yields and fertilizer costs for the period 1974-80 (yield objective, 170 bu/a).

Nutrient	Laboratory A	B	C	D	E (UNL)	Check yield
	Nutrients recommended, lbs/a					
Nitrogen	156	210	240	190	180	
Phosphorus (P_2O_5)	75	20	--	87	--	
Potassium (K_2O)	30	--	--	--	--	
Magnesium (MgO)	15	--	--	--	--	
Sulfur	18	--	70	--	--	
Zinc	--	--	3	--	--	
Iron	--	--	--	--	--	
Manganese	--	--	--	--	--	
Copper	--	--	--	--	--	
Boron	1.2	--	½	--	--	
	Grain yields, bu/a, 1974-80					
1974	167	168	155	155	159	134
1975	216	208	210	217	222	122
1976	128	130	133	128	132	34
1977	173	180	177	176	172	121
1978	160	156	149	160	157	63
1979	158	167	163	155	154	106
1980	177	171	175	172	171	120
Total 8-year yield	1179a[1/]	1180a	1162a	1163a	1167a	
	Fertilizer costs, $/a, 1974-80					
1974	$53.70	$67.69	$81.65	$39.30	$28.90	
1975	81.00	46.80	75.45	45.60	34.20	
1976	60.32	61.67	74.50	38.86	29.00	
1977	22.20	51.55	50.45	21.60	21.60	
1978	44.36	49.46	54.60	30.37	17.21	
1979	31.07	50.85	74.35	51.96	18.00	
1980	67.53	44.20	68.80	62.04	32.40	
Total 8-year cost	$360.18	$372.22	$480.50	$289.73	$181.31	

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

Table 4. Fertilizer recommendations from five soil testing laboratories for corn production at the South Central Station in 1980 along with grain yields and fertilizer costs for the period 1974-80 (corn yield objective 170 bu/a, 1974-75; 200 bu/a 1976-79. Soybeans grown in 1980 without added fertilizer treatments).

Fertilizers re. grain yields costs	Laboratory A	B	C	D	E (UNL)	Check Yields
	Nutrients recommended, lbs/a					
Nitrogen						
Phosphorus (P_2O_5)						
Potassium (K_2O)						
Magnesium (MgO)	Residual year for soybean production. No fertilizers applied in 1980, only long term costs for lime assigned					
Sulfur						
Zinc						
Iron						
Manganese						
Copper						
Boron						
Lime						
	Grain yields, bu/a, 1974-80					
1974 Corn	186	189	187	189	184	134
1975 "	203	206	196	201	194	120
1976 "	188	186	186	196	199	118
1977 "	154	155	156	154	166	93
1978 "	197	203	189	199	199	132
1979 "	181	179	183	194	193	99
1980 Soybeans	49.5	50.5	50.2	50.1	48.8	49
Total corn yield	1109a[1/]	1118a	1097b	1133a	1135a	
	Fertilizer costs, $/a, 1974-80					
1974	$81.65	$71.99	$79.20	$46.40	$37.65	
1975	96.12	70.55	93.50	43.40	55.20	
1976	71.19	45.41	65.74	26.36	36.30	
1977	47.44	62.57	71.89	50.76	8.70	
1978	60.20	53.19	46.89	23.88	24.36	
1979	27.54	30.21	15.44	52.37	18.90	
1980	2.34	1.56	3.44	1.56	3.90	
Total 7-year cost	$386.98	$335.42	$376.10	$244.73	$185.01	

1/ Yields followed by the same letter are not significantly different at the 5% level of probability.

BUILDUP/DECLINE IN SOIL P AND K

G. Rehm and R. A. Olson

Objectives:

1. Determine level of soil P and K required for assuring most economic yields.
2. Establish rates of applied P and K required for maintaining satisfactory soil test levels for optimum yields on representative Nebraska soils.

Procedure:

This experiment is conducted with irrigated corn on Sharpsburg sicl at the Mead Field Lab, with non-irrigated corn on Moody-Nora soil at the Northeast Station, and with non-irrigated wheat on Keith sil and Rosebud Fsl at the High Plains Ag Lab. The various rates of applied P and K are broadcast before final tillage prior to planting except for the one row treatment at Mead. This having been the fallow year for wheat at the High Plains Lab there are no yields reported for that site.

Results and Discussion:

The irrigated corn on Sharpsburg sicl (slightly acid subsoil of high P level) in its 8th year reveals a small but economic response up to 20 lbs applied P/acre. Check yields have held steady at around 165 bu/a with some decline in soil test P level in the surface soil finally becoming apparent in the 7th and 8th years. Annual applications of 20 lbs P have essentially tripled soil P test levels compared with the control (Table 1). It seems apparent at this stage that a rate between 10 and 20 lbs P/a will afford most economic return while at the same time modestly increasing soil test P level.

Quite similar results have been measured with non-irrigated corn production on Moody-Nora sil in Northeast Nebraska (calcareous subsoil) except that somewhat higher application rates are required for increasing soil P test levels (Table 2). Neither location has given evidence of response to applied K, nor have the years of cropping or the rates applied affected the soil test K level on the Sharpsburg soil. There does appear to have been some decline in soil test K on the Moody-Nora soil (although still remaining at a high level) which was compensated by the annual 50 lbs K treatment.

These experiments along with others on wheat in dryland farming indicate that applying P according to established soil test calibration data rather than employing the 'maintenance' concept will achieve most economic production without depleting soil P levels excessively.

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, 1973-80.

No.	Treatment[1] P	K	Application Schedule	Grain yield 1980	8 yr. ave.	Soil test P[2] (Surface) 1973	1975	1977	1978	1979	1980	Soil test K[2] (Surface) 1973	1975	1977	1978	1979	1980
				bu/a		- - - - - - - - ppm P - - - - - - - -						- - - - - - - ppm K - - - - - - - - -					
1	0	0	Control	163	165	15	12	14	14	7	6 d	320	350	320	355	333	361
2	10	0	Every year@	151	165	15	15	18	23	11	12 cd	311	301	347	330	337	341
3	20	0	Every year@	168	171	16	16	24	33	14	20 b	310	323	337	353	349	330
4	30	0	Every year@	166	172	19	27	34	40	17	29 a	300	286	334	326	318	329
5	20	0	Every other year@	167	164	16	20	30	19	14	9 d	300	321	391	328	326	331
6	30	0	Every 3rd year	162	167	25	12	21	17	11	12 cd	288	297	360	313	291	309
7	60	0	Every other year@	159	165	22	41	51	30	19	27 a	283	307	402	317	302	309
8	60	0	Every 6th year	160	162	30	14	19	15	19	19 b	288	285	377	306	299	315
9	20	25	Every year@	166	171	16	16	30	30	14	18 bc	296	316	389	345	319	329
10	20	50	Every year@	167	163	14	20	24	27	13	18 bc	296	304	326	340	327	352
11	10	25	Every year-row@	160	160	11	14	18	22	11	10 d	268	285	420	341	338	330

[1] Uniform N application made to all plots for optimum yield (200 lbs N/a in 1980); P and K treatments broadcast before final tillage (except for indicated row application); grain yield on 15.5% moisture basis. An @ indicates application in 1980. Means followed by the same letter are not different (p = 0.05) based on Duncan's Multiple Range Test.

[2] Soil P by Bray and Kurtz No. 1 extraction; soil K is exchangeable from NH_4OAc 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, 1973-80. Data reported by George Rehm.

No.	Treatment[1] P	Treatment[1] K	Application Schedule	Grain yield[2] 1980	Grain yield[2] 7 yr. ave.	Soil test P[3] (Surface) 1973	1975	1977	1978	1980	Soil test K[3] (Surface) 1973	1975	1977	1978	1980
1	0	0	Control	79 b	108	10	10	9	6	8 c	223	185	195	192	169 b
2	10	0	Every year@	86 ab	117	9	11	13	10	9 bc	220	179	179	197	157 b
3	20	0	Every year@	89 ab	120	12	12	16	14	11 bc	228	177	187	200	164 b
4	30	0	Every year@	86 ab	118	22	20	27	20	17 a	234	175	108	211	164 b
5	20	0	Every other year@	85 ab	112	9	11	12	7	8 bc	218	179	196	200	181 ab
6	30	0	Every 3rd year	86 ab	114	17	9	12	8	8 c	224	178	190	205	166 b
7	60	0	Every other year@	93 a	118	11	13	22	25	17 a	213	173	202	197	155 b
8	60	0	Every 6th year	90 ab	115	11	12	11	10	9 bc	202	166	189	208	175 b
9	20	25	Every year@	88 ab	117	10	12	16	12	13 abc	220	181	204	203	170 b
10	20	50	Every year@	85 ab	113	11	14	19	13	14 ab	238	210	218	228	214 a

1 Uniform N application made to all plots for optimum yield (80 lbs N/A in 1980); P and K treatments broadcast before final tillage; grain yield on 15.5% moisture basis. An @ indicates application in 1980. Means followed by the same letter are not different (p= 0.05) based on Duncan's Multiple Range Test.

2 No yield in 1974 due to drouth.

3 Soil P by Bray and Kurtz No. 1 extraction; soil K is exchangeable K from NH_4Ac extraction. Soil samples were not obtained in 1979.

PHYSICS OF WATER IN SOILS AND POROUS MEDIA

D. Swartzendruber

Objective:

The general objective of this project is to analyze and quantify the processes by which water flows into and through porous media and soils under both saturated and unsaturated conditions. Swelling and nonswelling soils will be considered, under both flooded and unflooded modes of water application.

Procedure:

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

Results and Discussion:

The theory of Green and Ampt for water infiltration into porous material was investigated experimentally. Quartz sand, of particle size in the narrow range 0.15 to 0.21 mm, was used for the theoretical requirement of a rectangularly abrupt rise of water content versus time at given depth in the sand. Water contents at highly localized positions in the sand were measured nondestructively with gamma-ray attenuation. For vertically downward infiltration, the Green-and-Ampt expectations were fulfilled very well, with respect to both rectangular abruptness and cumulative water infiltration versus time. For vertical capillary rise of water in the same sand, however, rectangular abruptness occurred only at beginning times, and the time course of cumulative water infiltration did not fulfill Green-and-Ampt expectations even at the small times of rectangular abruptness. This unexpected finding is being followed up to assess the limitations in Green-and-Ampt theory as currently employed to characterize water infiltration in a practical and field sense.

Improvement in the dual-energy gamma-ray method, for measuring soil bulk density and water content in laboratory columns, has also been achieved. A modified equation was employed for making resolving-time corrections of the gamma-ray count intensities, as based on the count intensity of the low-energy Am-241 plus that of the higher energy Cs-137. The need for two resolving-time constants, one for each energy range, was accounted for by introducing a so-called wide-beam build-up term into the basic gamma-ray attenuation equation. The use of water and/or optically flat glass as absorbers in the dual-energy beam was found to be convenient and accurate for calibration purposes.

FERTILIZER MANAGEMENT FOR FORAGES ESTABLISHED WITH REDUCED TILLAGE TECHNIQUES

G.W. Rehm

Objective:

Pastures continue to be the most abused crop in northeast Nebraska. Fertilization, weed control, and rotational grazing may improve production from many of these acres. 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 developments 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 a limited amount of tillage. The objective of this study is to evaluate the effect of the applciation of fertilizer to grasses and/or legumes seeded with reduced tillage techniques.

Procedure:

This study is conducted in Knox and Dixon Counties. The soil at the Knox County site is a Nora silt loam while the soil at the Dixon County site is a Crofton silt loam. The study in Knox County was initiated in late August of 1976. Glyphosate at a rate of 2 lb. a.i./acre was sprayed on existing vegetation approximately two weeks before seeding. Mixtures of smooth bromegrass plus cicer milkvetch and intermediate wheatgrass plus cicer milkvetch were seeded with the John Deere Powr-Till drill. Rates of N (0, 40, 80, 120 lb./acre) and P (0, 20, 40 lb./acre) were broadcast to the established stand in mid-April of 1978, 1979, and 1980. Yields were measured in mid-June.

Research in Dixon County was initiated in the fall of 1977. Two methods of seedbed preparation were compared at this site. One method involved preparation of a conventional seedbed by the use of a power tiller followed by seeding with a John Deere Grassland Drill. In the second method, glyphosate was used to kill the exisitng vegetation and grasses were seeded with the John Deere Powr-Till Drill. Intermediate wheatgrass was seeded in the fall of of 1977. Switchgrass was seeded in the spring of 1978. Various rates of N (0, 40, 80, 120 lb./acre) and P (0, 20, 40 lb./acre) were broadcast to the established intermediate wheatgrass in mid-April of 1979. The same combinations of N and P were broadcast to the established switchgrass in late May of the same year.

Results and Discussion:

Total production for the 1978-1980 period from the grass/legume seeding trial is summarized in Table 1. Total production from the intermediate wheatgrass and cicer milkvetch mixture was increased by applied N. Application of fertilizer P had no effect on the yield of this mixture and there was no significant N x P interaction. Production from the smooth bromegrass + cicer milkvetch was increased by the use of both N and P, but there was no significant N x P interaction.

Table 1. Effect of rate of N and P on total production (1978-1980) of grass-legume mixtures seeded with reduced tillage techniques. Knox Co.

P Applied (lb./acre)	N Applied (lb./acre) 0	40	80	120
	- - - - - - - - - - ton dry matter/acre - - - -			
intermediate wheatgrass + cicer milkvetch				
0	4.29	5.36	5.03	6.69
40	5.81	4.99	6.41	6.17
80	4.48	5.01	6.02	6.52
smooth bromegrass + cicer milkvetch				
0	2.88	3.97	3.91	5.06
40	3.70	4.78	5.39	5.31
80	3.27	4.69	5.73	5.27

Considering all treatments, the yield from the intermediate wheatgrass + cicer milkvetch mixture was significantly greater than the yield from the mixture of smooth bromegrass + cicer milkvetch.

After three years of repeated fertilization, the cicer milkvetch comprises nearly 90% of the total forage where it was seeded with the intermediate wheatgrass. When seeded with smooth bromegrass, the cicer milkvetch accounts for about 50% of the total forage. The dominance of the cicer milkvetch over the intermediate wheatgrass is evident at all rates of N applied. It is somewhat surprising that intermediate wheatgrass fertilized with 120 lb. N/acre would be dominated by a legume, but apparently this grass will not withstand the type of competition provided by the cicer milkvetch.

Total production for 1979 plus 1980 from the Dixon County site is summarized in Tables 2 and 3. Both switchgrass and intermediate wheatgrass responded to the use of fertilizer N and P and there was a highly significant N x P interaction in all cases. The method of seedbeed preparation did not influence the nature of the response to fertilizer N and P.

Although there were some exceptions, the response to N was linear with 120 lb. N/acre producing maximum yield for both grass species. The response to P was largely curvilinear with the use of 20 lb. P/acre producing maximum yield in the majority of the cases over the two-year period.

When yields from all fertilizer treatments are combined, the effect of method of seedbed preparation varied with grass species. Total production for the 1979 and 1980 growing seasons was higher when intermediate wheatgrass was seeded into the seedbed prepared with conventional techniques (Tables 2 and 3). The yield of switchgrass, on the other hand, was greater when seeded with reduced tillage techniques. At the present time, the data do not provide an explanation for this difference in method of seedbed preparation.

Table 2. Effect of rate of fertilizer N and P as well as method of seedbed preparation on total forage production of intermediate wheatgrass in 1979 and 1980.

P Applied (lb./acre)	N Applied (lb./acre) 0	40	80	100
	- - - - - - - - - ton dry matter/acre - - - -			
reduced tillage seedbed:				
0	.31	1.09	1.18	1.53
20	.32	1.55	3.18	3.11
40	.38	2.04	2.78	3.88
conventional tillage seedbed:				
0	.56	2.06	1.41	2.25
20	.76	2.28	3.55	4.04
40	.89	2.85	3.94	5.07

Table 3. Effect of rate of fertilizer N and P as well as method of seedbed preparation on total forage production of switchgrass in 1979 and 1980.

P Applied (lb./acre)	N Applied (lb./acre) 0	40	80	100
	- - - - - - - - ton dry matter/acre - - -			
reduced tillage seedbed:				
0	3.17	2.25	2.79	2.62
20	2.41	4.34	5.52	5.63
40	2.67	4.03	5.32	5.68
conventional tillage seedbed:				
0	3.60	4.34	4.79	4.35
20	3.98	5.12	6.44	7.91
40	3.21	5.58	7.14	8.35

APPLICATION OF FERTILIZER WITH TILLAGE EQUIPMENT USED IN ROW CROP PRODUCTION

G.W. Rehm

Objective:

For the most part, fertilizer nutrients, other than nitrogen, needed for production of row crops can be either broadcast and incorporated or applied in a band below seed level at planting (starter). The current practice of broadcasting fertilizer requires an extra trip over the field and this increases production costs. Yet, many farmers are reluctant to use starter fertilizer.

Although minimum tillage or reduced tillage is widely discussed, it seems apparent that the majority of the farmers will continue to use one major tillage implement for row crop production. If fertilizer could be effectively applied with these tillage implements, this practice could result in a savings for the farmer. The purpose of this study is to evaluate the effectiveness of phosphate fertilizer applied with two major tillage implements.

Procedure:

This study was initiated in Dixon County in 1980. The soil is classified as a Nora silt loam and the properties are listed in Table 1. Treatments were selected so that various placements of fertilizer P could be evaluated. The treatments are listed in the following tables. The rate of N was 80 lb./acre in all treatments. Except for the chisel check and disk check treatments, the P rate was 18 lb./acre. In treatments where starter placement was combined with broadcast, chisel or disk placement, one-half of the P was applied in the starter.

Placement of fertilizer P varied with the method of application. The broadcast P was incorporated with a disk. With the chisel, fertilizer P was applied in bands on 12 in. centers at a depth of 8-10 in. When applied with a disk, the fertilizer P was placed in bands 12 in. apart at a depth of 4-6 in. The starter P was placed below and to the side of the seed at planting.

Whole plant samples were collected one month after planting. The most recently matured leaf was sampled in early July. The ear leaf was collected at silking. All plant samples were dried, ground and analyzed for P. Yields were measured in October.

Results and Discussion:

Application of fertilizer P increased the weight of young corn plants (Table 2). Plant weights were lowest when no phosphate was applied while highest plant weights resulted from the use of fertilizer P in a starter. The effect of fertilizer placement on the weight of young corn plants was not reflected in yield. The lack of significant treatment effects in yield can be attributed, in part, to the large amount of variability in the data (CV = 21.2%). Although effort was made to keep error low, yields were curtailed by dry weather and dry weather always appears to increase variability in yields.

The P content and subsequent P uptake by young plants was influenced by placement of fertilizer P (Table 3). The placement of fertilizer P in the row at planting (starter) produced the highest P content. As would be expected, P content in the plant was lowest when no fertilizer P was applied. Phosphorus concentrations resulting from other placements were intermediate.

The placement of fertilizer P had no significant effect of the P concentration in the leaf tissue of the more mature corn.

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

Property	Depth (in.) 0-6	6-12	12-24	24-36	36-48	48-60	60-72
texture	silt loam	-	-	-	-	-	-
pH	6.5	-	-	-	-	-	-
O.M., %	3.0	-	-	-	-	-	-
$K(NH_4C_2H_3O_2)$, ppm	291	-	-	-	-	-	-
NO_3-N, lb./acre	3.4	7.0	6.4	6.4	6.4	7.2	8.4
P(Bray), ppm	8.6	3.5	3.7	4.7	2.0	1.5	3.1

Table 2. Effect of placement of fertilizer P on growth of young plants and grain yield.

Placement	Plant Weight	Yield
	g/plant	bu./acre
disk control (no phosphate)	1.66 bc*	69.0 a
chisel control (no phosphate)	1.18 d	69.4 a
starter only	2.30 a	64.7 a
all phosphate with disk	2.08 a	78.4 a
phosphate with disk + starter	2.29 a	70.7 a
all phosphate with chisel	1.54 cd	73.1 a
phosphate with chisel + starter	1.80 bc	88.8 a
all phosphate broadcast	2.05 ab	79.1 a
broadcast phosphate + starter	2.09 ab	74.3 a
CV: %	13.9	21.2

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

Table 3. Effect of placement of fertilizer P on P uptake by young corn and the P content of corn tissue during the growing season.

	Growth Stage			
Placement	Whole Plant P Content	Whole Plant P Uptake	Recently Matured Leaf P Content	Ear Leaf P Content
	%	mg/plant	%	%
disk control (no phosphate)	.36 cd*	6.0 cde	.200 a	.186 a
chisel control (no phosphate)	.35 d	4.1 e	.216 a	.183 a
starter only	.42 a	9.6 a	.226 a	-
all phosphate with disk	.38 bc	8.0 ab	.225 a	.183 a
phosphate with disk + starter	.39 ab	9.0 ab	.240 a	.202 a
all phosphate with chisel	.36 cd	5.5 de	.222 a	.193 a
phosphate with chisel + starter	.38 bc	7.0 bcd	.222 a	.193 a
all phosphate broadcast	.38 bc	7.9 abc	.204 a	.186 a
broadcast phosphate + starter	.38 bc	7.9 abc	.225 a	.185 a
CV: %	5.1	16.9	10.1	7.9

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

GROUNDWATER N AND FERTILIZER MANAGEMENT

J. S. Schepers (USDA-SEA-AR)

Research conducted as part of the Hall County Water Quality Special Project (HCWQSP) involves multidisciplinary personnel. The immediate problem is summarized by a 1980 survey of 144 pumping irrigation wells in the Platte River Valley. Nitrate-nitrogen (NO_3-N) concentrations in the water ranged from 1.2 to 31.0 ppm and averaged 12.9 ppm with 74% of the samples containing over 10 ppm NO_3-N. Those wells with low NO_3-N concentrations are known to be pumping from a deep well aquifer relatively low in NO_3-N. Two separate aspects of the project are reported hereafter.

Re-use Pit Study:

Grand Island Pit

During July and August, one irrigation re-use pit dug into the sand aquifer was studied to determine the quality of water entering and being taken from the pit. Water typically entered the pit on 24 hour intervals and was pumped out over a 4 hour period at varying intervals. Usually, inflow was sufficient to fill the pit in one or two days, but re-use may not be until 2-3 days after the pit was full to capacity. During this time the water that would normally enter the pit ran down a drainage ditch on the adjacent property. Three times during the study the inflow-recycling modes were such that we could determine changes in water depth within the pond due to seepage and evaporation. In each case at least an eight hour period of data was used. The decline in water level ranged from 9-12 mm per day, of which 6-7 mm could be attributed to evaporation, leaving 2-6 mm per day as seepage into the aquifer.

Chemical quality of water entering the above re-use pit was monitored over three intervals during the irrigation season. These samples were collected at 30 minute intervals and found to contain 17.0 $\pm$ 3.7, 14.9 $\pm$ 0.9 and 17.2 $\pm$ 2.7 mg/l NO_3-N on July 24, August 1 and August 8 respectively. The average NH_4-N concentration over these periods was 0.19 mg/l.

One set of 13 water samples collected at 10 minute intervals while the pit was being pumped on August 8, 1980 had average NO_3^- and NH_4-N concentrations of 15.4 $\pm$ 4.5 and 0.2 $\pm$ .3, respectively. Although the average NO_3-N concentration of water entering the pit (17.2 mg/l) was higher than that being pumped from the pit (15.4 mg/l), the two values were not significantly different.

Shelton Pit

Runoff water entering a re-use pit having a silty clay loam bottom near Shelton, Nebraska, was sampled several times during the irrigation season. Water flowing into the pit due to irrigation contained 2.9 $\pm$ 0.6

mg/l NO_3-N and 0.01 ± 0.02 mg/l NH_4-N. These levels are similar to that found in the water being pumped from the deep wells. Runoff from the field due to rainfall on August 9 & 10, 1980 contained 1.5 ± 0.2 and 0.02 ± 0.08 mg/l NO_3-N and NH_4-N, respectively. The NO_3-N concentration in runoff from rainfall was lower than that from irrigation, but the rainfall for this event only contained 0.54 ± 0.16 and 0.71 ± 0.53 mg/l NO_3^- and NH_4-N, respectively. This indicates that as the rainfall flowed off the field it picked up NO_3-N and lost NH_4-N. This NH_4-N, being positive in charge, was probably adsorbed by the soil/organic matter complex. Rainfall occuring on August 15, 1980 contained 0.33 ± 0.15 and 0.97 ± .38 mg/l of NO_3^- and NH_4 -N respectively. The runoff from this event had NO_3^- and NH_4-N concentrations of 0.77 ± and 0.42 ± 0.19 mg/l respectively. Once again NO_3^- from the soil was picked up by the water and NH_4^+ was scrubbed from the runoff, but the extent of each was less than from the previous rainfall runoff event only 5 days before. The greater amount of antecedent soil water at the time of the second rainfall probably reduced the potential for NO_3^- accumulation in the runoff and NH_4^+ scrubbing from the rainfall.

Residual Soil Nitrogen and Fertilization:

As part of the farmer survey conducted by the Economics Service (ES) of USDA, producers within the Hall County Water Quality Special Project were asked how much N fertilizer they applied during 1979 and the corresponding corn yield. The distribution of data points (Fig 1) indicates there was no apparent correlation between yield and fertilizer N applied. Based on the actual yields obtained idealized fertilizer recommendations were made according to the University of Nebraska (UN-L) Soil Test Laboratory procedures. These recommendations were compared with the actual fertilizer applied (Fig 2) again with no correlation, however, those points below the 1:1 line indicate producers who applied N fertilizer in excess of that needed for the realized yield. The UN-L fertilizer recommendations did not include considerations for residual nitrate nitrogen (NO_3-N) in the soil in the spring of the year, N in the water, or N mineralization from the breakdown of organic matter and plant residues. As each of these N sources is considered, the N recommendations would be reduced, or in effect move the 1:1 line upward suggesting that more producers applied fertilizer N in excess of that required for the yield obtained.

The adjustment of fertilizer recommendations for residual NO_3-N varies between fields and is dependent on soil type and previous cropping history. During 1980, 67 different fields were part of the fertilizer N management program within the 65 square mile special ASCS project area. A total of 304 soil cores to a depth of 4 foot were taken in the spring prior to fertilization from the 67 fields. Average residual NO_3-N from the 67 fields ranged from 13 to 240 lb N/Acre with 50% of the fields having more than 75 lb N/Acre (Fig 3).

The influence of soil type on residual NO_3-N is shown in figure 4. Much of variability within a soil type is probably due to previous cropping history and mineralization of organic matter in the surface soil. In general, the coarse textured soils (soil texture in parenthesis on Fig 4, sand = s, silt = si, loam = l, fine = f) contained the lowest amounts of residual NO_3-N while the finer textured soils having an argillic horizon (increased clay content at 12-30 inches) had the highest amounts of residual NO_3-N. These finer textured soils typically have the lowest potential for water percolation and the greatest amount of organic matter which can mineralize to produce NO_3-N. The amount of N mineralization is being evaluated so it can be incorporated into the fertilizer N recommendations. Nitrogen mineralization is affected by many factors and therefore assigning a value to the process is difficult. Preliminary data obtained by deep coring in the spring and fall indicate over 280 lb N/Acre were mineralized by a Wood River silt loam during the 1980 growing season.

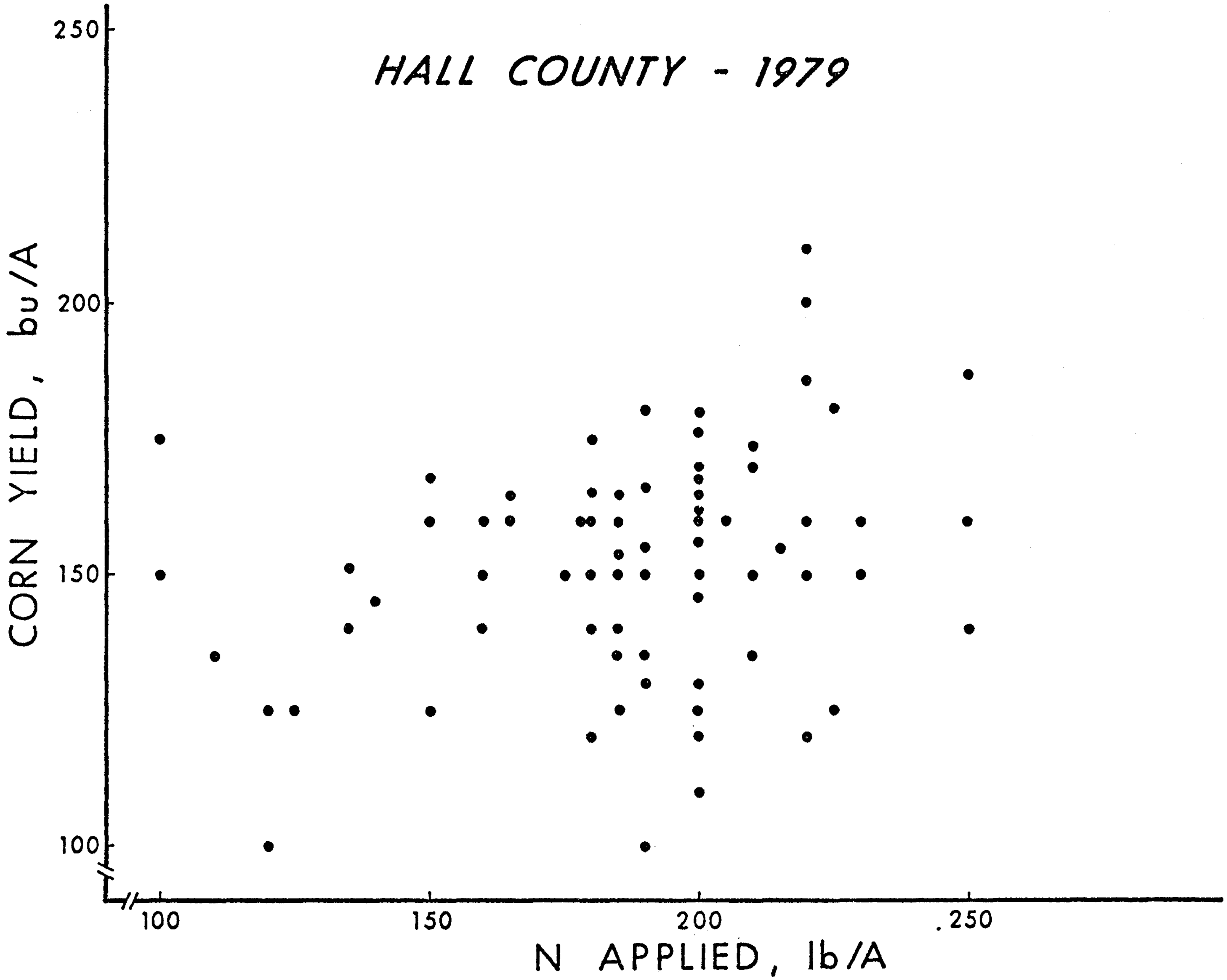
HALL COUNTY - 1979
CORN YIELD, bu/A
250
200
150
100
N APPLIED, lb/A
100
150
200
.250

Figure 1

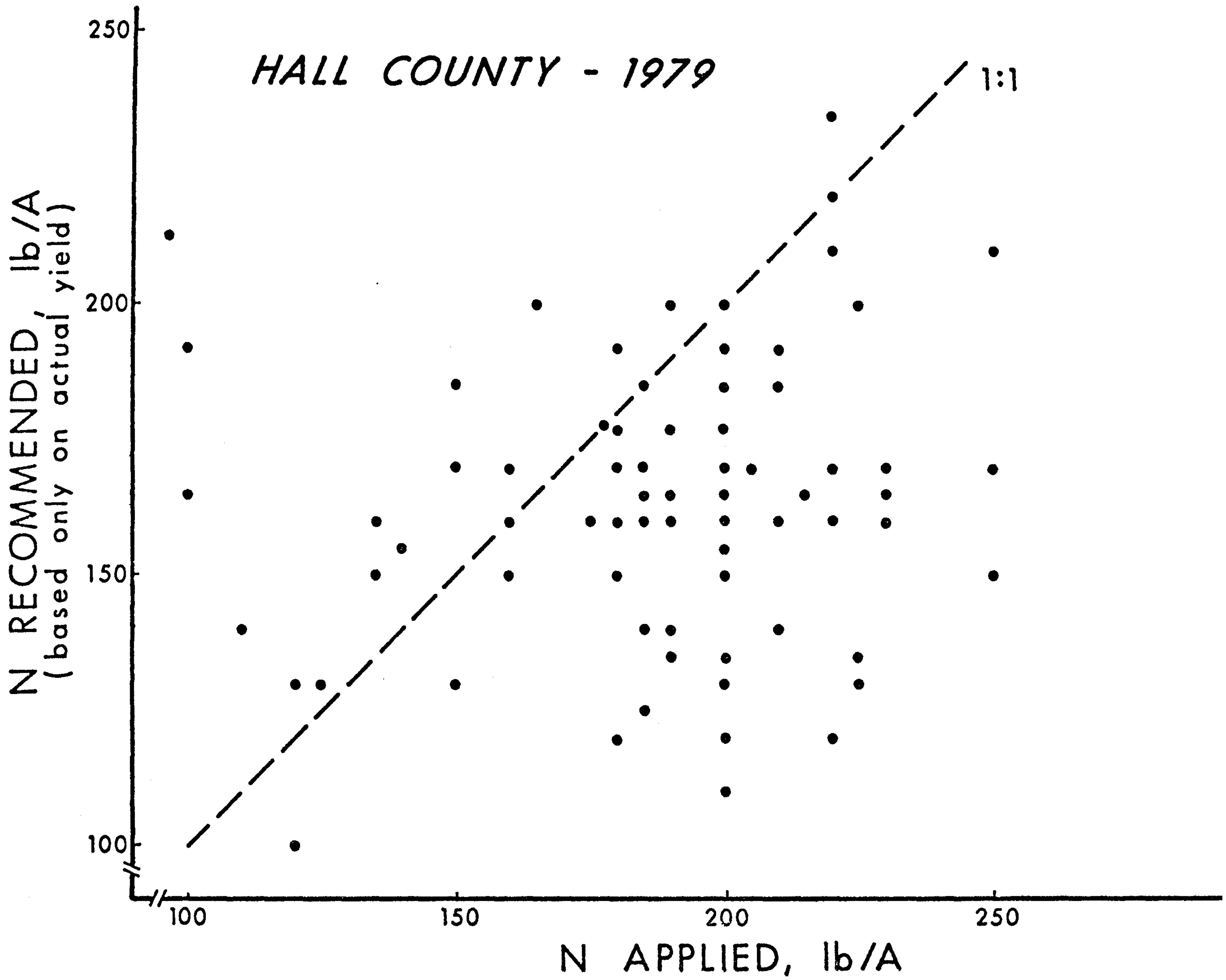
HALL COUNTY - 1979
1:1
N RECOMMENDED, lb/A
(based only on actual yield)
250
200
150
100
100
150
200
250
N APPLIED, lb/A

Figure 2

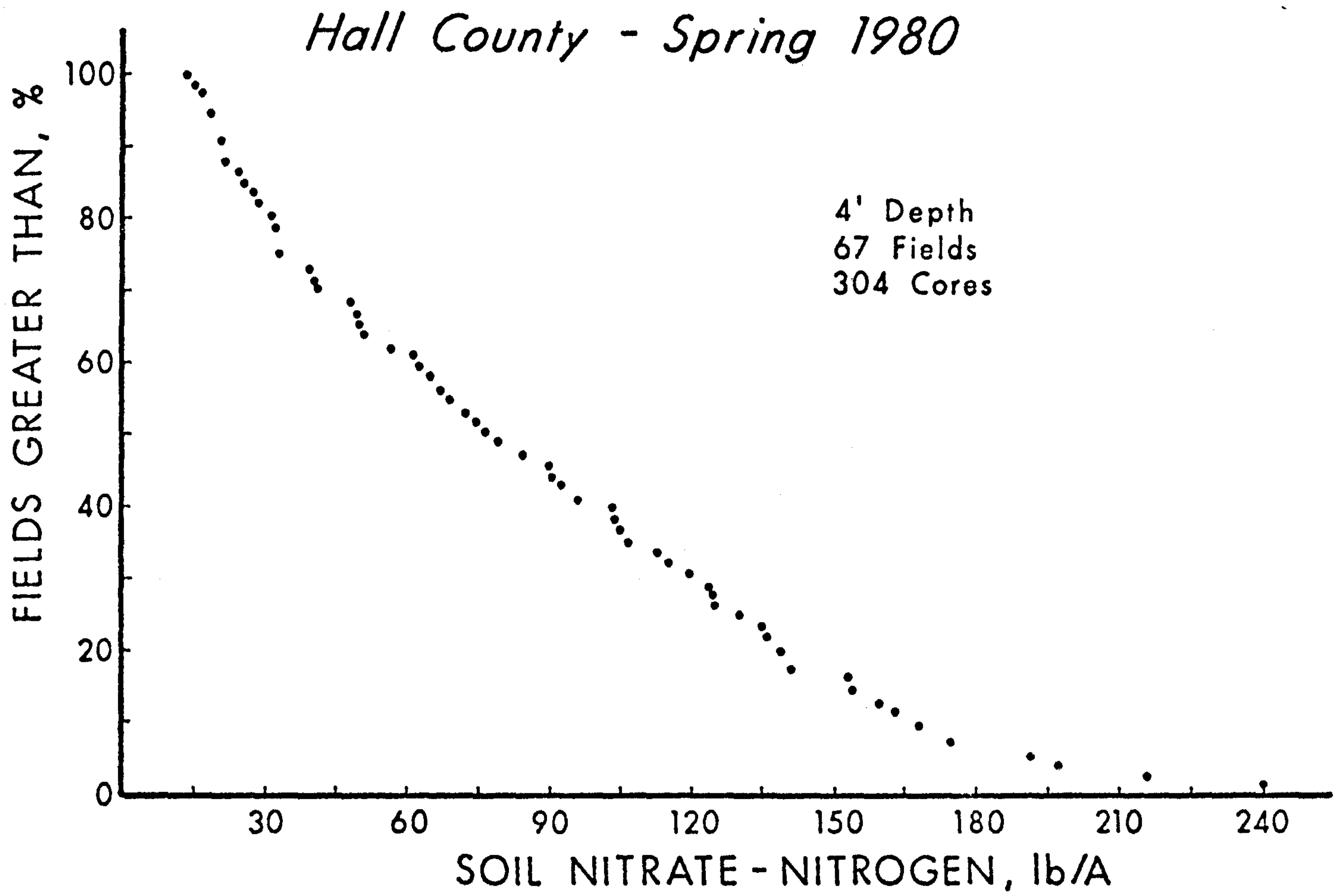
Hall County - Spring 1980
4' Depth
67 Fields
304 Cores
FIELDS GREATER THAN, %
0
20
40
60
80
100
30
60
90
120
150
180
210
240
SOIL NITRATE - NITROGEN, lb/A

Figure 3

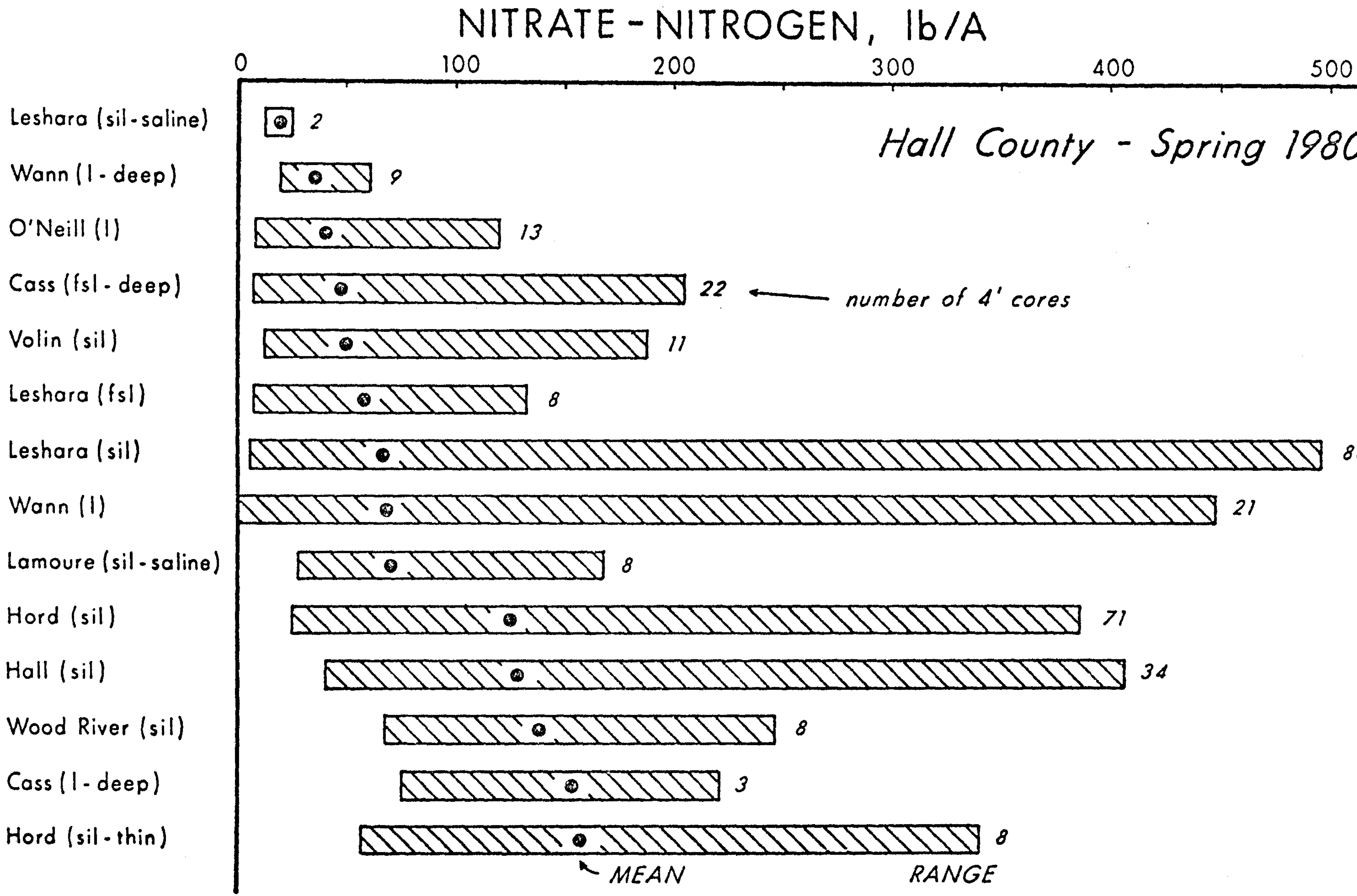
NITRATE - NITROGEN, lb/A
0
100
200
300
400
500
Hall County - Spring 1980
Leshara (sil-saline) 2
Wann (l-deep) 9
O'Neill (l) 13
Cass (fsl-deep) 22
number of 4' cores
Volin (sil) 11
Leshara (fsl) 8
Leshara (sil) 86
Wann (l) 21
Lamoure (sil-saline) 8
Hord (sil) 71
Hall (sil) 34
Wood River (sil) 8
Cass (l-deep) 3
Hord (sil-thin) 8
MEAN
RANGE

Figure 4

PROBLEMS IN MINERAL N DETERMINATION BY STEAM DISTILLATION DUE TO CARBONATES

C. R. Clausen, M. P. Russelle, and R. A. Olson

A follow-up study to one on Mg^{+2} interference in NO_3^- measurement by steam distillation revealed an added problem with the method when used on calcareous soils. The CO_3^{-2} ion was presumed responsible, prompting the current investigation on the effect of soil CO_3^{-2} level on NH_4^+ and NO_3^- determination by steam distillation.

Four series of CO_3^{-2} amendments were made to soil to simulate levels of (1) low solubility $CaCO_3$ and $MgCO_3 \cdot Mg(OH)_2$, (2) soluble CO_3^{-2} as K_2CO_3, (3) combinations of Mg^{+2} and soluble CO_3^{-2}, and (4) soluble CO_3^{-2} in a Mg^{+2}-free system. All received a uniform 40 ppm N injection as NH_4NO_3 with NH_4^+ and NO_3^- measured by prescribed procedure. The results show that Mg^{+2} and CO_3^{-2} independently suppress recovery of NO_3^- and interacting together interfere with both NH_4^+ and NO_3^- determination.