Soil Science Research Report - 1981

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DEPARTMENT OF AGRONOMY
UNIVERSITY OF NEBRASKA-LINCOLN
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SOIL SCIENCE RESEARCH REPORT - 1981

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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 broadcast and incorporated or applied in a band below the level of the seed (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 a 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 objective 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 and continued in 1981. The soil is classified as a Nora silt loam and the properties are listed in Table 1. The treatments used are listed in the following tables. The N rate throughout was 80 lb./acre. Except for the chisel check and disk check treatments, the P rate was uniform at 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. When applied with the chisel, fertilizer P was applied in bands on 12 in. centers at a depth of 8-10 in.. When applied with the 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. The treatments used in 1980 were repeated in 1981.

Sampling procedures were the same each year. Whole plants were sampled one month after emergence and at the 12-16 in. growth stage. 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 each October.

Results and Discussion:

The effect of P placement on early growth and yield is summarized in Table 2. Dry weather caused a large amount of variability in yields in 1980 and there was no significant treatment effect. In 1981, yields were increased by the application of fertilizer P. Placement had no significant effect. Considering early growth, the data again show a significant effect of fertilizer P. In general, plant weights were higher when a starter fertilizer was used. This effect was only signficant for some measurements. These data show that the effects of fertilizer placement on early growth do not necessarily have the same effect on grain yield.

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

Property	Depth (in.) 0-6	6-12	12-24	24-36	36-48	48-60	60-72
texture	silt loam-		-	-	-	-	-
pH	6.5	-	-	-	-	-	-
organic matter, %	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 + Kurz #1), ppm	8.6	3.5	3.7	4.7	2.0	1.5	3.1

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

Placement	1980 1 mo. post. emerg.	12-16 in.	Yield	1981 1 mo. post emerg.	12-16 in.	Yield
	---- g/plant ----		bu/acre	---- g/plant ---		bu/ac
disk control	1.66 bc	11.3 a	69.0 a	2.17 a	16.1 a	134.2 ab
chisel control	1.18 d	8.8 a	69.4 a	2.14 a	14.3 a	126.7
starter only	2.30 a	-	64.7 a	3.62 c	22.8 d	144.8
P_2O_5 with disk	2.08 a	13.7 b	78.4 a	2.72 b	18.0 bc	142.7 b
P_2O_5 with disk + starter	2.29 a	12.7 ab	70.7 a	2.79 b	20.0 cd	140.3
P_2O_5 with chisel	1.54 cd	10.7 a	73.1 a	2.53 ab	18.3 bc	143.3 b
P_2O_5 with chisel + starter	1.80 bc	13.7 b	88.8 a	2.14 a	18.7 c	147.0
broadcast	2.05 ab	11.5 a	79.1 a	2.65 b	17.8 bc	141.5 ~~ab~~
broadcast + starter	2.09 ab	12.5 ab	74.3 a	2.84 b	18.5 bc	135.4 ab

At the time of this writing, analysis of plant samples collected in 1981 had not been completed. Therefore, data from 1980, only, are included in this report. The P content of young plants was affected by P placement. The P content of the control treatments was lowest while the use of the starter produced the highest P content in the whole plant tissue. Placement of fertilizer P had no significant effect on the P concentration in the tissue as the plants matured (Table 3).

Table 3. Effect of placement of fertilizer P on the P concentration in corn tissue at various stages during the growing season. 1980.

Placement	1 mo. after emergence	Stage of Growth recently mature leaf	ear leaf
	- - - - - - - - - - - - -	% P - - - - - - - - - - - - -	
disk control	.36 cd	.200 a	.186 a
chisel control	.35 d	.216 a	.183 a
starter only	.42 a	.226 a	-
P_2O_5 with disk	.38 bc	.225 a	.183 a
P_2O_5 with disk + starter	.39 ab	.240 a	.202 a
P_2O_5 with chisel	.36 cd	.222 a	.193 a
P_2O_5 with chisel + starter	.38 bc	.222 a	.193 a
broadcast	.38 bc	.204 a	.186 a
broadcast + starter	.38 bc	.225 a	.185 a

THE INFLUENCE OF SOURCE OF N, N RATES, AND A NITRIFICATION INHIBITOR ON THE YIELD OF PIVOT IRRIGATED CORN GROWN ON A SANDY LOAM SOIL. MERRICK COUNTY, 1981

Kenneth D. Frank

Location: The plot was located in the N1/2 of the S1/2 of SW1/4, Section 5, T14N, R6W, Merrick County. The cooperators were Brandis, Inc. Soil types across the experiment were O'Neill sandy loam, O'Neill loam, Lockton loam, and Blendon fine sandy loam.

Objective: Evaluate the influence of a nitrification inhibitor with both anhydrous ammonia and nitrogen solution when nitrogen is sidedressed on irrigated corn.

Procedure: The field was planted in late April using a Mo17 x B73 hybrid. A starter fertilizer supplying approximately 5 N, 16 P_2O_5, 4 K_2O, 4 S, and 1 Zn (pounds per acre) was placed two inches to side and two inches below the seed at planting. An additional 40 pounds of nitrogen was applied through the center pivot to the entire plot area. The experimental treatments were applied to individual plots--five 30-inch rows x 100 feet long. Each treatment was replicated four times. In order to account for soil variability across the field, a standard rate of 120 pounds of N as anhydrous was applied on both sides of the five rows containing the individual treatments. The nitrogen materials were sidedressed on June 3, 1981. On June 3, the corn was in the 5 to 7 leaf stage. The rest of the field adjacent to the plot area had received a preplant nitrogen application and appeared darker green in color and 4 to 6 inches taller. Yields were determined by hand-harvesting 20 feet of row from two rows of each plot. Yields were taken from the standard plots as near to the treatment plots as possible. Yield checks from the adjacent farmer's field that received preplant N were taken in several locations.

Results and Discussion: Treatments applied and mean grain yields are shown in Table 1. Table 3 shows the grain yield for each standard plot harvested with relative field position.

As shown in Table 2, the standard plots remove a large amount of the variability. That variability existed is evidenced by the range in yield of the standard plots as shown in Table 3. The check plot which received approximately 40 pounds of supplemental N is significantly different than the nitrogen treatments. There were no differences between sources. Visual examination of the data shows that Treatment 13 (120 # N as 28% solution) does not have the same relationship with the two lower solution rates as does Treatment 16 (120 # of N as solution plus N-Serve). Thus, what may appear to be a response to inhibitor is not substantiated by the data.

Based on results from this experiment, it is encouraging to note that the use of a nitrification inhibitor with a sidedress nitrogen application has not decreased grain yield. There was no attempt to measure any effect of inhibitor on nitrogen carryover as nitrate. Past experiments have shown that variability with field measurement of nitrate-nitrogen exceeds any possible expected differences due to treatment.

Based on the yields obtained in this experiment; i.e., 190 bushels of corn with 85 pounds of supplemental nitrogen (40 pounds sidedressed plus 5 starter and 40 through the pivot), it is obvious that the crop is obtaining additional nitrogen. Past experiments in this particular field have shown approximately 60 pounds of nitrate-nitrogen in the soil profile, plus about 15 pounds from the water. Thus, when adding these sources together that shows approximately 160 pounds of nitrogen available to the crop. That leaves approximately 100 pounds of nitrogen unaccounted for.

Recent mineralization studies by Dr. Jim Schepers with a Wood River silt loam soil from Hall County would indicate that mineralization during the growing season on these irrigated soils could account for nitrogen available to the crop in this 100 pound range. Consequently, laboratory studies on mineralizable nitrogen from the sandy soils will be conducted next year.

Five yield checks were taken from the adjacent farmer's field that received preplant nitrogen (Table 3). The yields ranged from 142 to 206 bushels per acre, with a mean yield of 173 bushels per acre. Thus, even though the corn receiving preplant nitrogen was taller and darker green, there was no indication that yield was improved over sidedressing.

Table 4 contains results from a similar experiment conducted in a different part of this same field in 1980. This experiment was conducted like the 1981 experiment. The cooperators applied similar amounts of fertilizer on the experimental area. There were no standard treatments in the 1980 design. The 1980 crop yields were lower than 1979 or 1981 because of poor stand and more corn borer problems.

It is evident from the data that results from 1981 were similar to 1980. There was a response from 40 pounds of N over the check, but no differences in sources or rates of N nor in nitrification inhibitor.

These experiments continue to show that optimum corn yields can be produced with less nitrogen than is currently used on these soil types.

ACKNOWLEDGMENT

Dow Chemical Company supplied grant funds to support this work.

Cargill Elevator, Central City, supplied nitrogen fertilizer.

Table 1. Treatments applied and grain yield. Merrick County, 1981.

Treatment			N-Serve[1/]	Grain Yield #2
Number	N Rate #/A	Source		Bu/A
1	0			169
2	40	NH_3	0	188
3	80	NH_3	0	186
4	120	NH_3	0	188
5	160	NH_3	0	169
6	200	NH_3	0	188
7	40	NH_3	1/4 #/A	181
8	80	NH_3	1/4 #/A	187
9	120	NH_3	1/4 #/A	196
10	160	NH_3	1/4 #/A	180
11	40	28% Sol	0	179
12	80	28% Sol	0	185
13	120	28% Sol	0	179
14	40	28% Sol	1/2 # 24E/A	180
15	80	28% Sol	1/2 # 24E/A	190
16	120	28% Sol	1/2 # 24E/A	192

[1/] N-Serve is the trade name of Dow Chemical Company's product whose active ingredient is 2-chloro-6-(trichloromethyl)pyridine.

Table 2. Analysis of variance for grain yield as influenced by N rate, source, and nitrification inhibitor.

Source	df	Mean Square	Prob f	R^2	C.V.
Model	16	1,742	.0001	.0077	7.08
Treatments	15	234	.188		
Covariant	1	12,660	.0001		
Error	49	168			

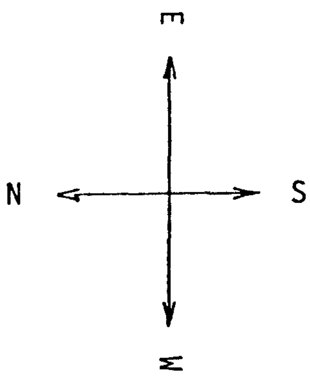

Table 3. Yield of the standard 120 lbs N as anhydrous ammonia treatment as influenced by uncontrolled factors.

Farmer's Field		5 - 30" Rows Treatments Applied		5 - 30" Rows Treatments Applied		5 - 30" Rows Treatments Applied		5 - 30" Rows Treatments Applied		
	133		126		142		181		192	
	217		201		212		225		208	
195	183		195		185		202		192	
178	171		173		195		196		199	
	175		166		145		142		176	
	182		188		199		205		202	
143	162		189		180		196		181	
	181		190		187		189		181	
142	165		189		174		203		203	
	187		180		195		206		193	
	190		194		183		211		205	
	191		202		195		198		197	
	183		210		191		218		212	
	196		199		190		214		207	
206	193		179		205		208		188	100'
	204		203		173		199		179	100'
	211		213		196					
	5 30" Rows		5 30" Rows							

Table 4. Influence of Nitrogen Rate, Source, and Nitrification Inhibitor for a Sidedress Application on Irrigated Corn Yield. Merrick County. 1980.

Nitrogen Treatments			Mean Yield #2 Corn Bu/A
Rate #/A	Source	+ or - 1/4 # N-Serve	
0		-	142
40	NH_3	-	155
80	NH_3	-	158
120	NH_3	-	154
160	NH_3	-	148
40	NH_3	+	152
80	NH_3	+	150
120	NH_3	+	150
160	NH_3	+	151
40	28% Sol	-	148
80	28% Sol	-	154
40	28% Sol	+	153
80	28% Sol	+	154

THE INFLUENCE OF TWO DIFFERENT STARTER FERTILIZERS ON GRAIN YIELD OF EIGHT HYBRID VARIETIES GROWN ON CASS FINE SANDY LOAM CONTAINING FREE LIME

K. D. Frank & R. A. Wiese

Problem:

There is some evidence from past experiments that ammonium thiosulfate added to ammonium polyphosphate and band-applied at planting has increased corn yield on high pH soils. There are numerous areas of soil in central and western Nebraska under cultivation where whole fields or parts of fields have free lime present. Further, the question was raised relative to the response of different varieties on the high pH soils.

Objective:

To evaluate the starter effect of adding ammonium thiosulfate to ammonium polyphosphate on corn yield of several different varieties grown on high pH soil.

Procedure:

The plot was located on a Cass fine sand loam soil on land farmed by Mr. Sear in Kearney County. Eight Pioneer varieties were planted in six 36-inch row plots 1,120 feet long by Mr. Sear on April 28. The starter fertilizer was placed approximately two inches below and to the side of the seed. Rather than use replications, a standard variety was planted beside each treatment to use as a measure of variability. Leaf samples were taken at early silk. The plots were combined and field-weighed on October 20. Mr. Herb Bonsack, Jr., provided the seed and weigh wagon at harvest. The fertilizer material was provided by Fox Grain of Gibbon.

The overall fertility status of the soil was high as shown by soil test results in Table 1 from plots from another experiment located in the same field. Thus, the variance in levels of phosphorus and other nutrients in the two treatment materials were assumed to have minimal effect. The two starter treatments were as follows:

F_1 = 15 Gal/A of 8-20-5-4S-0.8 Zinc

F_2 = 15 Gal/A of — [4 Gal 8-20-5-4S-0.8 Zinc; 6 Gal 12-0-0-26S]

At the rate of 15 Gal/A, each material supplied the approximate pounds of nutrients/A:

F_1 = 13.2 N, 33 P_2O_5, 8 K_2O, 6.6 S, 1.3 Zn

F_2 = 17 N, 13 P_2O_5, 3.3 K_2O, 28 S, 0.5 Zn

The varieties involved were Pioneer 3541, 3732, 3382, 3713, 3591, 3536, 3720, and 3183. Pioneer 3541 was planted as the standard variety.

Table 1. Soil Test Information for the Experimental Area[1/]

Depth Inches	pH	Excess Lime	#/Acre[2/] N	ppm $NaHCO_3$-P	ppm Bray-1 P	ppm K	ppm Na	ppm SO_4-S
0- 6	8	Medium	45	27	33	347	79	24
6-12	8	Medium	62	15	16	312	111	32
12-18	8.1	Medium	53	17	17	301	111	32
18-24	8.0	Medium	38	15	10	286	110	33

Depth	% Organic Matter	DTPA Micro-Nutrient ppm Manganese	Copper	Iron	Zinc
0- 6	1.2	10	.51	6.9	4
6-12	1.0	13	.56	7.9	3
12-18	0.9	9	.47	9.0	3.5
18-24	0.8	9	.51	8.5	1.7
	Adequate Range	>1	>.2	>4.5	> 1

1/ Values are the mean of 3 areas in the field.

2/ Pounds of N as nitrate are based on 1.8 million pounds of soil/acre 6".

Results and Discussion:

Analysis of the standard variety showed there was no significant variation across the plot area.

Analysis of variance for yield as shown in Table 2 shows no effect on yield from the two fertilizer treatments. However, yield was significantly influenced by variety.

Also, as shown in Table 2, the low C.V. indicates this was a uniform experiment and the R-Square value indicates 78 percent of the variation in yield was accounted for by the treatments. Mean grain yields and percent moisture in the grain at harvest are shown in Table 3. The significant levels for variety yield differences were obtained from the regression analysis correlation matrix. Duncan's new multiple range test was used to develop the significant different ranges for grain moisture.

Table 2. Analysis of Variance for Grain Yield with some Statistical Parameters for the Variety Trial.

Source	df	Mean Square	Probability F
Treatments	8	152	0.0001
Varieties	7	165	0.0001
Fertilizer	1	0.09	0.939
Error	22	15.2	
R-Square = 0.78, C.V. = 2.5, Mean Yield = 155			

Table 3. Mean Grain Yield and Percent Moisture Across Fertilizer Treatments as Influenced by Variety.

Variety	Grain Yield bu/A	Variety	% Moisture
3183	163 a[1/]	3183	29.15
3541	158 ab	3382	24.6
3382	157 ab	3536	21.2 a
3536	156 bc	3591	20.75 a
3720	150 c	3713	19.85 b
3591	145	3541	19.55 b
3732	145	3732	19.15 b
3713	140	3720	17.65

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

Based on the results of this experiment, there was no indication that adding ammonium thiosulfate to the starter increased grain yield. There was, however, a yield difference due to variety. It is important to point out as shown in Table 3 that grain moisture at harvest needs to be considered.

For the producer who does not use wet corn and thus must either dry the corn or take a dock when selling at harvest, moisture and yield potential of varieties need close observation. Based on current drying costs, and under the conditions of this experiment, Variety 3541 has an economic advantage over Varieties 3183 and 3382 even though there was no significant yield increase.

The Influence of Limestone and Promesol-30 on Soil pH and Yield of Irrigated Corn Grown on a Crete Silty Clay Loam Soil

K. D. FRANK

Objective: Two major objectives of this experiment were: (1) to compare Promesol-30 with $CaCo_3$ on changing the pH of a Crete scl soil, and (2) observe the influence of these materials on yield of corn.

Procedure: The experiment was established on a Crete Scl gravity irrigated soil in Thayer County, Nebraska. Fine-ground limestone was hand-applied at a rate to give the equivalent of 4 ton of 60% ECCE in April of 1976. The initial application of Promesol-30 was also applied and disked in by the farmer cooperator. Table 1 contains the treatments applied. Soil samples for pH determination were taken in April of 1976, 1977, and 1979. All plots were treated equally by the farmer cooperator. Grain yields were determined by hand-harvesting two rows 20 feet long from each plot. The plots were 35 feet long and 24 feet wide.

The Promesol-30 was provided by Carpenter Sales, Inc., Bondurant, Iowa. Table 1 contains characteristics of the liquid material on a volume basis.

Table 1. Some Chemical and Physical Characteristics of Promesol-30 on a Volume Basis.

Trihydroxy Glutaric Acid	54%
Elemental Calcium	25%
Elemental Nitrogen	5%
pH	3.7
Specific Gravity	1.36 g/ce

Discussion: Table 2 contains the treatments and mean yields for the four years. There were no significant differences in yearly corn yields, nor in the four-year mean due to treatment.

Table 2 also shows the change in pH the first year after application and in 1979, 3 years after application. $CaCO_3$ significantly increased pH in 1977 and in 1979. The pH change due to $CaCO_3$ was significant in 1979 over the 1977 value. Promesol-30 had no significant influence on pH under the conditions of this experiment. The pH values were converted to hydrogen ion concentrations for statistical analysis; however, the results were within rounding error, so average pH values were used.

Table 2. Lime and Promesol-30 Treatments and Their Influence on Soil pH and Grain Yield.

Treatment	pH April 76	pH April 77	pH April 79	Grain Yield 1976	Grain Yield 1977	Grain Yield 1978	Grain Yield 1979	4-Year Mean
1. Check	5.3	5.3	5.37	156	164	178	169	168
2. 4 Tons Ag Lime	5.3	5.9	6.35	167	164	172	177	170
3. 8 Gal/A Promesol-30 in 1976 12 Gal/A Promesol-30 in 1977	5.3	5.3	5.22	162	159	176	163	165
4. 4 Gal/A Promesol-30 in 1976 12 Gal/A Promesol-30 in 1977 8 Gal/A Promesol-30 in 1978	5.3	5.3	5.34	156	160	173	172	165

THE INFLUENCE OF ACID-FORMING MATERIAL ON IRRIGATED CORN GROWN ON HIGH pH SOIL

K. D. Frank and R. A. Wiese

Location: The experiment was located in the NE1/4 of NW1/4 Section 16-8N-13W Kearney County on land farmed by Mr. H. D. Sear

Objective: To study the affect on corn yield of acid-forming materials applied to high pH soils containing free lime.

Procedure: The experimental area was fertilized in fall of 1980 by Mr. Sear with 100 pounds/A of 18-32.5-30.8-7.2-1.2 applied with a chisel. An additional 142 pounds of N was fall-applied as anhydrous ammonia.

Mr. Sear marked out the rows. Treatments were applied at planting time on April 28, 1981. Each individual plot was two 36-inch rows, 75 feet long, and replicated four times. In order to compensate for soil variability within the experimental area, a standard treatment was applied on both sides of the experimental plots. The fertilizer materials were placed approximately two inches to the side and two inches below the seed. Pioneer 3541 was planted at an approximate seeding rate of 28,000 seeds per acre.

Leaf samples were taken on July 20 at early silking. Plot yields were determined by hand-harvesting 40 feet from each plot, including the standard treatments on October 9.

Results and Discussion: Table 1 shows the treatments applied and the grain yields adjusted for the standard treatments. There was considerable variability in the field, and using the standard treatments has significantly reduced variability. As shown in Table 2, the yield from plots receiving the liquid materials was significantly greater than the yield from the dry material (178.8 for treatments 2, 3, 4, 5, and 11 vs 169.4 for treatments 6, 7, 8, 9, and 10). Before placing too much emphasis on one experiment, a word of caution needs to be expressed. The dry material (Iron Sul) was not placed with the seed. An experiment on corn conducted by Hergert at North Platte shows a positive yield effect when iron sul was placed with the seed. Therefore, this type of experiment will be run again to evaluate the iron sul placed with the seed.

Table 3 shows the yield of the standard treatments across the experimental area. Obviously there was a large amount of variability which is why field experimentation with these types of soil problems is difficult. The mean of 176 bu/A for the standard treatment of 10 gal per acre of 10-34-0-1 zinc under the conditions of this experiment would be a significant response over the plots receiving no starter fertilizer. Even though the treatments with ammonium thiosulfate added were not significantly different than the standard, there is sufficient indication to evaluate the acid-forming materials further while simultaneously working towards refining the experiments in order to detect true differences in yield.

Based on the conditions of this experiment, it appears that on these high pH soils with excess lime, a starter fertilizer with at least nitrogen, phosphorus, and zinc may show a response even though the overall fertility level of the soil is adequate as shown in Table 4. Again, caution should be used when taking the data from this one experiment and extending it to other field conditions.

Plants were sampled for analysis in late June. There were no indications of nutrient deficiencies at this time.

Table 1. Grain yield as influenced by banding fertilizer materials at planting time for irrigated corn grown on high pH calcareous soil. Kearney County, 1981.

Treatment Number	Material	Applied Nutrients #/A N	P_2O_5	Zinc	S	Iron	Yield Bu/A
1	Check						166
2	5 Gal 10-34-0-1 Zinc 5 Gal 12-0-0-26	12	18	.55	14	0	181
3	10 Gal 10-34-0-1 Zinc 10 Gal 12-0-0-26	24	36	1.1	28	0	184
4	10 Gal 12-0-0-26	13			28		179
5	10 Gal 10-34-0-1 Zn + 5 # Fe 138	11	37	1.1	0	.3	170
6	100 # Iron Sul				30	20	172
7	50 # Iron Sul				15	10	171
8	50 # 18-46-0-2 Zinc 50 # Iron Sul	9	23	1	15	10	172
9	50 # Agri Sul				45		158
10	50 # 18-46-0-2 Zinc 50 # Agri Sul	9	23	1	45		174
11	10 Gal 10-34-0-1 Zn + 5 # Hamp Iron	11	37	1.1	0	.3	180

Table 2. Analysis of variance for grain yield as influenced by banding fertilizer materials at planting time for irrigated corn grown on high pH calcareous soil. Kearney County, 1981.

Source	df	MS	Prob > F
Treatment	10	234.8	.34
Co-Variate	1	9,474	.0001
Treatment 2, 3, 4, 5, 11 vs 6, 7, 8, 9, 10	1	867	.05
Error	34	202	

R^2 = .67, C.V. = 8.22

Table 3. Yield variability associated with the standard treatment of 10 Gal/A 10-34-0-1 zinc applied at planting 2 inches below and to the side of the seed. Kearney Co. 1981.

	I	II	III	IV	V	Total	Mean Acres	[illegible]
A	161	176	176	203	208	924	185	
B	177	179	184	184	205	929	186	
C	169	191	182	178	200	920	184	
D	188	190	187	165	181	911	182	
E	180	182	176	183	174	895	179	
F	169	144	157	181	180	831	166	
G	175	179	159	173	188	874	175	
H	175	148	160	147	137	767	153	
I	137	143	168	161	186	795	159	
J	185	175	188	193	203	944	189	
K	188	171	164	178	191	892	178	
Total	1904	1878	1901	1946	2053			
Mean Yield Down Row	173	171	173	177	187			

←6'→
←18'→
2 36" Rows
75'

OVERALL MEAN OF STANDARD - 176 Bu/A
Range in yield 137 - 208 Bu/A

Table 4. Soil test information for three locations within the experimental area for depths to two feet. Kearney County, 1981.

Plot	Depth	pH	Excess Lime	ppm					
				NO_3-N	$NaHCO_3$-P	Bray 1 P	K	Na	SO_4-S
211	0- 6	8.0	Medium	18	27	42	353	77	28.2
	6-12	7.9	Medium	35	21	25	230	80	44.4
	12-18	7.9	Medium	28	26	33	207	70	36.1
	18-24	7.8	Low	10	21	15	214	85	42.6
251	0- 6	8.0	Medium	13	19	28	313	70	19.7
	6-12	7.9	Medium	25	18	23	249	70	22.9
	12-18	7.8	Medium	29	12	19	210	74	24.2
	18-24	8.0	Medium	18	14	14	227	75	23.4
124	0- 6	8.0	Medium	45	35	29	376	92	26.3
	6-12	8.3	High	43	7.3	2.2	459	184	31.3
	12-18	8.4	High	31	12	1.1	486	190	40.0
	18-24	8.3	High	36	11	1.1	419	170	34.8

DTPA MICRO-NUTRIENT[1/]
ppm

Plot	Depth	%		Manganese	Copper	Iron	Zinc
		OM	$CaCO_3$ Eq.				
211	0- 6	1.4	1.3	12.9	0.51	6.5	5.6
	6-12	1.2	1.3	11.0	0.53	9.1	4.1
	12-18	0.8	.9	10.7	0.43	10.3	7.4
	18-24	0.8	.5	11.3	0.62	9.7	2.9
251	0- 6	1.3	1.0	11.9	0.51	7.8	3.8
	6-12	1.5	1.2	24.4	0.54	8.1	4.0
	12-18	1.6	1.4	10.7	0.51	11.7	2.5
	18-24	1.0	1.1	10.1	0.50	8.4	1.6
124	0- 6	0.8	1.3	7.5	0.52	6.3	2.9
	6-12	0.5	6.2	3.9	0.67	6.2	0.5
	12-18	0.5	10.4	5.6	0.47	6.2	0.8
	18-24	0.5	4.6	5.4	0.46	5.7	0.6
Adequate Range				> 1	> .2	> 4.5	> 1

EFFECT OF DIFFERENT METHODS OF P APPLICATION ON IRRIGATED CORN PRODUCTION

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

Objective:

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

Procedure:

Treatments were reapplied on the same locations as in 1980 — Greeley County and Mead except for treatment 6 which was a knife-together treatment with N-Serve in 1980. This treatment in 1981 was a knife-together treatment without N-Serve in a 30 inch spacing. All other treatments were applied in a 15 inch spacing in 1981 compared to a 30 inch spacing in 1980. Treatments were as follows:

1) Knife-together (NH_3 + 10-34-0)
2) Knife-separate NH_3 knifed separate from 10-34-0
3) Broadcast 10-34-0
4) Row at planting 10-34-0
5) Surface rows
6) Same as 1 but in 30" spacing

The Greeley location was abandoned due to weed control problems associated with application of the preplant herbicide. Plots were disked after application and at Mead were planted to Pioneer 3388 at a population of 28,600 plants/acre on May 15. Poor stands forced replanting. Replanting was accomplished directly in old rows without tillage on May 22. Forty feet of row was thinned for harvest after emergence. All plots received 200# N as ammonia and APP. Early plant samples were collected at the seven leaf stage and ear leaves collected at early silk. Soil test for P as measured by the Bray No. 1 extractant was 7 ppm in 1980. Soil at Mead is an eroded Sharpsburg.

Results and Discussion:

Results indicate that yields were significantly affected by both applied P and by the method of application (Table 1 and 2). The knifed treatments performed very well in this experiment. In fact, the knife-separate treatment had a significantly higher yield than any other treatment except the knife-together treatment including the row applied treatment which was not superior to either surface row or broadcasts disked in treatments. The poorest yield was obtained when the P was knifed in a 30 inch spacing. Knife treatments in 15 inch spacing had significantly higher grain yields than when knifed in a 30 inch spacing. Grain moisture was not significantly affected by either P rate or method of application.

Table 1. Effect of P rate and method of P application on corn yield, early P content, ear leaf P content, and grain moisture. Mean, 1981[1/]

P Rate	Grain: Yield	Grain: Moisture	P Content: Small Plant[2/]	P Content: Ear Leaf
	bu/A	%	g	% P
0	111 b	17.1 a	Not Available	Not Available
10	123 ab	16.8 a		
20	119 ab	16.8 a		
30	125 a	16.5 a		
Method of P application:				
1) Knife together	125 ab	16.4 a	Not Available	Not Available
2) Knife separate	133 a	16.6 a		
3) Broadcast	123 bc	16.4 a		
4) Row (at planting)	121 bc	17.0 a		
5) Surface row (dribble)	117 bc	16.9 a		
6) Same as 1) 30" spacing	114 c	16.9 a		

1/ Means followed by same letter are not significantly different at the 5 percent probability level.
2/ Seven leaf stage
3/ Refers to method by which NH_3 and 10-34-0 was applied.
Knife spacing = 15 inches
All plots received 200# N/A
All plots were disked after application

Table 2. Analysis of Variance

Source of Variation	Grain		P Content, %	
	Yield	Moisture	Small Plant	Ear Leaf
P Rate	++	NS	Not Available	Not Available
Method	**	NS		
Rate x Method	**	NS		

EFFECT OF THE AMOUNT OF AMMONIA APPLIED WITH APP ON IRRIGATED CORN YIELD

D. H. Sander and J. Lamb

Objective:

To determine if ammonia rates affect the performance of APP as a P fertilizer for corn production when placed together in bands.

Procedure:

Four ammonia rates (0, 50, 100, 150 lbs N/acre) were applied together with 30 lbs P/acre as 10-34-0 with dual application knives. Nitrogen rates were balanced with ammonium nitrate to provide a total of 260 lbs of N/acre on all plots. McCurdy 6475 corn was planted in 30 inch rows at a population of 28,600/acre on May 7. Sutan + was used for weed control. Corn was irrigated with center pivot. Plant samples were taken at the 7 leaf stage and ear leaves were collected at early silk. Soil test for P was 5 ppm as measured by the Bray No. 1 extractant.

Results and Discussion:

Placing different rates of ammonia with APP (10-34-0) did not affect corn yield (table 1). While there was no OP treatment, soil is quite P deficient according to either the Bray or $NaHCO_3$ soil tests. Soil pH is about 8.1 with some free calcium carbonate. It was hypothesised that high rates of NH_3 with APP could reduce P uptake and availability because of the high pH that occurs in the ammonia band area. Early plant P uptake or ear leaf uptake could show differences, but analysis were not available for this report.

Table 1. Effect of Ammonia rates on corn yield when applied with APP. Greeley County 1981.

NH_3 1/ Rate	Grain yield	Grain moisture
lbs N/A	bu/A	%
0	110	12.0
50	116	11.8
100	114	11.7
150	115	11.6

1/ Total N rates balanced with ammonium nitrate to provide 260 lbs N/A.

Analysis of Variance

Source of variation

Ammonia	NS	NS
Check vs ammonia	NS	NS

Project: Preplant UAN Solution With and Without N-Serve on Irrigated Corn

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

Objective: Compare N response of preplant urea ammonium nitrate solution (28-0-0) with and without N-Serve. Compare soil nitrate and ammonium levels from the treatments.

Procedure: The nitrogen solution was mixed with herbicide and applied through a disc mounted sprayer on May 5. A single discing was used. Treatment design was a two factor factorial with four N rates (40, 80, 120, 160# N/AO and 2 N-Serve (0 or 0.5#/A) plus a check. Individual plots were 10' wide x 120' long to accomodate use of standard size farm equipment. Treatments were replicated four times.

The soil was a Valentine fine sand with the following analyses: pH - 5.7; O.M. - 1.6%; Bray 1 P - 21 ppm; K - 180 ppi; SO_4-S - 10H; Zn index 12VH; NO_3-N/A-6' - 120 lbs. Soil samples for NO_3 and NH_4 were taken June 5 and June 26 from the check, 80 N, 80 N + N-Serve, 160 N, and 160 N + N-Serve. Rainfall from the late April soil sampling to June 5 was 5.08 inches; to June 26, 7.16 plus 1 inch of irrigation for 8.16 inches. This is sufficient water to leach a significant amount of N, and indeed, it occurred when the check plots on June 5 and 26 are compared to the late April sampling (Figure 1). Significant movement of the residual NO_3-N to 4 feet or more occurred. A striking difference in NO_3 content between the 160 N and 160 N + N-Serve treatment was shown at the June 5 sampling (Figure 2). The N-Serve apparently delayed nitrification and less NO_3-N moved where N-Serve was applied. Nitrate N was leached from all treatments, however, even with N-Serve (Figure 2). The magnitude of the difference in NO_3-N movement was related to N rate and N-Serve.

Significant NH_4-N movement occurred at both N rates by June 26 (Figure 3). At the 80# rate, NH_4-N distribution with or without N-Serve showed significant NH_4-N enrichment compared to the check at all depths. At the 160# rate, more NH_4-N was present at all depths than the check. A significant increase in NH_4-N below 2 feet between the 160 N and 160 N + N-Serve was evident. With more NH -N retained by the N-Serve treatment more NH_4-N was available for movement. If NO_3-N plus NH_4-N are summed for the 160# treatments, 160# N had 303# and 160# N + N-Serve had 342#. The totals are not greatly different but the distribution between forms is. After June 26 rain and irrigation managementwere such that little leaching should have occurred.

Grain yields for the whole experiment analyzed as a randomized complete block are given in Table 1. N rates of 80# or more were significantly better than the check. Analysis of the experiment as a factorial showed the only significant effects to be block and N rate.

Table 1. Grain yield for the N-Serve treatments.

Treatment	Yield
160 N + N-Serve	137 a*
160 N	134 a
120 N	133 a
120 N + N-Serve	133 a
80 N + N-Serve	129 a
80 N	123 a
40 N + N-Serve	114 ab
40 N	114 ab
Check	92 b

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

Discussion: With the high level of residual NO_3-N in the plot maximum yields near 140 bu/A should have been achieved with about 100# N/A. This is fact was what occurred even though early season leaching moved the residual NO_3 to 4 and 5 feet. The plant roots apparently reached some of this N or the check yield would have been less than 92 bu/A.

The N-Serve did delay nitrification (Figure 2) and reduce NO_3 movement. The retention of more NH_4 at the 2, 3 and 4 foot levels did show that the 160# N plus N-Serve retained more N than the 160# N rate plots.

The soil analysis data show conclusively that NH_4-N does leach in these loamy sands (Figure 3). The N leaching, however, was not severe enough to cause significant grain yield differences between treatment plots receiving N-Serve and those which did not.

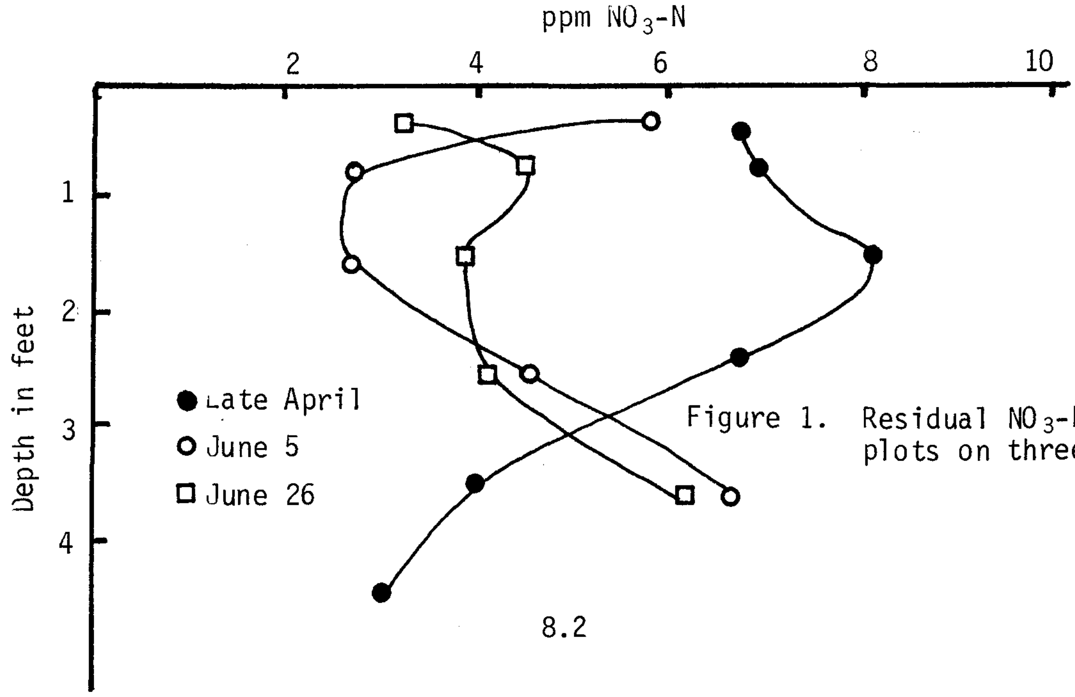

Figure 1. Residual NO_3-N in the plots on three dates

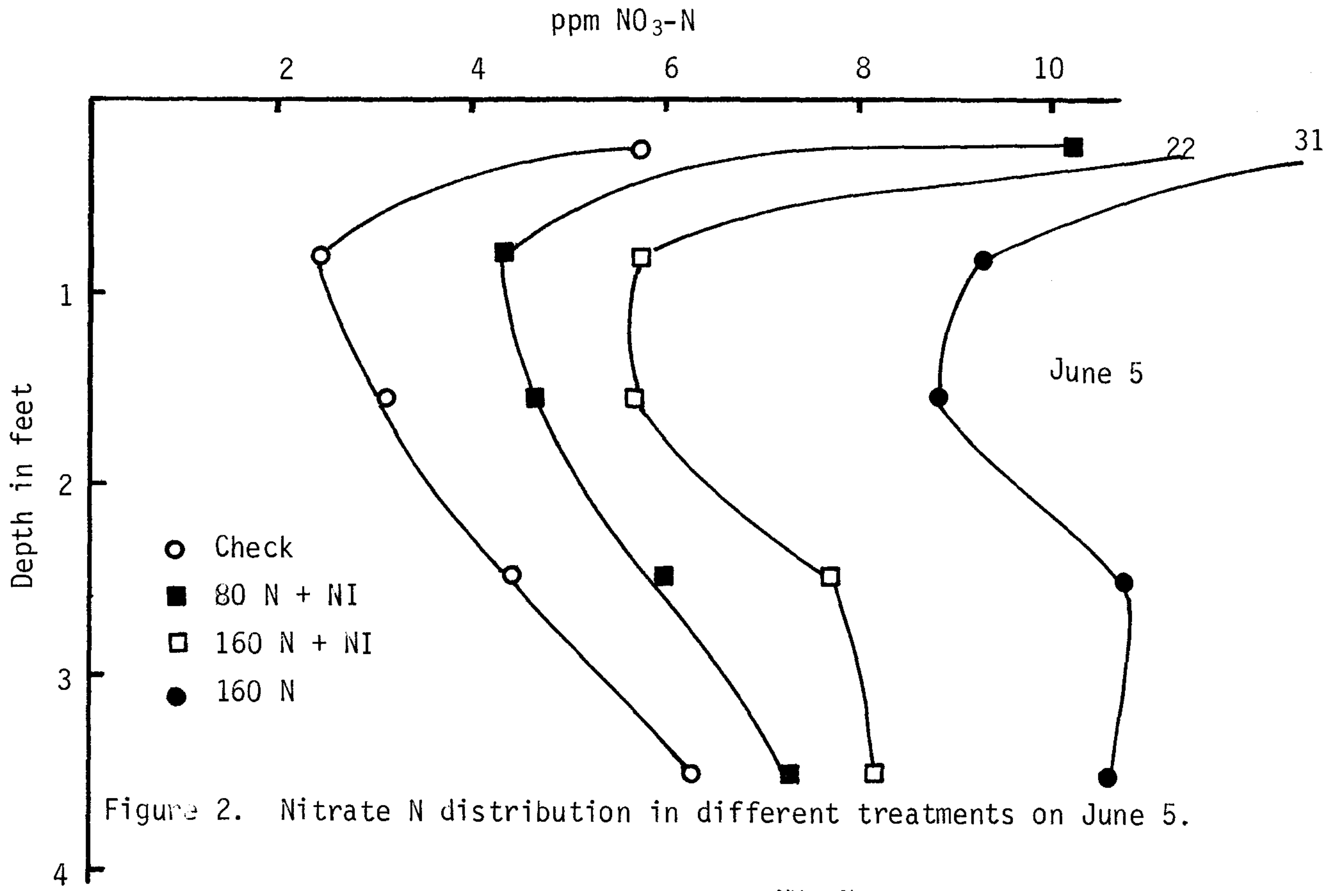

Figure 2. Nitrate N distribution in different treatments on June 5.

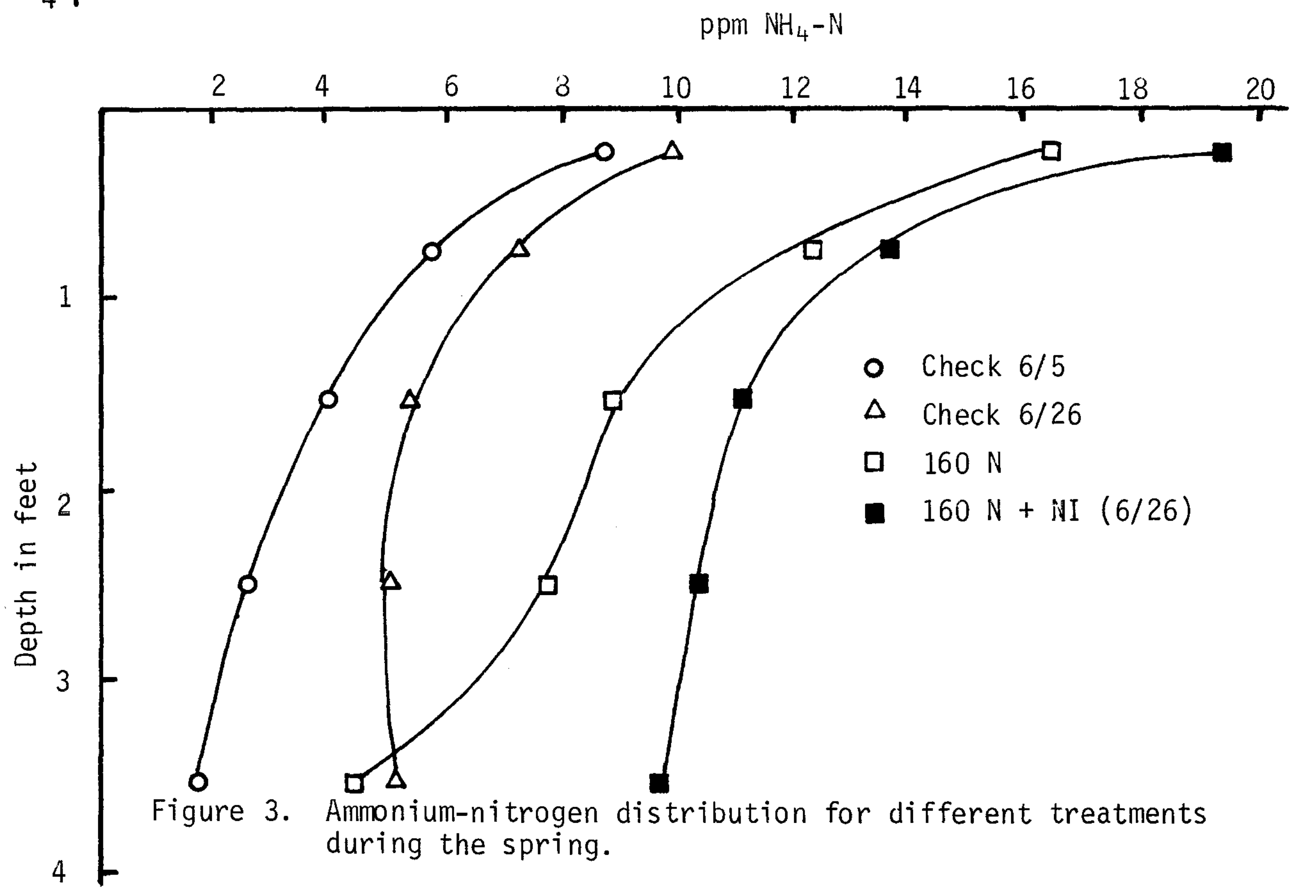

Figure 3. Ammonium-nitrogen distribution for different treatments during the spring.

IMPROVING NITROGEN FERTILIZER RECOMMENDATIONS ON CORN

E.J. Penas, G.W. Rehm, G.W. Hergert and D.H. Sander

Objectives:

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

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

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

Procedure: This study included 11 experimental plots selected in Districts II, III, IV and V. Data were collected from all 11 sites. Other experiments with nitrogen rates and carriers on corn were conducted in District IV and are being reported separately by the researchers involved. At three sites, experiments were conducted in two fields side-by-side where one field has been corn the previous year and the other soybeans.

Soil samples were collected to a depth of 6 feet at each site except Platte County and Sandhills Ag Lab (5 ft). These samples were analyzed for pH, phosphorus, potassium, zinc and organic matter for the surface sample and for nitrate 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 20 or 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 tables.

Results and Discussion: Corn grain yields were not increased by nitrogen at any of the four non-irrigated sites even though yield levels were satisfactory (73 to 121 bushels per acre). Soil nitrate-nitrogen levels ranged for 60 to 150 pounds per acre 6 feet of soil and these levels were adequate for the grain yields achieved.

Nitrogen increased corn grain yields at three of the seven irrigated sites. These three sites had low levels of nitrate-nitrogen in the soil. The two experimental sites in Platte County also had low levels of nitrate nitrogen in the soil; however, there was no response to the applied rates of nitrogen. Nitrogen applied by the farmer as a mixed dry blend (16 pounds of N per acre) and as a herbicide carrier (30 pounds of N per acre) plus nitrate nitrogen in the soil and the irrigation water was sufficient for 170 bushel corn per acre that was produced.

The site in Burt County where corn was grown in 1980 contained 142 pounds of nitrogen in the soil which, along with some nitrogen in the irrigation water, was sufficient for the 131 bushels per acre produced. The other site in Burt County contained 105 pounds of nitrogen per acre which, following soybeans, was sufficient for the 150 bushels per acre produced.

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

NITROGEN RATES ON CORN, 1981
SOIL TEST DATA

County & Cooperator	Soil pH	Nitrogen, lbs/ac 6 ft.	Phosphorus, ppm	Potassium, ppm	Zinc, ppm	Organic Matter, %
Burt						
Tippery						
Corn	6.8	142	18 Med	224 VHi	9.9 Hi	4.5
Soybeans	6.5	105	24 Med	251 VHi	9.4 Hi	4.5
Platte						
Fluckiger						
Corn	6.8	97/5 ft.	32 Hi	359 VHi	2.8 Med	2.1
Soybeans	6.8	64/5 ft.	42 Hi	333 VHi	5.0 Hi	2.1
Washington						
Lottman						
Corn	6.1	150	26 Hi	292 VHi	6.1 Hi	3.0
Soybeans	6.0	82	10 Low	197 VHi	6.5 Hi	2.8
NE Station						
NS I	7.8	81	3 VLo	210 VHi	5.9 Hi	1.4
NS II	6.5	60	38 Hi	517 VHi	7.1 Hi	2.7
NP Station	7.6	66	15 Low	451 VHi	4.2 Hi	1.5
Sandhills Ag Lab	5.8	102/5 ft.	22 Med	164 VHi	11.8 Hi	1.3
Greeley Sander	8.1	90	8 Low	384 VHi	8.1 Hi	1.1

NITROGEN RATES ON CORN, 1981
GRAIN YIELDS

County:	Burt	Burt	Washington	Washington
Cooperator:	Tippery	Tippery	Lottman	Lottman
Previous Crop:	Corn	Soybeans	Corn	Soybeans
Nitrogen Rate, lbs/ac	-----------Grain Yield, bushels/acre-----------			
0	126	152	106	124
20	132	154	114	122
40	138	150	110	120
60	126	152	109	122
80	132	149	113	124
100	138	144	107	116
120	129	153	111	123
140	130	144	113	113
Response:	No	No	No	No
Soil NO_3-N, lbs/ac 6 ft:	142	105	150	82
Starter N, lbs/ac:	0	0	8	8
N in Water:	7.4 ppm	7.4 ppm	--	--

County:	Platte	Platte
Cooperator:	Fluckiger	Fluckiger
Previous Crop:	Corn	Soybeans
Nitrogen Rate, lbs/ac	--Grain Yield, bushels/ac--	
0	166	167
40	---	174
80	166	172
120	176	166
160	170	158
200	178	172
240	166	170
280	170	174
Response:	No	No
Soil NO_3-N, lbs/ac 5 ft:	97	64
Starter N, lbs/ac:	46	46
N in Water:	12.9 ppm	12.9 ppm

NITROGEN RATES ON CORN, 1981
GRAIN YIELDS

Location: Previous Crop: Nitrogen Rate, lbs/ac	Greeley Corn	North Platte Station Corn	Sandhills Ag Lab Corn
	Grain Yield, bushel/acre		
0	81	99	106
40	100	130	135
80	115	154	148
120	126	170	150
160	133	179	148
200	137	181	146
240	137	175	150
Response:	Yes	Yes	Yes
Soil NO_3-N, lbs/ac 6 ft.	90	66	102/5 ft.
Starter N. lbs/ac.	12	0	27
N in Water	0.1 ppm	1.7 ppm	0.6 ppm

Location: Previous Crop: Nitrogen Rate, lbs/ac	NS I Corn	NS II Corn
	Grain Yield, bushel/acre	
0	69	103
20	73	104
40	75	96
60	78	103
80	74	101
100	70	109
120	70	101
Response:	No	No
Soil NO_3-N, lbs/ac 6 ft.	81	60
Starter N, lbs/ac	10	0

Improving the Efficiency of Fertilizer N Use by Irrigated Corn 1/

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. Evaluate effects of planting date as it interacts with N management practice.

Procedure:

Corn was planted as in the two prior years at early, intermediate and late planting dates to a stand of 25,000 plants/A. Uniform irrigation was applied as needed in this third year of residual study without further N application. (^{15}N depleted $(NH_4)_2SO_4$ fertilizer was applied in the first two years at rates of 80 and 160 lbs N/A at planting or at 4-, 8- or 16-leaf growth stages.)

Results and Discussion:

Grain and stover yields were outstanding in 1981 considering the lack of fertilizer N additions (Table 1). Undoubtedly the warm fall, winter and spring prior to planting afforded substantial N mineralization from the native organic matter source to account for the average 142 bu/A check yield.

The greater previous N rate (160 vs 80 N/acre/year) increased grain yield an average 30 bu/A across all planting dates and times of N application in 1981 and raised grain:stover ratio from 1.23 to 1.35. There was virtually a linear effect of previous N application time on grain yield, the more delayed applications resulting in larger yields, i.e. from 161 bu/A for planting time N to 175 bu for N applied at 16-leaf stage. Since higher yields were obtained during the treatment years for the delayed applications as well, the 3-year N utilization efficiency values were notably enhanced by the delay especially with the nominal 80-lb rate that afforded most economic yield. Obviously, N losses from the soil system have occurred with early applications.

1/ Work supported by T.V.A. and Regional Research Funds

Table 1. Grain yield and N-use efficiency of irrigated corn on Sharpsburg sicl, 1979-81 (fertilizers applied in 1979 and 1980, none in 1981).

Planting time	N rate	N time	Grain yield 1979	1980	1981	FUE in grain[1/] 1979	1980	1981	3-yr
	lb/A		------- bu/A -------			-------------- % ------------			
Early	0	CK	173	108	141	--	--	--	--
	80	pl	183	149	153	41	31	5	41
		4-leaf	203	164	167	45	37	9	50
		8-leaf	188	178	161	47	59	9	62
		16-leaf	209	184	160	47	67	11	68
	160	pl	194	170	184	33	35	11	45
		4-leaf	196	156	175	28	34	11	42
		8-leaf	209	192	174	34	44	11	50
		16-leaf	198	194	196	23	42	15	48
Mid	0	CK	176	72	154	--	--	--	--
	80	pl	204	127	147	39	29	3	37
		4-leaf	207	146	165	47	34	9	50
		8-leaf	197	169	158	54	49	6	57
		16-leaf	211	163	162	50	59	9	63
	160	pl	189	160	178	33	29	9	40
		4-leaf	208	153	180	35	29	8	40
		8-leaf	202	166	190	30	36	13	46
		16-leaf	215	173	201	31	33	14	46
Late	0	CK	169	107	130	--	--	--	--
	80	pl	176	169	133	41	31	7	43
		4-leaf	188	184	159	48	43	13	59
		8-leaf	176	179	134	47	54	7	57
		16-leaf	163	175	142	40	57	8	57
	160	pl	183	182	173	34	30	11	43
		4-leaf	186	171	174	33	31	14	46
		8-leaf	182	189	182	32	34	15	48
		16-leaf	178	190	187	28	32	15	45

[1/] Calculated from isotopic distribution in 1979 and 1980, and by difference in 1981 $\left(\frac{\text{lbs in grain}}{\text{(lbs N applied 1979 and 1980)}}\right)$ The 1981 FUE values would be larger had N in the stover been included in the FUE.

INFLUENCE OF RATES OF K AND MG FOR CORN PRODUCTION ON IRRIGATED SANDY SOILS

G.W. Rehm

Objective:

Current K and Mg 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 and Mg. Some soils from the Sandhillls and bordering areas have levels of K and Mg which are currently considered to be in the medium or low range. The requirements for K and Mg for production of corn on these sandy soils should be determined. 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 Holt County in 1979 and continued in 1980 and 1981. The soil at the experimental site is classified as a Valentine loamy fine sand. 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 $MgSO_4 \cdot 7H_2O$ with treatments selected to fit a central composite factorial design are broadcast to the plots in mid-April of each year. All treatments receive 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 $MgSO_4 \cdot 7H_2O$, granular gypsum and $ZnSO_4$. Adequate N (a combination of 33-0-0, 82-0-0, and 28-0-0 with the irrigation water) was used on all treatments. All dry fertilizers are incorporated with a disk before planting.

Whole plant samples were collected at the 16-20 inch growth stage. The ear leaf at silking was also sampled. Samples of the harvested grain were saved in 1980 and 1981. These samples were dried, ground to pass a 2 mm screen and analyzed for K and Mg. Yields were recorded in mid-October each year.

Results and Discussion:

In each of the 3 years completed to date, the application of both K and Mg had no effect on both the early growth of the corn and the grain yield (Tables 2 and 3). The yields varied from year to year due to the interaction of corn growth with the environment.

Previous research from other states has shown that crops grown on soils with similar K contents will respond to the application of fertilizer K. In this study, the irrigation water supplies relatively small amount of K (8 lb./acre ft.). Since the organic matter content of the surface soil is less than 1.5%, the amount of K supplied from the mineralization of this source should be relatively low. The data collected throughout the 3 years indicate that this sandy 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 (11 lb./acre ft.) as well as the Mg content of the soil, the lack of a response to applied Mg could be anticipated.

The results of the analysis of plant samples collected in 1980 are presented in Tables 4 and 5. Considering the K concentrations, the percentage of K in the whole plant tissue as well as the K content of the ear leaf tissue was affected by rate of applied K. Response to applied K was curvilinear in both cases. The K concentration in the grain as well as the amount of K removed in the grain was not affected by rate of K applied.

Considering the effects of applied Mg, the Mg content of the young plants and ear leaf tissue increased linearly with rate of applied Mg. The Mg content of the grain and removal of Mg by the grain was not affected by rate of Mg applied.

This study will be continued in 1982.

Table 1. Soil properties of the experiment site. 1979.

			Soil Test				Exchangeable			
Depth	pH	NO_3-N	Bray #1-P	K	Zn	O.M.	CEC	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 early growth and yield of irrigated corn grown one a Valentine loamy fine sand, Holt County.

K Applied	Early Growth 1979	Early Growth 1980	Early Growth 1981	Yield 1979	Yield 1980	Yield 1981
lb./acre	- - - g/plant - - -			- - - - bu./acre - - - -		
0	15.6	8.9	7.0	178.9	170.7	141.1
30	15.0	8.9	6.7	181.0	161.1	141.8
60	14.6	9.3	6.4	182.5	163.6	142.3
90	14.4	8.9	6.2	183.4	162.7	142.6
120	14.4	8.5	6.0	183.7	162.4	142.8
150	14.6	7.5	5.9	183.4	164.4	142.6
180	14.6	6.9	5.8	182.5	162.1	142.3
210	15.5	7.4	5.8	181.0	160.9	141.8
240	16.3	7.6	5.7	179.0	158.8	141.1

Table 3. Effect of rate of applied Mg on early plant growth and yield of irrigated corn grown on a Valentine loamy fine sand. Holt County.

Mg Applied	Plant Weight 1979	Plant Weight 1980	Plant Weight 1981	Yield 1979	Yield 1980	Yield 1981
lb./acre	- - - - - g/plant - - - - -			- - - - bu./acre - - - -		
0	14.3	7.7	5.8	181.0	162.3	138.1
5	14.7	8.2	6.0	181.3	165.1	140.4
10	15.1	7.6	6.2	181.4	159.5	142.1
15	15.3	7.9	6.3	181.6	162.2	143.3
20	15.4	8.9	6.3	181.7	165.8	143.9
25	15.4	8.5	6.4	181.9	164.9	144.0
30	15.3	8.6	6.3	182.0	166.2	143.5
35	15.1	8.0	6.3	182.1	157.0	142.4
40	14.8	8.5	6.1	182.2	164.9	140.8

Table 4. Effect of rate of applied K on the K content of corn tissue and the K removed in the grain. 1980. Holt County.

K Applied	K Content: Whole Plant (12-16 in.)	K Content: Ear Leaf	K Content: Grain	K Removal
lb./acre	% K			lb./acre
0	3.45	1.91	.576	45.7
30	3.69	2.03	.571	45.0
60	3.88	2.15	.570	44.5
90	4.03	2.24	.571	44.2
120	4.14	2.32	.575	44.2
150	4.20	2.37	.583	44.5
180	4.21	2.41	.593	45.0
210	4.19	2.43	.605	45.7
240	4.19	2.43	.621	46.7

Table 5. Effect of rate of applied Mg on the Mg content of corn tissue and the Mg removed in the grain. 1980. Holt County.

Mg Applied	Mg Content: Whole Plant (12-16 in.)	Mg Content: Ear Leaf	Mg Content: Grain	Mg Removal
lb./acre	% Mg			lb./acre
0	.258	.270	.202	15.5
5	.269	.280	.199	15.3
10	.279	.290	.196	15.1
15	.287	.298	.194	15.1
20	.294	.304	.194	15.0
25	.301	.310	.195	15.1
30	.305	.315	.196	15.2
35	.309	.318	.199	15.4
40	.312	.320	.202	15.6

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 studies have shown that S is needed for sandy soils, only. Yet, there are still many farmers and fertilizer dealers who raise questions about the use of S for corn on soils having a silt loam or silty clay loam texture. Therefore the objective of this study was to evaluate the effect of rate and source of S on production of corn grown on silt loam soils.

Procedure:

This study was initiated at the Northeast Experiment Station in 1980 and repeated in 1981. The soil is classified as a Nora silt loam. Soil properties are listed in Table 1. Two S sources (granular gypsum, elemental sulfur) were used. These sources were broadcast to supply 0, 10, 20, 30, 40 lb. S/acre. All treatments received N at 80 lb./acre as 82-0-0. The starter fertilizer was 100 lb. 10-34-0/acre. The S sources were broadcast and incorporated with a disk before planting. Grain yields were harvested in mid-October each year.

Results and Discussion:

Neither the source nor rate of S applied had a significant effect on yield in both 1980 and 1981 (Table 2) . Because of more favorable weather in 1981, yields were higher than those recorded in 1980. The data from this study are consistent with the results of studies conducted in past years. The data reported here when combined with the data from earlier studies clearly show that sulfur fertilizers are not needed for corn production on the non-sandy soils.

Table 1. Properties of the soil 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, ppm	5.6	3.9	3.5	3.6	3.3	4.9	5.0
P(Bray + Kurtz #1),ppm	7.7	-	-	-	-	-	-
K($NH_4C_2H_3O_2$), ppm	218	-	-	-	-	-	-
Zn(.1N 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 dryland corn on a silt loam soil. Northeast Experiment Station.

S Applied	Granular Gypsum 1980	Granular Gypsum 1981	Ave.	Elemental Sulfur 1980	Elemental Sulfur 1981	Ave.
lb./acre	- - - - - - - - -	- - - - - - - - -	- - - - - bu./acre	- - - - - - - - -	- - - - - - - - -	- - - - -
0	76.6	132.9	104.8	68.7	136.2	102.5
10	76.0	136.5	106.3	82.2	135.3	108.8
20	79.5	131.1	105.3	77.4	137.7	107.6
30	70.0	136.5	103.3	73.6	139.7	106.7
40	82.7	134.0	108.3	75.0	139.6	107.3

EVALUATION OF LIME FOR CORN PRODUCTION ON IRRIGATED SANDY SOILS

G.W. Rehm

Objective:

The importance of lime for crop production on the acid soils of other states has been well documented. The pH of the irrigated sandy soils in the Sandhills and the bordering areas usually drops into the acid range with the continuous corn production system. There is some question, however, 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 3 sites in northeast Nebraska in 1979 and continued in 1980 and 1981. Finely ground agricultural lime was broadcast and incorporated before planting in the spring of 1979. Adequate amounts of N, P, K, S, and Zn are applied yearly to all treatments at each site. The normal crop production practices used by the cooperating farmers are followed. No additional lime has been applied since the spring of 1979.

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

Results and Discussion:

Yields recorded to date are listed in Table 2. Severe hail prevented harvest from the Nelson and Ericson sites in 1979. The application of lime produced small increases in yield at the Kunz site in 1980 and the Nelson site in 1981. Otherwise, the rates of lime applied in 1979 have had no effect on corn yield.

The responses to lime, however, are not consistent with soil properties. The initial pH at the Kunz location was 5.9 while the pH at the Nelson location was 5.5. The pH of the Ericson site was also 5.5. Yet, there was no response to lime at this site.

As would be expected, the application of lime altered soil pH. The resulting pH values are shown in Figure 1.

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. Therefore, this study will be continued in 1982.

Table 1. Properties of the soils at the experimental sites sampled spring 1979.

Property	Depth (in.)	Name: 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 + Kurtz #1), ppm	0 - 6	21	38	5
K($NH_4C_2H_3O_2$), ppm	0 - 6	158	263	147
Zn(.1N HCl), ppm	0 - 6	3.2	9.5	1.9
organic matter, %	0 - 6	1.1	1.3	2.1
CEC, m.e./100 gm	0 - 6	6.51	5.25	8.51
texture	0 - 6	loamy fine sand	loamy fine sand	sandy loam

Table 2. Effect of rate of lime applied in 1979 on corn production from irrigated sandy soils.

Lime Applied	Ericson (80)	Ericson (81)	Ave.	Nelson (80)	Nelson (81)	Ave.	Kunz (79)	Kunz (80)	Kunz (81)	Ave.
	Site and Year									
ton/acre	bu./acre									
0	127.9	148.7	138.3	155.7	159.1	157.4	149.5	177.5	170.4	165.8
.5	126.4	153.4	139.9	140.8	151.8	146.3	140.8	174.0	172.2	162.3
1.0	130.5	171.8	151.2	152.7	156.1	154.4	148.3	182.1	171.1	167.2
1.5	121.9	148.2	135.1	140.1	156.5	148.3	150.5	191.2	156.6	166.1
2.0	122.6	154.1	138.4	155.1	157.4	156.3	139.2	180.3	167.2	162.2
2.5	132.6	152.4	142.5	146.1	156.7	151.4	147.4	193.6	167.9	169.6
3.0	127.8	155.0	141.4	145.0	161.9	153.5	146.0	186.4	161.5	164.6
3.5	134.7	156.6	145.7	141.9	162.1	152.0	151.1	192.7	172.5	172.1

Table 3. Nutrient content of the irrigation water used at the experimental sites.

Nutrient	Ericson	Site Nelson	Kunz
	- - - - - - - - lb./acre foot - - - - - -		
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

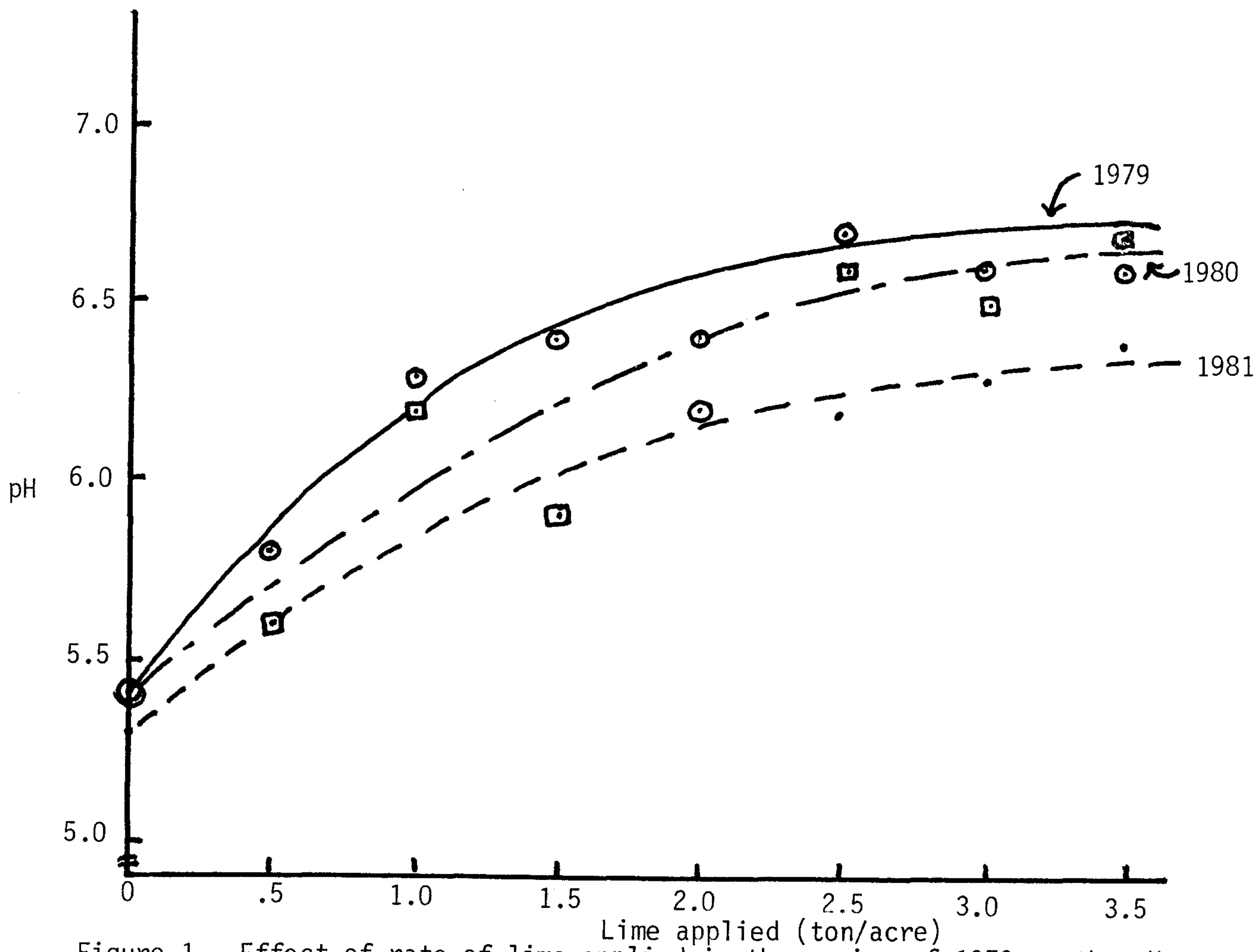

Figure 1. Effect of rate of lime applied in the spring of 1979 on the pH at the Ericson location.

Acid-Neutralized Ammonia Through Sprinkler Irrigation 1/

J.W. Zupancic, K.D. Frank, G.W. Hergert and R.A. Olson

Objective:

1. This study was conducted for evaluating feasibility of applying acid-neutralized ammonia through a sprinkler system for irrigated corn.

2. Determine in how far phosphoric acid can serve combined P fertilization and acidification purposes.

Procedure:

Field studies were conducted during 1981 on Sharpsburg sicl at the Mead Field Lab and on Hastings sil at the South Central Station (SCS). Urea-ammonium nitrate (UAN) solution and acid-neutralized ammonia (ANA) were applied through sprinkler systems at two rates in three increments from the 8-leaf growth stage to silking, taking care that the solution of ANA and irrigation water did not exceed pH 8. Nitrogen as ammonium sulfate (AS) was also side-dressed at the 8- and 16-leaf growth stages for comparison.

Experimental Results:

No significant yield differences for treatments were measured at SCS (Table 1). This soil recently plowed out of brome sod of 30 years vintage has a very high N mineralization potential as evidenced by the 185 bu/A check yield. The Sharpsburg soil at Mead also produced the very high check yield of 169 bu/A, presumably explained by the warm fall, winter and early spring prior to planting. Corn growing in this plot area during the previous two years had been very N deficient. At neither location was there any real difference between injected UAN and ANA in the measured parameters. However, side-dressed AS was generally superior to sprinkler-applied treatments at the Mead location.

Experience with the Mead sprinkler system emphasized the importance of injecting both acid and NH_3 at a point of turbulence to insure complete mixing. If this precaution is not taken the two injections may not interact resulting in damaged vegetation and possible damage to the sprinkler system.

Field and laboratory experiments were also conducted on Sharpsburg sicl (pH 6.5) to measure NH_3 losses from UAN and ANA applied with irrigation water. The NH_4OH employed was neutralized with various combinations of H_2SO_4 and H_3PO_4. Measured NH_3 losses did not exceed 1% of the 179 lbs N/A rate applied with irrigation water. These findings agree with previous work showing minimal loss when nominal rates are distributed in irrigation water, but further investigation is needed on coarse-textured and alkaline soils.

1/ Work supported by Farmland Industries and Phillips Chemical Co.

Table 1. Effect of N source and application method on corn yield and N uptake at two locations, 1981. See text for description of treatments.

Nitrogen		Yield[1/]			Nitrogen content		Nitrogen Uptake		
Source	Rate	Grain	Stover	Total	Grain	Stover	Grain	Stover	Total
	lb N/acre	bu/acre	lb/acre		-----%------		-----lb N/acre-------		
				SCS					
Control	0	185	6840	15600	1.48	0.65	129	43	173
UAN	89	187	7560	16400	1.36	0.62	118	46	164
UAN	178	187	7040	15900	1.27	0.74	112	55	167
ANA	89	182	6240	14900	1.32	0.56	116	36	152
ANA	179	196	6710	16000	1.32	0.53	122	36	158
AS	179	169	6160	14200	1.56	0.76	125	48	173
				MEAD					
Control	0	169	5430	13500	1.25	0.47	101	25	126
UAN	89	181	5750	14300	1.30	0.60	112	34	146
UAN	178	162	5440	13100	1.28	0.51	98	28	126
ANA	89	146	5650	12500	1.27	0.55	88	31	119
ANA	178	186	5750	14500	1.28	0.56	113	32	146
AS	89	184	6360	15100	1.38	0.64	119	40	160
AS	178	188	7270	16200	1.37	0.60	122	44	166

[1/] Grain yield expressed on 15.5% moisture basis; stover and total yields expressed on dry matter basis.

DEEP PLACEMENT OF N FERTILIZER FOR N-DEFICIENT, IRRIGATED CORN[1/]

E. G. Gatliff, G. W. Hergert and R. A. Olson

OBJECTIVE:

1. Measure the yield and N uptake response of irrigated corn to placement of N at varied depths in the rooting profile.

PROCEDURE:

Treatments on Sharpsburg sicl at the Mead Field Lab consisted of injecting 32% UAN solution into 5 holes over a lineal distance of 5 feet between two 30-inch rows of N-deficient irrigated corn. Rate was 150 lbs. N/A placed at respective depths of 1, 2, 4 and 6 feet during the late silk stage of development (granted, later than desirable).

A more comprehensive series of treatments was made on Cozad sil at the North Platte Station including injection of 32% UAN solution into ten ¼" diameter holes over a lineal distance of 10 feet between two 30-inch rows of furrow-irrigated corn. Two N rates of 60 and 120 lbs. N/A were applied at 6, 26, 46 and 66 inches depth approximately 2 weeks after planting.

RESULTS AND DISCUSSION:

The late N treatment notwithstanding on Sharpsburg, significantly greater grain yield, N content and N uptake were obtained with treated plots compared to the unfertilized control plots (Table 1). No differences existed among treatments except for grain N content which decreased with increasing depth of application. Only 20 percent of the N applied at the one-foot depth was recovered (by 'difference' method) indicating that rate was substantially more than needed for most economic N response. Nevertheless, the data indicate that irrigated corn on Sharpsburg soil is readily capable of utilizing N that has accumulated at considerable depth in the soil as long as N is not plentifully available in upper horizons.

The 120 lb. N rate on Cozad sil showed a significant yield response at all placement depths while the 60 lb. rate gave significant response only at the 6 and 26 inch depths (Table 2). Under the conditions of this study it appeared that little yield difference occurred except that caused by N rate as long as the N source was placed within the upper 26 inches of soil. Higher concentrations of N were needed, however, to realize response to that occurring below 26 inches.

1/ Work supported by extramural USDA-SEA funds

Table 1. Depth of placement of N fertilizer effects on grain moisture, yield and nitrogen content, 1981, (150 lbs. N applied at silking).

Depth of Application	Moisture	Dry Matter	Yield	Nitrogen		F.U.E.[2/]
ft	%	lb/acre	bu/acre[1/]	%	lb/acre	%
0	17.8	5300	112	1.18	62	0
1	19.0	6490	137	1.42	92	20
2	21.3	6590	139	1.39	91	19
4	20.1	6360	134	1.36	87	17
6	19.6	6410	135	1.26	81	13

[1/] 15.5% moisture

[2/] Fertilizer use efficiency = $\frac{\text{lb N in grain (fertilized) - lb. N in grain (control)} \times 100}{\text{150 lb N applied}}$

Table 2. Effect of placement of N fertilizer and N rate on grain moisture and yield, 1981, (N applied at 4 leaf stage).

Rate	Depth of Application	Stover Yield	Grain Yield	Green Moisture
lb./Acre		lb./Acre	bu./Acre[1/]	%
0	0	2909	90	26.3
60	6"	3690	113	26.2
60	26"	2948	107	25.5
60	46"	2890	96	26.3
60	66"	2637	86	25.2
120	6"	3572	131	24.3
120	26"	3441	143	23.7
120	46"	2777	105	26.3
120	66"	2838	107	26.1

1/ 15.5% moisture

PLACEMENT OF FERTILIZER-P FOR CORN PRODUCTION ON P

DEFICIENT SOILS IN THE EASTERN GREAT PLAINS

G.W. Rehm and D.H. Sander

Objective:

The use of fertilizer-P is an important component of any management for corn production on the soils of northeastern and eastern Nebraska which have a low or very low level of P as measured by routine soil tests. In the past, P fertilizer has generally been either broadcast and incorporated with a tillage implement or applied in a band below and to the side of the seed at planting. This study was designed to evaluate other placements of fertilizer P in an effort to improve the efficiency of use of fertilizer P.

Procedure:

This study was conducted at two sites in northeast Nebraska in 1981. General properties for the 0-8 in. surface soil are listed in Table 1. Five placements of fertilizer P were evaluated at each location. A short description of each placement specific for this study follows.

Starter: Fertilizer P is placed in a band to the side of and below the seed at planting. The distance between fertilizer and seed was 2.0-2.5 inches.

Broadcast: Fertilizer P is broadcast on the soil surface and incorporated with a disking operation before planting.

Deep Band: The corn planter was modified with the addition of standard injection knives to allow for placement of fertilizer P about 6 in. to the side of and 6 in. below the seed at planting.

Disk Applied: Fertilizer P is placed in a band on 18 in. centers by means of equipment attached to a normal disk. The depth of placement was about 6 in. below the soil surface for the sandy soil and 4 in. below the surface for the silt loam soil.

Sidedress: Fertilizer P is injected at a depth of 8-10 in. between corn rows after emergence. In this study, the sidedress P was applied to both locations in early June.

The P source was 10-34-0 for all treatments. The P rate was 15 lb./acre for all treatments. When a starter placement was used in combination with another treatment, 7.5 lb. P/acre were applied in the starter with the remaining 7.5 lb. P/acre applied in the respective placement.

Corn (Golden Harvest 2500) was planted at 27,000 seeds/acre in early May. All plots at the sandy site (Antelope County) received 80 lb. K_2O/acre as 0-0-60, 32 lb. N and 36 lb. S/acre as 21-0-0-24 and 2 lb. Zn/acre as NZN. All materials were broadcast and incorporated before planting. Total N applied at each site was 220 lb./acre.

Whole plant samples were collected for each plot 3 weeks after emergence and at the 12-16 in. growth stage. The most recently matured leaf was sampled in early July before silking. The ear leaf at silking was also sampled. These samples, in addition to the grain, will be analyzed for P in an effort to measure any effect of P placement on P uptake by corn throughout the growing season.

Results and Discussion:

Although the P concentration (Bray and Kurtz #1) of the soil at the Northeast Station site was in the low range, applied P did not increase corn yield (Table 2). Compared to the control, all treatments increased yield at the Antelope County site.

Placement also affected the weight of plants at the 12-16 in. growth stage at the Antelope County site. Plants from the control and sidedress treatments were smallest at this stage of growth. Plant weights were highest when ½ of total P was placed in the starter fertilizer. Values from other treatments were intermediate. Differences in plant weights were not consistent at the Northeast Station site.

The use of fertilizer P has been known to affect the maturity of grain crops on low-P soils. In this study, the moisture content of the grain at harvest was used as a measure of maturity. Although there were significant differences among treatments, there was no consistent pattern and no specific conclusions can be reached at this time.

Table 1. Properties of the soils (0-8 in.) at the experimental sites.

Property	Antelope County	Northeast Station
soil type	Valentine loamy fine sand	Nora silt loam
pH	6.4	7.1
P(Bray and Kurtz # 1), ppm	5.8	12.0
$K(NHy^4C_2H_3O_2)$, ppm	169	195
organic matter, %	1.3	2.2
P ($NaHCO_3$), ppm	2.9	8.4

Table 2. Effect of P placement on early growth, grain yield, and moisture content of grain at harvest

Placement	Antelope County			Northeast Station		
	Plant weight (12-16 in.)	Yield	Moisture	Plant weight (12-16 in.)	Yield	Moisture
	g/plant	bu./acre	%	g/plant	bu./acre	%
control	9.1 c*	152.5 d	25.4 ab	10.6 ab	147.1 a	23.7 b
starter	17.5 a	199.8 a	22.6 c	11.0 ab	159.4 a	25.4 ab
broadcast	15.8 ab	175.5 bc	24.3 abc	11.9 ab	158.9 a	24.8 ab
broadcast + starter	18.6 a	193.1 a	22.4 c	11.4 ab	156.8 a	25.4 ab
deep band	12.0 bc	174.1 bc	24.7 abc	10.5 ab	163.6 a	25.9 a
deep band + starter	16.8 a	188.3 ab	22.3 c	10.4 ab	147.8 a	25.5 ab
sidedress	9.2 c	164.2 cd	25.6 a	9.1 b	148.4 a	26.0 a
sidedress + starter	16.2 a	194.6 a	22.6 c	10.3 ab	157.1 a	26.0 a
disk applied	16.8 a	189.8 ab	23.2 abc	11.7 ab	157.1 a	24.3 ab
disk applied + starter	19.7 a	200.5 a	22.9 bc	12.5 a	160.8 a	24.6 ab
CV: %	16.9	6.2	6.6	15.8	6.5	4.8

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

SALT EFFECT OF UREA PHOSPHATE FERTILIZER[1/]

Kenneth D. Frank

Objective:

To determine the effect of TVA material urea phosphate (14-28-0) and 7-21-7 produced from the 14-28-0, as well as ammonium polyphosphate (10-34-0) and 7-21-7 produced from 10-34-0 on corn plant emergence and final stand when the above materials were applied directly on the seed at different rates.

Procedure:

An experiment was established on a Hastings silty clay loam soil at the University of Nebraska South Central Station. Each material was applied to provide three rates of salt (N + K) [10, 20, and 30 pounds/A]. A zero check was included. The materials were applied directly with the seed at planting time using a four row Buffalo till planter with a slot attachment. Four planting times were used. Soil temperature and moisture content were recorded at each planting time. Stand counts were taken three times for each planting date. The planting depth was approximately 1 1/2 inches for each planting time. Planting times were not randomized within the experimental plot area. Within each planting time, material was the whole plot and rates the subplots. Materials were randomized within each of four replications. Each rate was applied from each of the four planter rows which should have reduced the variability associated with different rates of planting from each planter box.

Discussion:

Table 1 contains the soil moisture and temperature data for each time of planting.

Table 1. Soil temperature and moisture content for the 1 to 4" depth and date stand count taken for each of four planting times.

	Planting Dates			
	May 1	May 15	May 26	June 11
Soil temperature ^{o}F	67	55	70	75
Soil moisture %	26.3	27.1	27.5	25.5
Stand Count 1	May 21	June 2	June 11	June 23
Stand Count 2	May 27	June 11	June 18	June 29
Stand Count 3	June 11	June 22	June 26	July 6

1/ Report on a cooperative project with Dr. Gary Hergert and Dr. Don Sander. Support for the investigation supplied by TVA.

As shown in Table 2, with the urea phosphate material, there is an indication that even the 10-pound rate of salt is delaying emergence as shown by the May 21 count. The ammonium polyphosphate has less influence, but at higher rates, is causing some stand reduction. Also, the 7-21-7 materials (TVA and ammonium polyphosphate) has less effect than the 14-28-0 and 10-34-0 (Table 3 source x rate interaction significant).

Table 2. Observed number of plants per 40 feet of row[1/] as influenced by time after planting, source, and rate of total salt. Planted May 1, 1981.

Material	Rate #/A Total Salt	Observation Dates May 21	May 27	June 11
TVA				
14-28-0	0	56	61	61
14-28-0	10	39	55	53
14-28-0	20	23	42	37
14-28-0	30	18	31	30
TVA				
7-21-7	0	58	62	59
7-21-7	10	46	56	55
7-21-7	20	41	60	51
7-21-7	30	37	54	57
7-21-7	0	59	63	63
7-21-7	10	58	62	57
7-21-7	20	50	57	55
7-21-7	30	46	58	59
10-34-0	0	51	61	58
10-34-0	10	49	58	58
10-34-0	20	40	49	51
10-34-0	30	24	37	43

1/ Mean of four replications.

Table 3. Analysis of variance for observed number of plants as influenced by treatments. May 1 planting.

Source	Observation Dates		
	May 21	May 27	June 11
	Probability of a Greater F		
Replication	0.95	0.74	0.24
Rate of Material	0.0001	0.0001	0.0001
Source of Material	0.0001	0.0001	0.0001
Source x Rate	0.25	0.009	0.0006
R-Square	0.68	0.71	0.74
C.V.	23.3	12.8	11.5

Table 4 shows the observed plants for the May 15 planting. The reduction in observed plants is not following the same pattern as the May 1 planting as shown in Table 2. There is a significant difference in rate of salt, but not as pronounced as the May 1 planting.

Table 4. Observed number of plant per 40 feet of row[1/] as influenced by time after planting, source, and rate of total salt. Planted May 15.

Material	Rate #/A Total Salt	Observation Dates		
		June 2	June 11	June 22
TVA				
14-28-0	0	52	55	57
14-28-0	10	59	55	56
14-28-0	20	43	47	49
14-28-0	30	47	49	52
TVA				
7-21-7	0	49	50	52
7-21-7	10	56	57	59
7-21-7	20	56	52	53
7-21-7	30	55	56	58
7-21-7	0	50	57	58
7-21-7	10	54	55	58
7-21-7	20	51	52	52
7-21-7	30	47	51	54
10-34-0	0	57	56	57
10-34-0	10	54	49	52
10-34-0	20	45	48	47
10-34-0	30	54	48	52

1/ Mean of four replications.

Table 5. Analysis of variance for observed number of plants as influenced by treatments. May 15 planting.

Source	Observation Dates		
	June 2	June 11	June 22
	Probability of a Greater F		
Replication	0.29	0.40	0.30
Rate of Material	0.05	0.03	0.02
Source of Material	0.47	0.26	0.28
Source x Rate	0.13	0.26	0.54
R-Square	0.39	0.38	0.36
C.V.	14.0	10.9	10.5

Table 6 shows the observed plants for the May 26 planting date. The situation is similar to the May 1 planting date. However, the urea phosphate 14-28-0 shows a larger reduction than the 10-34-0. The same trend is continued in the last planting date (Table 8). The number of observed plants is less for all treatments than for the other three planting times. There is no ready explanation for this unless the planting rate was less than planned for. Nevertheless, the relative change in observed plants follows the same pattern as the other times. The urea phosphate 14-28-0 siginficantly reduced the number of observed plants, especially at higher rates of salt.

Table 6. Observed number of plants per 40 feet of row as influenced by time after planting, source, and rate of total salt. Planted May 26.

Material	Rate #/A Total Salt	Observation Dates		
		June 11	June 18	June 26
TVA				
14-28-0	0	64	65	65
14-28-0	10	44	44	44
14-28-0	20	29	28	29
14-28-0	30	8	8	9
TVA				
7-21-7	0	65	66	66
7-21-7	10	61	62	63
7-21-7	20	57	60	59
7-21-7	30	54	47	50
7-21-7	0	64	65	64
7-21-7	10	60	62	61
7-21-7	20	44	47	46
7-21-7	30	51	52	52
10-34-0	0	64	64	64
10-34-0	10	59	62	62
10-34-0	20	60	59	60
10-34-0	30	52	54	55

Table 7. Analysis of variance for observed number of plants as influenced by treatments. May 26 planting date.

Source	Observation Dates		
	June 11	June 18	June 26
	Probability of a Greater F		
Replication	0.01	0.045	0.08
Rate of Material	0.0001	0.0001	0.001
Source of Material	0.0001	0.0001	0.001
Source x Rate	0.0001	0.0001	0.001
R-Square	0.85	0.82	0.84
C.V.	14.0	16.2	14.7

Table 8. Observed number of plants per 40 feet of row[1/] as influenced by time after planting, source, and rate of total salt. Planted June 11.

Material	Rate #/A Total Salt	Observation Dates		
		June 23	June 29	July 6
TVA				
14-28-0	0	39	43	45
14-28-0	10	40	39	39
14-28-0	20	32	30	29
14-28-0	30	38	32	31
TVA				
7-21-7	0	39	37	38
7-21-7	10	39	38	38
7-21-7	20	39	38	37
7-21-7	30	39	40	41
7-21-7	0	42	44	44
7-21-7	10	41	42	44
7-21-7	20	42	42	44
7-21-7	30	40	41	42
10-34-0	0	43	42	43
10-34-0	10	43	43	44
10-34-0	20	39	39	40
10-34-0	30	34	34	34

[1/] Mean of 4 replications.

Table 9. Analysis of variance for observed number of plants as influenced by treatments. June 11 planting date.

Source	Observation Dates		
	June 23	June 29	July 6
	Probability of a Greater F		
Replication	0.037	0.58	0.52
Rate of Material	0.097	0.04	0.02
Source of Material	0.098	0.02	0.01
Source x Rate	0.27	0.21	0.09
R-Square	0.43	0.43	0.48
C.V.	11.7	13.9	15.2

Summary:

Some general observations are as follows:

1. Urea phosphate 14-28-0 caused more reduction in observed plants than any other source.

2. The 7-21-7 materials from both sources cause less reduction than the parent material. Possibly indicating detrimental effect from ammonium.

3. For the two ammonium forms, the higher rates of salt reduced observed plants.

4. Higher rates of salt tended to slow emergence as evidenced by larger number of observed plants with increased time after planting.

Crop and Soil Response to Applied P and K
in a Long-Term Buildup/Depletion Study
(In Cooperation with T.V.A.)

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

Objectives:

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

Procedure:

The experiment is conducted with irrigated corn on Sharpsburg sicl at the Mead Field Lab, non-irrigated corn on Moody-Nora sil on the Northeast Station, and on non-irrigated wheat on Rosebud fsal and Keith sil on the High Plains Ag Lab. All P and K treatments are broadcast before final tillage and planting except for one row treatment at planting on the Mead station.

Results and Discussion:

The low rate of 10 lbs P/a was adequate in 1981 to effect the optimum yield of irrigated corn on the Sharpsburg soil in 1981 (Table 1). The 9-year average indicates response to 20 lbs P suggesting that only now has the 10 lb rate built up residually to the level needed. Note that 10 lbs has increased soil test P by 50%, 20 lbs has more than doubled and 30 lbs almost tripled the beginning soil test P level. Even the control plots without P are doing a good job of maintaining yields at 164 bu/a with but slight reduction in soil test P through the years. There has been no yield response to applied K other than the negative effect at the higher 50 lbs rate and when row applied. Soil test K has held up well without fertilizer, even gives indication of increasing through the years without K applied (due to N?).

The Moody-Nora soil has responded similarly in respect of yields, 10 lbs P being adequate in 1981 (Table 2). Twenty lbs P has modestly increased soil test levels while 30 lbs has doubled the level in 9 years. There has been no response to K applied on this soil, but soil test K appears to be declining except as 50 lbs K is applied annually.

The wheat plots at the High Plains Ag. Lab were fertilized and planted as scheduled in the fall of 1980 but were inadvertently harvested before yields were determined.

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, 1973-81.

No.	Treatment[1/] P	Treatment[1/] I	Application Schedule	Grain yield 1981	Grain yield 9 yr. ave.	Soil test P[2/] (Surface) 1973	1975	1977	1979	1980	1981	Soil test K[2/] (Surface) 1973	1975	1977	1979	1980	1981
				bu/a		ppm P						ppm K					
1	0	0	Control	157	164	15	12	14	7	6	11	320	350	320	333	361	375
2	10	0	Every year@	170	166	15	15	18	11	12	17	311	301	347	337	341	360
3	20	0	Every year@	167	171	16	16	24	14	20	32	310	323	337	349	330	350
4	30	0	Every year@	163	171	19	27	34	17	29	40	300	286	334	318	329	330
5	20	0	Every other year@	164	164	16	20	30	14	9	20	300	321	391	326	331	330
6	30	0	Every 3rd year	170	167	25	12	21	11	12	16	288	297	360	291	309	348
7	60	0	Every other year@	166	165	22	41	51	19	27	48	283	307	402	302	309	340
8	60	0	Every 6th year	158	162	30	14	19	19	19	20	288	285	377	299	315	343
9	20	25	Every year@	170	171	16	16	30	14	18	24	296	316	389	319	329	338
10	20	50	Every year@	167	163	14	20	24	13	18	25	296	304	326	327	352	368
11	10	25	Every year-row@	171	161	11	14	18	11	10	16	268	285	420	338	330	386

1/ Uniform N application made to all plots for optimum yield (200 lbs N/a in 1981); P and K treatments broadcast before final tillage (except for indicated row application); grain yield on 15.5% moisture basis. An @ indicates application in 1981. Means followed by the same letter are not different (p = 0.05) based on Duncan's Miltiple Range Test.

2/ Soil P by Bray and Kurtz No. 1 extraction; soil K is exchangeable with 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, 1973-81. Data reported by George Rehm.

Treatment[1/]			Application	Grain yield[2/]		Soil test P[3/] (Surface)					Soil test K[3/] (Surface)				
No.	P	K	Schedule	1981	8 yr. ave.	1973	1975	1977	1978	1980	1973	1975	1977	1978	1980
	lb/acre			bu/acre		ppmP					ppmK				
1	0	0	Control	117 b	109	10	10	9	6	8 c	223	185	195	192	169 b
2	10	0	Every year@	125 ab	118	9	11	13	10	9 bc	220	179	179	197	157 b
3	20	0	Every year@	125 ab	121	12	12	16	14	11 bc	228	177	187	200	164 b
4	30	0	Every year@	128 a	119	22	20	27	20	17 a	234	175	108	211	164 b
5	20	0	Every other year	127 a	114	9	11	12	7	8 bc	218	179	196	200	181 ab
6	30	0	Every 3rd year	127 a	116	17	9	12	8	8 c	224	178	190	205	166 b
7	60	0	Every other year	125 ab	119	11	13	22	25	17 a	213	173	202	197	155 b
8	60	0	Every 6th year	123 ab	116	11	12	11	10	9 bc	202	166	189	208	175 b
9	20	25	Every year@	128 a	118	10	12	16	12	13 abc	220	181	204	203	170 b
10	20	50	Every year@	122 ab	114	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 1981); P and K treatments broadcast before final tillage; grain yield on 15.5% moisture basis. An @ indicates application in 1981. 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 will be collected in spring 1982.

Project: 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 cholorsis in corn on high pH soils in west-central Nebraska.

Procedure: Two locations were selected for the experiments. The soil at both sites was a Cozad silt loam-saline-alkali. Thirteen treatments replicated four times was used at the Grabenstein site. Twelve treatments replicated three times were used at the Nordquist site. A modified Buffalo-Allis Chalmers air planter (4 row) was used. A John Blue squeeze pump allowed application of liquid materials. Buffalo dry fertilizer boxes were used to apply the Ironsul. All materials were placed on top of the seed in the seed furrow before closing except the urea phosphate and urea-phosphate plus iron which were banded 2 inches to the side and 2 inches below the seed (by hand) after planting.

Treatments are listed in Table 1. A paired plot technique was used so each treated row had a check row right beside it. A treated row ran the length of the field (¼ mile). The Eagle Iron was sprayed on at 15# of material/A in 20 gallons of water/A at 40 psi on July 7. Areas of fairly uniform chlorosis (based on check rows) were selected and flagged as harvest rows in July from all reps.

Table 1. Treatments used in iron chlorosis work, 1981.

1. 50# IronSul/A
2. 100# IronSul/A
3. 0.5# Fe/A KeMin experimental product (Not used at Nordquist)
4. 1# Fe/A from Iron KeMin (prepared as a solution)
5. 2# Fe/A from Iron KeMin (prepared as a solution)
6. 1# Fe from Hamp 845
7. 2# Fe from Hamp 845
8. 0.3# Fe from Seq. 138 (5# material/A)
9. UP (17.5 - 44.4 - 0) 44.7# material/A banded 2" x 2"
10. UP + Fe (15.2 - 38.7 - 3.9 Fe) 51.28#/A = 2# Fe/A banded 2" x 2"
11. Eagle Iron - 15# material/A - Total 20 gal/A solution at 40 psi applied 7/7.
12. Dow XP73022 0.5# Fe/A
13. Dow XP73022 1# Fe/A

Results:

The use of the paired plot technique was extremely effective. The Grabenstein area was fairly uniform for a chlorotic area but a simple analysis of variance on the 13 treatments using a Duncan's multiple range test showed no effect of any treatment even though there was a 30 bu/A spread in yield (Table 2). This typical analysis is actually misleading.

The inclusion of the covariate check for each treatment allows two statistical analysis. The first is a simple *t* test where the mean of the treatments is compared with the mean of the checks. Data for the *t* test are given in Table 3. On the basis of a 10% probability level the following

Table 2. Analysis of variance of the 13 treatment at Grabenstein not using the covariable check.

Source of Variation	df	ss	F	Prob >F
Total	51	52718.0577	-	
Block	3	18004.6731	7.54	0.0005
Treatment	12	6071.8077	0.64	0.80
Error		27641.5769	-	
			CV = 33.1%	

Duncan's Multiple Range Test 0.05

Treatment	Yield
Iron Sul - 100#	110 a*
Urea Phosphate + Fe	97 a
Iron KeMin - 2# Fe	92 a
Hamp 845 - 2# Fe	91 a
IronSul - 50#	90 a
Dow 1# Fe	90 a
Iron KeMin - 1# Fe	85 a
Urea Phosphate	83 a
KeMin Experimental - 0.5# Fe	76 a
Eagle Iron	75 a
Dow 0.5# Fe	74 a
Hamp 845 - 1# Fe	74 a
Sequestrene 138 - 0.3# Fe	70 a

*Yields followed by the same letter are not significantly different at the 10% level of probability.

Table 3. T Test and ANOCOVAR adjusted means for treatment and check means at Grabenstein's - 1981.

Treatment	Mean	Check Mean	|T|	Pr >|T|	Least square means
	------bu/A-------				---bu/A-----
50# IronSul	90	59	4.97	0.016	94
100# IronSul	110	56	5.99	0.009	116
New KeMin - 0.5# Fe	76	63	1.45	0.242	76
KeMin - 1# Fe	85	61	4.26	0.024	87
KeMin - 2# Fe	92	59	2.91	0.062	95
Hamp 845 - 1# Fe	74	57	3.87	0.031	80
Hamp 845 - 2# Fe	91	63	5.95	0.010	91
Sequestrene - 0.3# Fe	71	64	0.68	0.543	70
Urea Phosphate (TVA)	83	82	0.53	0.630	65
Urea Phosphate + Fe (TVA)	97	78	2.21	0.115	83
Eagle Iron	75	64	1.51	0.228	73
Dow - 0.5# Fe	74	60	2.00	0.139	77
Dow - 1.0# Fe	90	49	4.86	0.017	102

treatments produced significant yield increases: IronSul at 50 and 100#, Iron KeMin at 1 and 2# Fe, Hamp 845 at 1 and 2# Fe, and Dow at 1# Fe. Without use of the paired plot technique these differences could not have been expressed with any statistical confidence.

Use of the covariate check allows computation of an analysis of covariance (Table 4).

Table 4. Analysis of covariance for the Grabenstein plot, 1981.

Source	df	ss	F	Pr >F
Total	51	52718.0577	-	
Block	3	92.1838	0.12	0.948
Check	1	19693.2285	77.03	0.006
Treatment	12	9040.5082	2.95	0.0001
Error	35	8948.3485	-	0.0001
		CV = 18.8%		

The analysis of covariance (ANOCOVAR) reduced the CV from 35% to 18% and treatment differences were significant. The ANOCOVAR also predicts adjusted means based on the use of the check. The adjusted means are given in Table 3.

The Eagle Iron probably was applied too late in 1981 and may account for the poor yield response noted. The Sequestrene 138 showed few signs of correcting the deficiency all during the season. The urea phosphate with iron had to be applied early and unfortunately the degree of soil variability was extreme where it was used. This could not be ascertained at planting.

Because treated rows ran the length of the field a second area of harvest was selected from a non-chlorotic area. The UP, UP + Fe and Sequestrene 138 were not picked because the UP treatment did not run the length of the field and two of the Sequestrene 138 rows were picked out by the farmer as an alley for the first picking. The paired t tests are given in Table 5. Interestingly, none of the treatments had any effect except the IronSul. Both the 50 and 100# rates were significantly higher than the check rows. There was still variability in this area but the average of all the checks across this area of the field was about 130 bu/A. The least square adjusted means are given in Table 5. The increases from either of the IronSul treatments are interesting because it meant that treating the whole field was economical. More work will be needed to evaluate this response over several years. This work shows that some progress is being made in iron chlorosis.

Table 5. Paired T Test and ANOCOVAR adjusted means for the 1981 Grabenstein non-chlorotic area.

Treatment	Mean	Check	T	PR >|T|	Least square means
	------bu/A----				
50# IronSul	141	126	3.34	0.045	144
100# IronSul	158	137	2.92	0.061	155
New KeMin - 0.5# Fe	138	131	0.78	0.492	138
KeMin - 1# Fe	140	132	1.54	0.220	139
KeMin - 2# Fe	145	136	1.88	0.157	141
Hamp 845 - 1# Fe	134	135	-0.82	0.474	131
Hamp 845 - 2# Fe	140	136	0.76	0.503	137
Eagle Iron	129	128	0.18	0.869	130
Dow - 0.5# Fe	116	115	0.22	0.842	126
Dow - 1.0# Fe	132	130	0.38	0.727	132

Nordquist Site

Because two varieties were included inadvertantly the analysis will be given for each variety. This confounds looking at products at rates because of the variety confusion. The paired t test values for the two varieties are given in Table 6. Only two treatments seemed to have any effect: the IronSul and the Hamp 845. The Nordquist site is not as calcareous as the Grabenstein site. The high pH at Nordquist is primarily due to a higher sodium saturation of the soil. Chlorosis on this site is never as severe as Grabenstein's.

The most interesting thing noted at Nordquist was the effect of variety. The shorter season GH 2535 was more affected by high pH than the longer season GH 2500. No variety screening for iron chlorosis tolerance has been done in corn but similar varietal differences to tolerance of iron chlorosis may be present as it is in soybeans.

Table 6. T Tests for Nordquist site, 1981.

Treatment	Mean		Check mean	T	Pr >|T|	Adj. mean
	------bu/A-------					
Golden Harvest 2500						
50# IronSul	120	+19	101	2.92	0.099	117
100# IronSul	115	+16	99	1.69	0.232	114
KeMin - 1# Fe	95	-6	101	-0.57	0.627	62
Hamp 845 - 1# Fe	100	+26	74	9.01	0.012	123
Sequestrene 138 - 5# Fe	89	-1	90	-0.03	0.877	97
Urea Phosphate	113	-6	118	-2.44	0.135	94
Urea Phosphate + Fe	122	+2	120	0.28	0.809	100
Dow - 0.5# Fe	72	-10	82	-1.32	0.344	88
Golden Harvest 2535						
KeMin - 2# Fe	101	+3	98	1.94	0.192	87
Hamp 845 - 2# Fe	94	+13	81	3.21	0.085	96
Eagle Iron	81	+3	79	0.29	0.801	84
Dow - 1# Fe	74	-1	75	-0.14	0.904	82

Project: Nitrogen Rates and Sources for Ecofallow Corn

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

Objectives:

1. To determine the optimum nitrogen rate for maximum grain production in this system.

2. To compare the performance of different N carriers in this system.

Procedure: Three nitrogen sources were used at all locations: ammonium nitrate, urea, and urea ammonium nitrate. All dry or liquid N was broadcast applied and not incorporated. Anhydrous ammonia was shanked in at the UNL-Dryland Farm Site. A summary of site characteristics at the four locations is given in Table 1. Soil test data for the four sites is shown in Table 1. Residual nitrate levels at one of the sites was quite high. An N response would normally not be expected at residual soil nitrate levels above 120 lbs/A-6 ft unless rainfall was above normal for the region.

1981 was an above average rainfall year (Table 1). Soil moisture storage at planting was excellent at all locations. The complete root zone (6 feet) was near field capacity at all four sites.

Data for the UNL-Dryland Farm are given in Table 2. There was a significant N response at this site but no difference between the N sources. Grain yields for the other three sites are shown in Tables 3, 4 and 5, respectively. No difference between N sources was shown at any location. There was an N response at all locations. The N rate needed to maximize yield at each location was:

Site	Residual NO_3-N/6'	Maximum yield	N rate needed
UNL-Dryland Farm	93	100	65
Gene Huebner	76	110	100
Lawrence Huebner	121	112	60
Paul Schaffert	71	137	75

The encouraging result of the 12 locations over the past few years is that the surface-applied N solution performed essentially the same as ammonium nitrate. The data indicate (especially 1979) that there may be problems with N loss from surface applied urea in some years.

Table 1. Description of sites, cultural practices, and soil test levels.

Site	UNL-Dryland Farm	Gene Huebner	Lawrence Huebner	Paul Schaffert
Soil:	Holdrege silt loam	Hord silt loam	Hord silt loam	Hord silt loam
Planting	June 6	May 25	May 26	May 30
Seed Drop:	15,500/A	12,500/A	13,000/A	14,000/A
Row applied starter:	100#/A 10-34-0	100#/A 8-32-8	100#/A 8-32-8	None
N Fert. Applied	March 17	June 4	June 5	June 2
Growing season Rain:	15 inches	16 inches	16 inches	19 inches
pH	5.7	5.9	5.7	6.4
Bray 1 P	41	63	46	45
K	535	559	529	645
O.M.	1.2%	1.3%	1.1%	1.8%
Zinc	3.3M	5.3H	7.8H	5.2H
NO_3-N lbs/A-6'	93	76	121	71

Table 2. Corn grain yields for the UNL-Dryland Farm, 1981.

lbs N/A	Nitrogen Source UAN	AN	Urea	NH_3	Average
	(bu/A)				
0	74	74	74	74	74
25	84	95	87	95	90
50	96	105	86	101	97
75	101	95	100	106	100
100	108	99	95	103	101
125	101	101	104	103	102
Average	98	99	94	102	

Table 3. Corn grain yields for the Gene Huebner site, 1981.

lbs N/A	Nitrogen Source UAN	AN	Urea	Average
	(bu/A)			
0	84	84	84	84
25	88	90	94	91
50	97	98	99	98
75	99	108	97	101
100	111	98	110	106
125	112	115	105	110
Average	102	102	101	

Table 4. Corn grain yields for the Lawrence Huebner site, 1981.

lbs N/A	Nitrogen Source UAN	AN	Urea	Average
	(bu/A)			
0	88	88	88	88
25	108	103	91	100
50	104	102	104	104
75	111	114	110	112
100	105	110	111	109
125	117	114	107	113
Average	109	109	105	

Table 5. Corn grain yields for the Paul Schaffert site, 1981.

lbs N/A	Nitrogen Source UAN	AN	Urea	Average
	(bu/A)			
0	109	109	109	109
25	131	131	123	128
50	127	134	125	129
75	139	143	133	138
100	142	141	132	137
125	135	138	137	137
Average	135	137	130	

Nitrogen and Phosphorus Needs for Winter Wheat in Nebraska

D. H. Sander and G. A. Peterson

Winter wheat yields in 1981 were certainly among the highest ever harvested in experimental plots in Nebraska. One location in Gosper County averaged 5700 kg/ha (86 bu/acre). These high yields were the result of excellent growing conditions especially precipitation which was frequent and abundant.

Nine experiments comparing row vs broadcast P at six rates from 0 to 42 kg P/ha were harvested in 1981 (eight new locations and one permanent site). In addition, one experiment comparing 0-44-0 with 17-44-0 was studied, one experiment with expanded P application method was harvested, and a "dual placement" study with 10-34-0 and ammonia was harvested at one location.

The eight new soils studied in 1981 makes a total of 31 experimental locations available over a four year period to determine soil characteristics relating to the relative performance of seed versus broadcast P. Yield responses to P in 1981 were not as consistant as in past years. Wheat yields were not increased with P fertilization on two soils with low P soil tests (Table 1). Furnas County soil 81-13 and Hitchcock County soil 81-21 had Bray P levels of 12 and 8 ppm respectively in the surface 20 cm, yet wheat yields were not increased with P application. Row or seed applied P was significantly better than broadcast P on four soils (Gosper County 81-1 and 81-5, Frontier County 81-6, Hitchcock County 91-20). Seed applied P increased grain yield but broadcast did not at one location (Furnas County 81-15), and applied P increase yield at one location with no difference between methods of application (Furnas 81-16). Yields were increased with applied P from 4200 kg/ha to about 5000 kg/ha on a soil with a Bray No. 1 P level of 22 ppm. The higher than normal variability of grain yield response to applied P according to soil test P may have been caused by higher than normal precipitation.

One permanent or long term row vs broadcast study was harvested in 1981 (Hitchcock 79-17). Wheat at this location showed a very weak response to P, similar to 1979 results although soil test shows only 12 ppm P in surface 20 cm (Bray No. 1). An experiment comparing 0-44-0 (triple superphosphate) and 17-44-0 (urea phosphate) was also conducted at this location (Table 3). While yield differences were small, 0-44-0 produced a significantly higher yield than 17-44-0 (1800 kg/ha or 3 bu/acre). This was especially apparent at the 11 kg P/ha rate.

One experiment was established in Hitchcock County (81-21) to determine differences in several methods of P application with liquid and dry sources of P (Table 4). Although soil test was low (8 ppm in surface 20 cm), no real P response in yield was found and no method of application or P source differences could be determined.

In a continuing effort to improve our ability to recommend nitrogen for wheat, eight N rate studies were harvested in 1981 (Table 5). Soil nitrate N ranged from 56 kg/ha to 212 kg/ha to a depth of 180 cm. Recommendations according to present calibration data was quite good on four locations. Recommendations were high on two soils and low on two soils.

In southwest Nebraska one experiment was harvested comparing knifed 10-34-0 together and separate from ammonia with broadcast, seed applied and dribbled in rows (Table 6). Wheat yield response to applied P was not significant. Therefore no difference was observed between methods of applying P. However, all yield parameters showed the highest yields were obtained from the knifed in or row applied treatments.

Table 1. Effect of method and rate of P application on wheat yields in Southwest Nebraska in 1981.

Gosper County
Location 81-1
SW¼, NE¼, Sec 27, T7N, R2W

P Rate	Yield Grain	Yield Straw	Yield Heading
kg P/ha	kg/ha x 10^{-2}		
0	51.4	69.1	77.8
	Seed Applied		
8	55.4	75.1	90.1
17	55.0	75.6	97.2
25	55.0	75.8	86.4
33	58.9	81.8	108.6
42	59.3	80.4	108.9
Mean	56.7	77.8	98.2
	Broadcast		
8	49.1	65.6	75.0
17	54.2	71.8	89.5
25	53.2	69.1	89.0
33	55.6	75.2	104.8
42	53.4	70.3	84.9
Mean	53.1	70.4	88.6
Analysis of Variance			
Rate	++	*	**
Linear	**	**	**
Quadratic	NS	NS	NS
Method	*	**	*
Rate x Method	NS	NS	NS
C.V.	9.1	9.9	15.3

Soil Test

Depth	pH	Bray P	$NaHCO_3P$
cm		ppm	
0-10	6.0	14.0	7.4
10-20	6.2	5.8	3.2
20-30	6.7	3.0	2.6

Table 1. Continued

Gosper County
Location 81-5
NW¼, SE¼, Sec 34, R23W, T8N

P Rate	Yield Grain	Yield Straw	Yield Heading
kg P/ha	kg/ha x 10^{-2}		
0	33.7	48.9	48.4
	Seed Applied		
8	42.3	63.9	69.9
17	46.9	71.0	79.1
25	50.4	80.9	84.2
33	49.1	76.5	83.0
42	51.9	80.5	96.8
Mean	48.1	74.6	82.6
	Broadcast		
8	39.2	59.7	59.0
17	39.2	58.1	56.1
25	41.9	64.1	66.7
33	45.5	70.3	69.5
42	49.3	74.5	68.6
Mean	43.0	65.3	64.0
Analysis of Variance			
Rate	**	**	**
Linear	**	**	**
Quadratic	*	**	++
Method	**	**	**
Rate x Method	+	++	NS
C.V.	7.6	8.2	15.8

Soil Test

Depth	pH	Bray P	$NaHCO_3P$
cm		ppm	
0-10	6.1	7.3	4.3
10-20	6.4	4.3	2.6
20-30	7.2	2.6	1.4

Table 1. Continued

Frontier County
Location 81-6

P Rate	Yield: Grain	Yield: Straw	Yield Heading
kg P/ha	kg/ha x 10^{-2}		
0	32.6	52.8	35.6
	Seed Applied		
8	43.6	72.5	52.2
17	45.4	76.8	68.5
25	47.1	78.3	57.7
33	47.8	78.7	63.6
42	49.1	80.5	75.8
Mean	46.6	77.4	63.6
	Broadcast		
8	34.8	56.4	43.9
17	38.8	61.3	47.4
25	41.7	69.8	49.2
33	43.4	68.8	67.1
42	44.6	73.1	58.3
Mean	40.7	65.9	53.2

Analysis of Variance

	Grain	Straw	Heading
Rate	**	**	**
Linear	**	**	**
Quadratic	**	**	+
Method	**	**	**
Rate x Method	NS	+	+
C.V.	6.9	7.2	20.3

Soil Test

Depth	pH	Bray P	$NaHCO_3P$
cm		ppm	
0-10	6.8	6.9	3.7
10-20	6.9	2.6	3.2
20-30	7.4	2.6	2.6

Table 1. Continued

Furnas County
Location 81-13
SW¼, NE¼, Sec 23, T2N, R25W

P Rate	Yield Grain	Yield Straw	Yield Heading
kg P/ha	kg/ha x 10^{-2}		
0	37.2	75.4	86.2
	Seed Applied		
8	36.1	77.9	93.0
17	36.6	73.1	89.3
25	37.4	78.4	93.3
33	38.6	79.7	89.3
42	37.6	80.0	99.0
Mean	37.3	77.8	92.8
	Broadcast		
8	34.7	69.3	87.8
17	36.0	77.0	82.0
25	35.5	75.0	93.4
33	35.1	73.3	100.1
42	38.8	77.9	91.2
Mean	36.0	74.5	90.9

Analysis of Variance

	Grain	Straw	Heading
Rate	NS	NS	NS
Linear	NS	NS	++
Quadratic	NS	NS	NS
Method	NS	+	NS
Rate and Method	NS	NS	NS
C.V.	11.1	11.7	14.7

Soil Test

Depth	pH	Bray P	$NaHCO_3P$
cm		ppm	ppm
0-10	7.9	18.0	8.7
10-20	8.2	6.9	2.6
20-30	8.3	4.7	2.0

Table 1. Continued

Furnas County
Location 81-15
SW¼, SE¼, Sec 15, T3N, R22W

P Rate	Yield Grain	Yield Straw	Yield Heading
kg P/ha	kg/ha x 10^{-2}		
0	37.0	55.9	76.8
	Seed Applied		
8	37.4	55.7	63.3
17	37.2	53.2	78.9
25	43.2	58.5	76.9
33	37.1	56.1	90.9
42	38.5	55.9	92.3
Mean	38.7	55.9	80.5
	Broadcast		
8	34.7	49.7	79.4
17	39.6	58.5	80.9
25	38.3	55.4	74.3
33	38.3	54.0	74.1
42	38.1	55.6	86.3
Mean	37.8	54.6	79.0

Analysis of Variance

Rate	+	NS	**
Linear	+	NS	**
Quadratic	NS	NS	NS
Method	NS	NS	NS
Rate x Method	+	NS	*
C.V.	9.5	10.7	13.3

Soil Test

Depth	pH	Bray P	$NaHCO_3P$
cm		ppm	
0-10	6.9	21.0	11.0
10-20	6.6	6.9	3.7
20-30	7.0	3.0	3.2

Table 1. Continued

Furnas County
Location 81-16
NE¼, NE¼, Sec 27, T3N, R22W

P Rate	Yield Grain	Yield Straw	Yield Heading
0	42.4	70.2	90.9
	Seed Applied		
8	46.4	75.1	99.5
17	47.6	78.6	101.7
25	49.3	81.9	106.5
33	50.7	83.3	102.3
42	47.0	78.2	104.1
Mean	48.2	79.4	102.8
	Broadcast		
8	45.0	74.8	91.3
17	47.9	78.0	105.9
25	48.2	75.0	100.3
33	48.4	79.6	96.5
42	47.6	74.6	90.7
Mean	47.4	76.4	96.9

Analysis of Variance

	Grain	Straw	Heading
Rate	**	*	NS
Linear	**	**	NS
Quadratic	**	*	*
Method	NS	+	++
Rate x Method	NS	NS	NS
C.V.	8.3	8.9	13.1

Soil Test

Depth	pH	Bray P	$NaHCO_3P$
cm		ppm	
0-10	6.4	26.0	13.0
10-20	6.3	18.0	13.0
20-30	7.1	9.3	3.7

Table 1. Continued

Hitchcock County
Location 81-20
SW¼, SE¼, Sec 36, T2N, R32W

P Rate	Yield Grain	Yield Straw	Heading	Grain P Uptake	Grain P Conc.
kg P/ha	kg/ha x 10^{-2}				%
0	29.8	65.2	79.1	15.2	.5090
			Seed Applied		
8	30.0	70.3	90.3	15.4	.5120
17	32.0	71.7	87.1	15.7	.4920
25	33.5	73.2	85.5	16.8	.5020
33	31.7	68.4	95.5	16.1	.5100
42	36.5	71.6	76.6	18.9	.5200
Mean	32.7	71.0	87.0	16.6	.5072
			Broadcast		
8	31.9	68.5	80.8	15.0	.4720
17	31.9	68.5	82.3	16.4	.5140
25	33.7	72.8	80.2	18.1	.5400
33	31.2	68.6	85.8	17.0	.5420
42	30.0	67.2	90.4	15.0	.5020
Mean	31.7	69.1	83.9	16.3	.5140
Analysis of Variance					
Rate	**	++	NS	**	NS
Linear	**	+	NS	**	+
Quadratic	+	**	NS	**	NS
Method	+	+	NS	NS	NS
Rate x Method	**	NS	+	**	*
C. V.	6.7	7.5	13.1	9.4	6.8

Soil Test

Depth	pH	Bray P	NaHCO3P
cm		ppm	
0-10	7.1	17.0	9.4
10-20	7.4	6.5	7.4
20-30	7.9	4.0	3.2

Table 1. Continued

Hitchcock County
Location 81-21
SW¼, SW¼, Sec 31, T2N, R32W

P Rate	Yield Grain	Straw	Heading	1st Sampling1/
kg P/ha	kg/ha x 10^{-2}			
0	44.9	70.8	81.4	18.6
		Seed Applied		
8	42.0	75.8	85.9	21.5
17	46.4	76.5	89.0	21.6
25	48.5	79.9	98.0	24.5
33	46.9	72.9	95.1	24.0
42	48.0	80.1	94.5	24.9
Mean	46.4	77.0	92.5	23.3
		Broadcast		
8	46.4	73.8	79.0	18.3
17	45.3	73.4	77.8	18.1
25	46.3	76.3	89.5	21.1
33	46.5	73.3	85.5	18.6
42	47.2	75.1	91.9	22.2
Mean	46.3	74.4	84.7	19.6

Analysis of Variance

Rate	NS	*	**	*
Linear	**	**	**	**
Quadratic	NS	NS	NS	NS
Method	NS	++	**	**
Rate x Method	NS	NS	NS	NS
C. V.	5.8	7.2	10.5	18.1

1/

Soil Test

Depth	pH	Bray P	$NaHCO_3P$
cm		ppm	
0-10	7.0	12.0	5.5
10-20	7.5	4.0	3.2
20-30	7.9	3.3	1.4

Table 2. Effect of method and rate of P application in winter wheat yields during second year of application following fallow.

Hitchcock County
Location 79-17
SE¼, SE¼, Sec 25, T3N, R35W

P Rate	Yield Grain	Yield Straw	Yield Heading
kg P/ha	kg/ha x 10^{-2}		
0	29.0	49.5	67.2
	Seed Applied		
8	28.9	53.5	66.2
17	28.8	54.5	69.4
25	31.0	54.2	58.2
33	30.8	56.8	70.5
42	33.7	56.6	66.5
Mean	30.6	55.1	66.2
	Broadcast		
8	31.0	55.4	65.8
17	29.4	57.3	68.8
25	30.2	55.9	65.3
33	29.2	53.6	66.7
42	30.9	53.3	67.6
Mean	30.1	55.1	66.8

Analysis of Variance

Rate	NS	+	NS
Linear	++	*	NS
Quadratic	NS	++	NS
Method	NS	NS	NS
Rate & Method	NS	NS	NS
C. V.	9.7	9.9	18.3

Soil Test

Depth	pH	Bray P ppm
0-10	6.5	18
10-20	6.8	6
20-30	7.4	4

Table 3. Comparison of two phosphorus fertilizers, 0-44-0 and 17-44-0, on winter wheat yields. Location 79-17, Hitchcock County.

P Rate	Plant Weight	Bundle Weight	Grain Weight	Stover Weight
		kg/ha x 10^{-2}		
		0-44-0		
5.5	60.2	75.3	28.2	4.7
11	61.5	85.4	32.7	5.3
Mean	A 60.8	A 80.4	A 30.4	A 5.0
		17-44-0		
5.5	56.9	75.0	28.6	4.6
11	60.6	78.6	28.6	5.0
Mean	A 58.8	A 76.8	B 28.6	A 4.8
		Analysis of Variance		
Form	NS	+	*	NS
Rate	NS	*	*	*
Form x Rate	NS	NS	*	NS
C.V.	16.7	7.5	6.4	9.4

Table 4. Effect of methods of P placement on winter wheat yields in Hitchcock County. 1981 (81-21)

P Rate	Plant weight: 1st sample	Plant weight: 2nd sample	Harvest yield: Grain	Harvest yield: Straw	Harvest yield: Total (Bundle
kg/ha	kg/ha x 10^{-2}				
Check	18.2	81.3	115.8	44.9	70.8
		Broadcast, 0-44-0 (dry)			
8	18.3	79.0	120.2	46.4	73.8
17	18.1	88.6	118.8	45.4	73.4
Mean	18.2	83.8	119.5	45.9	73.6
		Broadcast, 0-34-0 (liquid)			
8	19.9	77.5	121.6	46.6	75.0
17	19.9	77.0	110.8	43.1	67.8
Mean	19.9	77.2	116.2	44.8	71.4
		Drill, 0-44-0 (dry)			
8	21.5	85.9	122.8	47.0	75.7
17	21.6	89.0	123.0	46.5	76.5
Mean	21.6	87.5	122.9	46.7	76.1
		Drill, 10-34-0 (liquid)			
8	21.0	86.0	113.5	42.9	70.6
17	21.9	87.3	123.7	47.1	76.6
Mean	21.4	86.7	118.6	45.0	73.6
		Knife, 10-34-0 (liquid)			
8	21.4	85.8	120.1	45.2	74.9
17	22.8	83.0	111.7	42.2	69.5
Mean	22.1	84.4	115.9	43.7	72.2
		Analysis of Variance			
Treatments	NS	NS	+	NS	NS
C.V.	17.5	12.9	7.2	7.1	7.9

Table 5. Effect of nitrogen on wheat yields in southwest Nebraska on soils containing different amounts of residual nitrate-N[1/]. 1981

Gosper County
Location 81-1

N Rate	Yield Grain	Yield Straw	Yield Heading
kg/ha	bu/A	(kg/ha x 10^{-2})	kg/ha x 10^{-2}
0	78	52.3	127.1
33	79	53.3	132.8
66	85	57.1	134.1
99	86	58.2	137.6
132	87	58.5	138.7
Mean	83	55.8	134.1

Analysis of Variance

C.V. (R^2)	4.1 (.65)	4.6 (.40)
Rate	*	NS
Linear	**	*
Quadratic	NS	NS

1/ Residual nitrate-N, 180 cm = 124 kg/ha
Recommended N rate = 33 kg/ha

Gosper County
Location 81-5

0	78	52.3	126.9
30	74	49.7	125.5
60	71	47.9	123.8
90	74	49.8	128.7
120	73	49.2	123.8
Mean	74	49.8	125.7

Analysis of Variance

C.V. (R^2)	6.0 (.27)	7.2 (.05)
Rate	NS	NS
Linear	NS	NS
Quadratic	NS	NS

1/ Residual nitrate-N, 180 cm = 212 kg/ha
Recommended N rate = 0

Table 5. Continued

Frontier County
Location 81-6

N Rate	Yield Grain	Straw	Yield Heading
kg/ha	bu/A	(kg/ha x 10^{-2})	kg/ha x 10^{-2}
0	63	42.4	107.1
30	67	45.3	118.6
60	71	47.9	125.1
90	74	49.9	130.1
120	71	48.0	127.6
Mean	69	46.7	121.7

Analysis of Variance

C.V. (R^2)	7.7 (.44)	9.0 (.46)
Rate	+	+
Linear	*	*
Quadratic	NS	NS

1_/ Residual nitrate-N, 180 cm = 56 kg/ha
Recommended N rate = 77 kg/ha

Furnas County
Location 81-13

0	53	35.7	117.9
30	50	33.7	123.5
60	56	37.6	122.2
90	55	37.2	117.2
120	55	37.0	119.1
Mean	54	36.2	120.0

Analysis of Variance

C.V. (R^2)	13.9 (.11)	10.1 (.06)
Rate	NS	NS
Linear	NS	NS
Quadratic	NS	NS

1/ Residual nitrate-N, 180 cm = 74 kg/ha
Recommended N rate = 44 kg/ha

Table 5. Continued

Furnas County
Location 81-15

N Rate	Yield Grain	Yield Straw	Yield Heading
kg/ha	bu/A	(kg/ha x 10^{-2})	kg/ha x 10^{-2}
0	54	36.4	91.8
30	59	39.5	95.4
60	68	45.8	107.8
90	64	42.8	106.9
120	71	47.9	115.4
Mean	63	42.5	103.5

Analysis of Variance

C.V. (R^2)	10.1 (.58)	9.8 (.52)
Rate	*	++
Linear	**	**
Quadratic	NS	NS

1/ Residual nitrate-N, 180 cm = 113 kg/ha
Recommended N rate = 33 kg/ha

Furnas County
Location 81-16

N Rate	Yield Grain	Yield Straw	Yield Heading
0	73	48.8	129.2
30	71	47.8	128.1
60	69	46.2	125.4
90	74	49.6	137.1
120	70	47.3	127.1
Mean	71	47.9	129.4

Analysis of Variance

C.V. (R^2)	11.2 (.07)	8.4 (.17)
Rate	NS	NS
Linear	NS	NS
Quadratic	NS	NS

1/ Residual nitrate-N, 180 cm = 104 kg/ha
Recommended N rate = 44 kg/ha

Table 5. Continued

Hitchcock County
Location 79-17
1981 Crop

N Rate	Yield Grain	Yield Straw	Yield Heading
kg/ha	bu/A	(kg/ha x 10^{-2}	kg/ha x 10^{-2}
0	46	31.3	86.8
30	52	34.8	90.9
60	53	35.5	95.3
90	48	32.6	91.3
120	50	33.7	92.2
Mean	50	33.6	91.3

Analysis of Variance

C.V. (R^2)	6.9 (.39)	6.7 (.23)
Rate	NS	NS
Linear	NS	NS
Quadratic	+	NS

1/ Residual nitrate-N, 180 cm = 189 kg/ha
Recommended N rate = 0

Hitchcock County
Location 81-20

0	39	26.2	90.9
30	47	31.8	102.2
60	50	33.7	109.2
90	50	33.4	104.9
120	52	34.6	109.0
Mean	47	31.9	103.2

Analysis of Variance

C.V. (R^2)	6.9 (.73)	4.3 (.77)
Rate	**	**
Linear	**	**
Quadratic	*	*

1/ Residual nitrate-N, 180 cm = 72 kg/ha
Recommended N rate = 44 kg/ha

Table 6. Effect of different methods of P placement on yields of winter wheat.

Gosper County
Location 81-5

Plant weight		Harvest yield		
1st Sample	2nd Sample	Grain	Straw	Grain & Straw
KT 19.4 a[1/]	KTN 81.6 a	KS 44.5 a	KT 77.1 a	KS 114.3 a
R 19.4 a	R 79.9 a	KTN 43.1 a	KS 70.0 ab	KTN 108.1 ab
KS 17.6 ab	KS 78.6 a	R 42.7 a	R 65.3 ab	R 108.0 ab
KTN 15.6 ab	B 78.5 a	B 41.7 a	KTN 65.0 ab	KT 105.3 ab
B 15.6 ab	D 76.4 a	KT 41.5 a	O 61.8 ab	B 102.6 ab
D 15.5 ab	KT 72.9 a	D 40.7 a	B 60.8 ab	O 102.2 ab
O 13.5 b	O 67.2 a	O 40.4 a	D 59.5 b	D 99.8 b

KT = Knife together, 30 cm spacing
KS = Knife separate, 30 cm spacing
KTN = Knife together with N-Serve
R = Seed applied
B = Broadcast, incorporated
D = Dribble on surface, 30 cm bands, incorporated
1/ Means followed by some letter not significant according to Duncan's Multiple Range test (5 percent level)
P rate = 11 kg P/ha

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 1980. Plots were located in Gage and Lancaster Counties. The accompanying table shows the soil test characteristics of both sites. Both locations were low in phosphorus. The Gage site was slightly acid and the Lancaster site was moderately acid.

Each plot area received 60 pounds of nitrogen per acre as ammonia and nitrogen from the 10-34-0 that was applied, except the ammonia only plots which received all 60 pounds of nitrogen as ammonia.

Phosphorus was applied at a constant rate of 23 pounds P_2O_5 (10# P) per acre as 68 pounds of 10-34-0. A double rate of phosphorus with the seed (135 pounds 10-34-0 per acre) was included as another treatment to determine if other treatments were applied at a sub-optimum rate.

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 bands 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 Lancaster County site, wheat yields were increased only where the 10-34-0 was knifed into the soil or applied at a double rate with the seed. 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 at the low rate of 10-34-0 did not increase yields significantly in the Lancaster County test.

At Gage County, phosphorus did not increase yields even though soil test level for phosphorus was low. Yield level was high.

DUAL PLACEMENT OF NITROGEN AND PHOSPHORUS ON WHEAT
1981

Location	Grain Yields, bu./ac.	
	Gage	Lancaster
Treatment[1/]		
Ammonia Alone	55.1	29.6
10-34-0 Broadcast and Ammonia	53.4	31.3
10-34-0 Dribbled and Ammonia	57.2	31.7
10-34-0 With Seed and Ammonia	60.9	35.1
10-34-0 With Seed (double rate) and Ammonia	63.5	49.2***
10-34-0 And Ammonia Knifed Separately	62.6	38.2*
10-34-0 And Ammonia Knifed Together	60.1	41.8**
10-34-0 And Ammonia with N-Serve Knifed Together	52.7	44.4**

[1/]Ammonia @ 60# N/ac and 10-34-0 @ 10# P (23# P_2O_5)/ac.

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

** Yield significantly higher (.01) than where no phosphorus applied

*** Yield significantly higher (.01) where double rate (135 pounds 10-34-0) applied as compared to lower rate with seed

Soil Test Information	Gage	Lancaster
Soil pH	6.1	5.4
Buffer pH	6.6	6.3
Phosphorus, ppm	8	9
Potassium, ppm	307	162
Organic Matter, %	2.5	2.0

EFFICIENT NITROGEN USE FOLLOWING SOYBEANS IN ROTATION

E.J. Penas and M.D. Clegg

Objectives:

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

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

Procedure:

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

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

Results and Discussion:

Polk County. This site was irrigated and yield level was good. Nitrate-nitrogen in the soil was medium and organic matter was moderate.

Nitrogen increased grain yield where sorghum followed sorghum. Approximately 40 pounds of nitrogen was needed for the most profitable yield level.

Nitrogen did not increase grain sorghum yield where soybeans were the preceeding crop. Soil nitrogen was slightly higher but organic matter was lower in this area. Yield level was 10-15 bushels per acre higher where soybeans were the previous crop.

Lancaster County. This site was non-irrigated, soil nitrate-nitrogen levels were low and organic matter was high. Soil nitrate level and release of nitrogen from organic matter was sufficient for maximum yields where sorghum followed sorghum.

Where soybeans were the previous crop, soil nitrogen is quite low; however, soil nitrogen as nitrate and from organic matter along with benefits from the previous soybean crop, provided adequate nitrogen for maximum yields.

Summary:

Data collected from these experiments agree with suggested nitrogen rates in NebGuide 74-112, "Fertilizing Grain Sorghum" provided the previous soybean crop is credited for nitrogen available to the following crop. The UNL Soil Testing Laboratory is currently suggesting that nitrogen rates for corn, sorghum and small grains can be reduced 50 pounds per acre where the preceeding crop was soybeans that yielded 30 or more bushels per acre.

More data are needed to confirm the current guidelines for suggested nitrogen rates for grain sorghum.

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

NITROGEN RATES ON GRAIN SORGHUM, 1981

Soil Test Data

County & Previous Crop	Soil pH	Nitrogen lbs/ac 6 ft	Phosphorus, ppm	Potassium, ppm	Organic Matter, %
Polk					
Sorghum	5.8	116	43 Hi	388 VHi	2.7
Soybeans	5.7	152	36 Hi	577 VHi	1.9
Lancaster					
Sorghum	5.8	76	14 Low	448 VHi	3.1
Soybeans	5.5	35	25 Med	444 VHi	3.2

Grain Yields

County: Previous Crop:	Polk Sorghum	Polk Soybeans	Lancaster Sorghum	Lancaster Soybeans
Nitrogen Rate, lbs/ac	Grain Yield, bushels per acre			
0	103	137	90	90
20	118	140	92	83
40	127	137	95	86
60	121	143	97	90
80	129	143	87	86
100	133	145	92	81
Response	yes	no	no	no
Soil NO_3-N, lbs/ac 6 ft	116	152	76	35
Organic Matter, %	2.7	1.9	3.1	3.2
Irr. Water N, ppm	1.0	1.0	--	--

TIME OF IRRIGATION AND N APPLICATION FOR OPTIMUM SOYBEAN PRODUCTION[1/]

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

Objective:

1. Determine parameters under which fertilizer N may be needed for the optimum production of the soybean crop.

2. Investigate timing of irrigation as a factor influencing seed yield.

Procedure:

Variables of soil pH through liming, residual mineral N in the soil at planting, timing of N fertilization, and timing of irrigation are integrated into both field and greenhouse experiments for estimating their combined influence on yield of seed and the symbiotic N-fixing process. The heavy ^{15}N isotope is incorporated into the fertilizer N for determining source of N that ends up in the seed through isotope ratio analysis.

In the field study of 1981 two pH levels of 5.5 and 6.5 were maintained on Sharpsburg sicl along with N rates of 0, 40 and 80 lbs N/a applied either at planting or at early bloom. Fertilizer tagged with ^{15}N was used in 2 x 2m portions of each N plot to permit isotope ratio analysis of seed produced. Two irrigation regimes were established, one beginning at final cultivation and the other at early bloom supplying sufficient supplemental water to provide 24" total growing season moisture in both cases. A high yielding dwarf variety was grown in 10" rows and individual plots were diked up on all sides for creating a basin into which water was measured by water meter.

The 1981-82 greenhouse experiment includes the 3 pH levels of 5.5, 6.0, and 6.5 with tagged N rates of 0, 40, and 80 lbs/a applied at planting, at 1/2 or at early blossom. Two moisture levels were established of depletion to 3/4 available water capacity and depletion to 1/4 available water. The experiment is being harvested at this writing.

Results and Discussion:

Seed yields in the field study were increased by early initiation of irrigation at the mid-vegetative stage, and by liming of the plots to a pH of 6.5 (Table 1). Fertilizer N rates and times of application had no effect on yield at this experimental site where yields averaged 62 bu/a. Stover yields were also increased by earlier initiation of irrigation, but were unaffected by pH and N treatment. The number of pods per plant showed a linear increase with delayed application of the 40 lb N rate, maximum numbers of pods being produced with mid-vegetative application. Average seed weight and seeds per pod are being determined to complete the components of yield. Sample preparation is underway for acquiring $^{15}N/^{14}N$ isotope ratio on seed from this field experiment for estimating source of N in the seed protein.

A method for grinding the seed was developed which produces a finely ground sample. Seed and dry ice are ground together for 1 minute in a Stein Laboratory Mill, thereby avoiding adherence of sample to the mill as occurs with added solvents which also produce changes in the chemical characteristics of the meal. The method also allows thorough cleaning between samples to obviate cross-contamination of ^{15}N.

1/ Work supported by the Nebraska Soybean Board.

Table 2. Harvest data from 1981 field experiment, Mead, Nebraska

pH	Irrigation Initiation	N Rate	N Time	Seed Yield	Stover Yield	Population	Pod Number
		lb N/a		bu/a	lb DM/a	plants M^2	pods/plant
5.6	Last Cultivation	0	---	62	5700	32	39
		40	Planting	58	5300	33	36
			Vegetative	65	5400	25	43
			Bloom	62	5200	25	46
			Ave.	62	5300	28	42
		80	Planting	60	5800	30	43
			Vegetative	72	6200	30	45
			Bloom	60	5300	28	42
			Ave.	64	5800	29	43
	Ave. for last cultivation irrigation initiation			63	5600	29	42
	Early bloom	0	---	55	4900	28	31
		40	Planting	54	4500	26	37
			Vegetative	55	5300	29	38
			Bloom	62	5000	28	34
			Ave.	57	4900	28	36
		80	Planting	57	4900	30	36
			Vegetative	56	5200	29	45
			Bloom	63	5100	31	44
			Ave.	59	5100	30	42
	Ave. for early bloom irrigation initiation			57	5000	29	38
	Ave. for pH 5.6			60	5300	29	40
6.5	Last Cultivation	0	---	66	5900	30	41
		40	Planting	70	5700	26	42
			Vegetative	63	5500	28	40
			Bloom	66	5700	28	44
			Ave.	66	5600	27	42
		80	Planting	66	5300	31	38
			Vegetative	64	6100	31	49
			Bloom	64	5700	35	37
			Ave.	65	5700	32	41
	Ave. for last cultivation irrigation initiation			66	5700	30	42
	Early bloom	0	---	68	5700	36	36
		40	Planting	69	5200	28	34
			Vegetative	64	5100	33	42
			Bloom	58	5200	29	47
			Ave.	64	5200	30	41
		80	Planting	60	4600	25	37
			Vegetative	51	5200	28	50
			Bloom	59	5300	30	49
			Ave.	57	5000	28	45
	Ave. for early bloom irrigation initiation			61	5200	30	42
	Ave. for pH 6.5			63	5400	30	42

Soil Compaction Removal and Its Effects on Sugarbeet Yield

F. N. Anderson and G. A. Peterson

There is a general interest among farmers in the North Platte Valley area to chisel their soils during early seedbed preparation. Many times chiseling is not the primary tillage operation, but is in addition to moldboard plowing. This experiment was conducted to determine what the benefits of chiseling might be under these circumstances.

In order to study the effects of plowing and chiseling in situations with a uniform history, three artifical compaction regimes were applied to a Tripp vfsl soil (Typic Haplustoll) at two different locations on the Panhandle Experiment Station at Scottsbluff, Nebraska. Yields were measured on a mechanically harvested area and infiltration measurements made with a double ring infiltrometer.

Table 1. Compaction effects where no plowing or chiseling was used on a Tripp vfsl soil in 1979 and 1980.

Compaction	Sucrose* Yield		Water Infiltration Rate	
	1979	1980	1979	1980
	--------kg/ha---------		--------kg/hr---------	
None	8530	----	0.59	----
Noble Blade	8080	8030	3.0	1.4
Sheeps Foot	1760	2980	0.47	0.02
Truck Tracks	5500	5880	0.42	0.10

*Raw sugar yield calculated by (% Sucrose)(Root Yield) = Sucrose Yield

Sheeps foot compaction was most severe in terms of yield reduction. This effect was obviously related to water infiltration, but other problems also existed. For example, truck track compaction had essentially the same poor infiltration rate but a much higher sucrose yield.

Table 2. The effect of plowing the compacted Tripp vfsl soil without chiseling.

Compaction	Plowing (No Chiseling)	Sucrose Yield		Water Infiltration Rate	
		1979	1980	1979	1980
		-----kg/ha----		-----cm/hr----	
None	Yes	8240	8020	1.0	2.4
	No	8530	----	0.59	----
Noble Blade	Yes	6880	7420	4.8	1.0
	No	8080	8030	3.0	1.4
Sheeps Foot	Yes	5190	6980	3.2	1.9
	No	1760	2980	0.47	0.02
Truck Tracks	Yes	6940	6670	4.2	2.2
	No	5500	5880	0.42	0.10

One of our hypotheses at the outset was that plowing was a good compaction correction implement. These data support this hypothesis in terms of sucrose yield and water infiltration rate.

Table 3. The effect of chiseling the compacted Tripp vfsl soil without plowing.

Compaction	Plowing (No Chiseling)	Sucrose Yield		Water Infiltration Rate	
		1979	1980	1979	1980
		-----kg/ha-----		-----kg/hr-----	
None	Yes	7490	5600	1.5	1.1
	No	8530	----	0.59	----
Noble Blade	Yes	7870	7360	1.1	1.8
	No	8080	8030	3.0	1.4
Sheeps Foot	Yes	2180	6700	2.0	0.64
	No	1760	2980	0.47	0.02
Truck Tracks	Yes	5890	8250	0.78	1.2
	No	5500	5880	0.42	0.10

Chiseling without plowing obviously had a dramatic effect on sucrose yield and infiltration rate. However, across the years, the effects were not as consistent. Chiseling was more effective in 1980 than in 1979 (Compare Tables 2 and 3). Plowing however, consistently increased infiltration rates more than did chiseling. This was the result of a rougher, more cloddy surface in the plowed treatments compared to the chisel treatments.

Table 4. The additive effect of chiseling on the compacted and plowed Tripp vfsl soil.

	Chiseling (Plowed)	Sucrose Yield		Water Infiltration Rate	
		1979	1980	1979	1980
		-----kg/ha----		-----kg/hr----	
None	Yes	8340	7890	2.1	3.9
	No	8240	8020	1.0	2.4
Noble Blade	Yes	7360	7400	2.5	1.2
	No	6880	7420	4.8	1.0
Sheeps Foot	Yes	6040	6200	4.3	4.9
	No	5190	6980	3.2	1.9
Truck Tracks	Yes	6700	7210	5.3	1.3
	No	6940	6670	4.2	2.2

A second hypothesis to be tested was that chiseling would provide little added benefit if the soil were already plowed. The data support this hypothesis. Chiseling provided a variable response with years in the most severely compacted treatment (Sheeps Foot).

The data indicate that chiseling when used in addition to plowing is not a worthwhile operation, because the plowing has adequately alleviated the compaction problem. If plowing is not used, the chisel will remove the compaction problem. These data are being submitted for publication in the journal entitled, "Soil and Tillage Research".

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. Therefore, this study is conducted for the purpose of measuring the response of alfalfa grown on irrigated sandy soil to the application of fertilizer phosphorus (P) and sulfur (S).

Procedure:

This study was initiated in Pierce County in August of 1978 and continued through 1981. The soil is classified as a Valentine loamy fine sand. Soil properties are listed in Table 1. Prior to seeding, lime at a rate of 1½ ton/acre was broadcast and incorporated. The alfalfa was seeded in August of 1978 at a rate of 15 lb./acre.

Rates of P (0, 10, 20, 30, 40, 50, 60 lb./acre) and S (0, 25, 50, 75, 100, 125, 150 lb./acre) with treatments selected to fit a central composite factorial design were applied on an annual basis. All treatments also receive an annual application of 15 lb. N/acre as 33-0-0 and 200 lb. K_2O/acre as 0-0-62.

The alfalfa was harvested 4 times each year. Whole plant samples are collected from each cutting and analyzed for P and S. The uptake of P and S by the alfalfa crop was also computed.

Results and Discussion:

Total alfalfa yields for 1979, 1980, and 1981 are listed in Tables 2 and 3. Total production each year increased curvilinearly with P rate in all years with maximum production resulting from the application of 30-40 lb. P/acre. Trends for individual cuttings paralleled the trends shown by the total yields. The application of S produced a small increase in yield in 1979 but the use of this nutrient had no significant effect on production in 1980 and 1981. With a low P content of the soil (6 ppm in 0-6 in.) a response to fertilizer P would be anticipated. The SO_4-S content of the soil is also very low but there was no response to fertilizer S. There is no apparent explanation for this result.

At the time of this writing, analysis of plant samples collected in 1981 had not been completed. Therefore, the analysis and uptake data for 1980 are included (Tables 4 and 5). As would be expected, the application of fertilizer P increased the P content of the tissue as well as P uptake by alfalfa (Table 4). For the most part response to rate of P was curvilinear.

The application of fertilizer S increased the S content of the tissue and S uptake by alfalfa. It should be pointed out that the S content of the control treatment was in excess of the .200% or .220% value generally considered to be the critical S level in alfalfa tissue.

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	-	-	-	-	-	-
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 + Kurtz #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 (.1N HCl), ppm	1.9	-	-	-	-	-	-

Table 2. Effect of rate of P applied on the total yield of alfalfa in 1979, 1980, and 1981.

P Applied	Year 1979	1980	1981	Average
lb./acre	- - - - - ton D.M./acre - - - - -			
0	3.73	3.04	2.90	3.22
10	4.21	4.02	4.08	4.10
20	4.53	4.71	4.94	4.73
30	4.69	5.12	5.44	5.08
40	4.70	5.25	5.63	5.19
50	4.55	5.11	5.49	5.05
60	4.26	4.67	5.02	4.65

Table 3. Effect of rate of S applied on total alfalfa yield in 1979, 1980, and 1981.

S Applied	Year 1979	1980	1981	Average
lb./acre	- - - - - ton D.M./acre - - - - -			
0	4.19	4.52	4.88	
25	4.25	4.56	4.87	
50	4.32	4.59	4.85	
75	4.38	4.60	4.81	
100	4.48	4.59	4.76	
125	4.51	4.56	4.69	
150	4.57	4.51	4.61	

Table 4. Effect of rate of P applied on the P content of alfalfa and P taken up by alfalfa. 1980.

P Applied	Content 1	Content 2	Content 3	Content 4	Uptake 1	Uptake 2	Uptake 3	Uptake 4	Total
lb./acre	- - - - % P - - - -				- - - - - lb./acre - - - - -				
0	.173	.149	.194	.152	2.8	2.5	2.5	1.2	9.8
10	.224	.185	.222	.184	4.8	4.4	4.4	2.9	17.1
20	.266	.217	.247	.211	6.4	5.7	5.7	4.1	22.8
30	.298	.243	.268	.233	7.6	6.7	6.7	5.0	26.9
40	.322	.265	.286	.251	8.2	7.2	7.2	5.5	29.2
50	.335	.282	.300	.264	8.5	7.3	7.3	5.6	29.9
60	.339	.294	.311	.272	7.0	7.0	7.0	5.4	28.8

Table 5. Effect of rate of S applied on the S content of alfalfa and S taken up by alfalfa. 1980.

S Applied	Content 1	Content 2	Content 3	Content 4	Uptake 1	Uptake 2	Uptake 3	Uptake 4	Total
lb./acre	- - - - % P - - - -				- - - - - lb./acre - - - - - -				
0	.283	.238	.301	.319	6.3	5.9	7.8	6.3	26.3
25	.329	.305	.374	.393	7.7	7.7	9.6	7.4	32.3
50	.365	.359	.430	.450	8.8	9.0	11.0	8.3	36.9
75	.393	.400	.471	.490	9.5	9.9	12.1	8.9	40.2
100	.412	.427	.496	.513	9.8	10.4	12.8	9.3	42.0
125	.421	.440	.505	.519	9.7	10.5	13.3	9.3	42.4
150	.422	.440	.499	.508	9.2	10.3	13.4	9.2	41.4

EFFECT OF POTASSIUM FERTILIZATION ON PRODUCTION OF ALFALFA

GROWN ON AN IRRIGATED SANDY SOIL

G.W. Rehm

Objective:

The potassium (K) 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. Fertilizer K requirements for alfalfa production on these sandy soils have not been determined. The objective of this study is to measure the effect of fertilizer K on yield, K uptake by alfalfa, 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 August of 1978. Yields were recorded in 1979, 1980, and 1981. 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 repeat applications in the springs of 1980 and 1981. The K_2O was supplied as 0-0-60. All plots received 1.5 ton lime/acre before planting. The yearly fertilizer application also 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 materials are applied to all treatments. Treatments are arranged to fit a complete factorial design with 4 replications.

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

Results and Discussion:

Total alfalfa production for each of the 3 years is summarized in Tables 2 and 3. Rate of applied K_2O (plowdown as well as annual application) had no significant effect on yield. Although total seasonal yields are presented in this report, K_2O had no significant effect on production from individual cuttings.

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 removed by the alfalfa in 1980 (Table 4). In general the K content of the alfalfa tissue increased as annual rate of K applied increased. Except for the 2nd cutting which showed a curvilinear response, the increase in K content was linear with rate.

As would be expected, K uptake also increased significantly as annual rate of K_2O increased. The effect of annual rate of K_2O applied paralleled the effect of this variable on the K concentration in the alfalfa tissue.

The relatively high values for uptake of K from the control treatment indicates that these sandy soils are capable of supplying adequate amounts of K for alfalfa production throughout the growing season even though the routine soil test shows a low value for K in the soil.

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			
pH	6.2	-	-	-	-	-	-
NO_3-N, ppm	.9	1.1	.7	.8	1.1	1.2	1.1
P (Bray + Kurtz #1), 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 (.1N HCl), ppm	1.9	-	-	-	-	-	-
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	1.7

Table 2. Effect of rate of K_2O broadcast and incorporated before seeding in 1978 on the total alfalfa produced in 1979, 1980, and 1981.

K_2O Applied	1979	1980	1981	Avg
		Year		
lb./acre		ton D.M./acre		
0	5.21 a	5.09 a	5.10 a	5.13
80	5.20 a	5.05 a	5.11 a	5.18
160	5.12 a	5.18 a	5.10 a	5.13
320	5.19 a	5.13 a	5.08 a	5.13

Table 3. Effect of rate of K_2O applied on an annual basis on total alfalfa produced in 1979, 1980, and 1981.

K_2O Applied	1979	1980	1981	
		Year		
lb./acre		ton D.M./acre		
0	4.89 a	5.02 a	5.13 a	5.01
40	5.27 a	5.21 a	5.06 a	5.18
80	5.14 a	4.92 a	5.10 a	5.65
160	5.13 a	5.22 a	5.04 a	5.13
320	5.19 a	5.06 a	5.14 a	5.13
640	5.44 a	5.23 a	5.11 a	5.26

Table 4. Effect of rate of K_2O broadcast and incorporated before seeding in 1978 on the K content of the tissue and K taken up by alfalfa. 1980.

K_2O Applied	Content 1	Content 2	Content 3	Content 4	Uptake 1	Uptake 2	Uptake 3	Uptake 4	Total
lb./acre	% K				lb./acre				
0	3.06	3.12	3.25	2.85	79.9	84.4	90.0	59.2	313.4
80	3.06	3.11	3.34	2.91	76.4	86.3	88.8	61.2	312.6
160	3.05	3.11	3.14	2.81	87.0	86.7	82.7	59.8	316.3
320	3.01	3.09	3.14	2.82	82.1	81.0	86.2	61.5	310.6

Table 5. Effect of rate of K_2O applied on an annual basis on the K content of the tissue and the K taken up by alfalfa. 1980.

K_2O Applied	Content 1	Content 2	Content 3	Content 4	Uptake 1	Uptake 2	Uptake 3	Uptake 4	Total
lb./acre	% K				lb./acre				
0	2.65	2.63	2.79	2.51	72.7	70.1	74.5	51.4	268.7
40	2.83	2.70	2.84	2.60	79.1	74.5	76.9	55.9	286.3
80	3.00	3.06	3.08	2.74	76.3	80.3	80.7	55.4	292.5
160	3.07	3.28	2.52	2.95	85.5	93.4	88.5	62.3	329.7
320	3.27	3.46	3.30	3.07	83.2	93.0	96.3	66.2	338.6
640	3.43	3.50	3.75	3.21	91.1	96.4	105.0	71.5	363.7

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 application of fertilizer to grasses and/or legumes seeded with reduced or lo-tillage equipment.

Procedure:

This study was initiated in Dixon County in 1978 and continued through 1981. The soil is classified as a Crofton silt loam. Two methods of seedbed preparation are being compared. In the conventional preparation system, the seedbed was prepared in the spring of 1978 by the use of a power tiller. Switchgrass was then seeded with a John Deere Grassland Drill. In the second method, glyphosate was used to kill the existing vegetation in the fall of 1977. Switchgrass was seeded into this killed vegetation in the spring of 1978 with the John Deere Powr-Till Drill.

Four rates of N (0, 40, 80, 120 lb./acre) and 3 rates of P (0, 20, 40 lb./acre) with treatments arranged in a complete factorial were broadcast to the established stand of switchgrass in late May of 1979. Treatments were repeated in late May of both 1980 and 1981. Yields are recorded in early August of each year.

Results and Discussion:

The yields recorded in 1981 are listed in Table 1. The application of both N and P produced significant increases in forage production for both methods of seedbed preparation. The N X P interaction was also significant at the .05 confidence level.

Compared to the non-fertilized control, the combination of N and P produced a 3 to 4 fold increase in yield. Considering the method of seedbed preparation, the forage yield in 1981 was not affected by planting system. These results are consistent with those reported in 1979 and 1980.

This study will be continued in 1982.

Table 1. Effect of rate of fertilizer N and P as well as method of seedbed preparation on yield of switchgrass in 1981.

P Applied	N Applied (lb./acre) 0	40	80	120
lb/acre	- - - - - - - ton dry matter/acre - - - - - -			
reduced tillage seedbed:				
0	1.36	1.49	2.00	2.22
20	.78	1.78	3.37	3.60
40	1.11	1.73	2.70	3.87
conventional tillage seedbed:				
0	.80	1.27	1.05	1.30
20	.66	1.87	3.10	3.62
40	.72	2.24	2.77	3.85

Economic, Agronomic and Environmental Impacts of Varied Soil Testing Philosophies

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

No substitute exists for the use of soil testing as the basis for recommendations on fertilizer use just as there is no substitute for mineral fertilizers in economic agriculture today. Three different concepts are commonly in use by the various organizations doing soil testing, viz. 'cation saturation ratio', 'nutrient maintenance', and 'sufficiency level'. The first of these projects an ideal soil as one having the following distribution of exchangeable bases: 65% calcium, 10% magnesium, and 5% potassium, or Ca/Mg ratio of 6.5, Ca/K of 13, and Mg/K of 2. Outside these ratios one or the other of Mg or K would be considered deficient. The 'nutrient maintenance' concept implies that, irrespective of soil test level, an amount of nutrient should be added to replace that expected to be removed by the crop to be grown. The 'sufficiency level' approach, finally, is based on soil test calibrations that reveal no yield response to an applied nutrient when the soil tests above a certain level. Because widely divergent recommendations are being given to farmers by different organizations using these varied concepts, a need has surfaced for bringing some uniformity into the philosophies employed in making recommendations.

Objectives:

This study has been carried out over the past nine years with objectives of: (1) evaluating effects of the fertilizer recommendations from several soil testing laboratories on crop yields and soil properties; and (2) comparing fertilizer recommendations of the University of Nebraska with those of commercial laboratories for determining if University recommendations are appropriate for meeting economic and environmental requirements. The current report summarizes yields and costs for the corn crop only through 1981. Prior reports have shown results with plots on wheat, sugar beets and potatoes in earlier years which have not been continued.

Procedure:

Reported here are results on four major soils of Nebraska comparing corn yields from treatments recommended by the five laboratories doing most of the soil testing in the state, one of which being the University's. In the first year of the study a representative soil sample was collected from the entire experimental area of each site, which was then thoroughly mixed, split into five subsamples, and sent to the various laboratories, A-D being commercial labs, E the University's. In subsequent years, each laboratory received a sample from each site composited from all replicated plots to which fertilizer had been applied according to that lab's recommendations. All samples were sent 'blind' under farmers names such that no laboratory, including the University's, would recognize the sample as representing other than a farmer's production field. By the end of the 1981 crop season yield results had been acquired from 32 field comparisons which are summarized here. This should have given sufficient time interval for all labs' objectives in soil testing to be realized.

All nutrients recommended by the various laboratories were broadcast and incorporated before planting a high yielding corn hybrid adapted to the specific locality. Cultural practices included planting in 76 cm rows at an average 24,000 seeds/a for the irrigated sites, 18,000 non-irrigated, with irrigation, cultivation and pest control practices applied as needed for each site. Fertilizer costs expressed in the accompanying figure were average retail costs for the nutrients during the spring peak consumption period for the years involved.

Following the 1980 harvest soil samples were taken of the surface 15 cm and by 30 cm increments throughout the 180-cm profile of all plots at each location. Determinations were made of soil nutrients in these samples by the University's laboratory for registering any changes in soil properties that may have transpired with the different labs' fertilizer programs.

Soils Characterized:

Soils employed for the investigation are Sharpsburg silty clay loam on the Mead Field Station, Hastings silt loam on the South Central Station, Moody silt loam on the Northeast Station, and Cozad silt loam on the North Platte Station (Fig. 1). The Sharpsburg, Hastings and Moody upland soils developed on loess are three of the most extensive soils in Nebraska embracing in aggregate in the order of 20 percent of the cropped land in the state. The Cozad occupies a large area of central Platte Valley benchland. All are regarded as productive soils with irrigation enhancing production potential at all but the Moody soil site.

A wide range in Ca/Mg ratios from 3.2 to 6.3 will be noted among the four soils, likewise of Ca/K from 10.3 to 19.6, and Mg/K of 1.9 to 6.2. Of further significance is the very high profile levels of enchangeable K^+, generally well in excess of 200 ppm. The large subsoil reserves of available P in most of the soils should presumably have a significant influence on soil P delivery potentials and the recommendations given for P fertilization. The profile pH values for Sharpsburg and Hastings are virtually ideal for maximizing overall nutrient availability while the high pH from excess lime in the deep subsoil of Moody and throughout the Cozad soil could possibly impose limitations for certain elements.

Recommended Treatments, Costs and Yield Results:

Yield goals were reasonably met at all locations throughout the 7-8 year investigation period despite the climatic, pest and other problems inherent in agricultural production (Table 1). There were no significant yield differences from treatments recommended by the various labs except for the South Central Station where yields for lab C were less than those for the other labs. But there were large differences in the kinds and amounts of nutrients advocated with great disparity in average costs for the fertilizer treatments made. Thus, from the purely economic standpoint there can be no question of the superiority of the more conservative fertilizer recommendations of lab E.

Soil Residual Effects:

Large differences in status of some soil nutrient elements have developed from the varied fertilizer treatments, little or none with others (Table 2). Note that the profile soil NO_3-N level had reached a point with all labs where a substantial reduction in fertilizer N rate should have been possible in 1981. Lab E did indeed reduce its recommendation to 50 kg N/ha for the Cozad soil in contrast with the average 219 kg of labs A, B and D, and no N was recommended for the Moody soil by lab E while the other four labs averaged 77 kg N to be applied. Since there were no yield differences among the 1981 plots and in consideration of ground water nitrate depollution projects already in operation in the state it is quite apparent that profile NO_3-N accumulations must be taken into account not only for economic reasons but the environmental as well.

Only lab A with its most liberal K recommendations has measurably changed the average soil exchangeable K status of the experimental sites. These loess and alluvial soils of very high exchangeable and reserve feldspar mineral K have not changed perceptibly in K level from the control even without supplemental K fertilizer despite the high yields obtained.

As with N and K, changes in extractable soil S, Mn, and Fe have been slight and are not portrayed here. Very substantial changes have occurred as an average, however, with extractable P and Zn, modest with Cu, and at least on one soil with soluble B. These changes are not surprising in view of the average 47 kg/ha of Zn applied to plots of lab C in the experimental period for example, and the 204 kg of P by lab D. The soil P and Zn levels have become quite excessive with certain of the labs' programs with potential for accentuating eutrophication of surface waters by the former and the possibility of inducing Fe problems by the two in tandem. The growing Cu concentrations, too, give portent of the possible induction of Cu toxicity problems as have been created in southern France and Florida from excessive use of Bordeaux mixture as fungicide. Likewise, the growing level of B in especially the Hastings soil will have to be a matter of concern.

Otherwise, these residual nutrient measurements give no indication of the 'sufficiency level' approach as practiced by lab E causing a depletion of soil nutrients with potential lowering of future soil productivity. There appears to be no cause for concern on this issue so long as continuous surveillance maintains soil test values above the sufficiency level. This does not mean to say that a farmer should not take advantage of a period of favorable fertilizer prices for assuring that sufficiency in subsequent years even though the level is reasonably adequate at the moment.

Table 1. Soil test recommendations, fertilizer doses and yield response for the soil test comparison study.

Fertilizer recommendations, ave. annual costs & yields	Lab A	B	C	D	E	Check
MEAD FIELD STATION, Sharpsburg sicl yield goal 170 bu/a, 1973-81						
Ave. annual recommendation, lbs/a						--
N	216	206	231	188	183	
P	36	33	27	32	13	
K	62	46	53	14	—	
Mg	3	1	--	--	--	
S	5	21	69	7	--	
Zn	3	2	6	2	1.4	
Mn	1.6	.3	.3	--	—	
Fe	--	--	--	1.3	--	
Cu	.7	.3	1	.1	—	
B	.1	--	.6	.1	—	
Ave. annual fertilizer cost, $/a	65.31	57.67	78.24	52.39	36.08	--
Ave. annual yield, bu/a	158	152	151	153	155	68
NORTH PLATTE STATION, Cozad sil yield goal 170 bu/a, 1974-81						
Ave. annual recommendation, lbs/a						
N	193	203	211	191	159	
P	26	23	14	24	--	
K	6	21	--	--	—	
Mg	2	11	.4	--	--	
S	11	18	61	—	--	
Zn	2	2	7	--	.7	
Fe	.4	.1	--	--	--	
Mn	.8	.4	--	--	--	
Cu	.3	.2	1.3	--	--	
B	.6	--	.4	--	--	
Ave. annual fertilizer cost, $/a	50.87	56.52	59.98	42.27	23.90	--
Ave. annual yield, bu/a	169	172	166	167	167	103

Fertilizer recommendations, ave. annual costs & yields	Lab A	B	C	D	E	Check
SOUTH CENTRAL STATION: Hastings sil yield goal 190 bu/a, 1974-79, 1981*						
Ave. annual recommendation, lbs/a						--
N	182	171	191	169	152	
P	33	20	17	19	2	
K	33	21	--	--	--	
Mg	3	10	.4	--	--	
S	21	27	43	4	--	
Zn	3	2	5	.6	1	
Mn	1	--	2	--	--	
Cu	.2	.1	.7	--	--	
B	.4	.4	.6	--	--	
Ave. annual fertilizer cost, $/a	55.28	47.92	53.73	34.96	26.43	--
Ave. annual yield, bu/a	184	183	182	188	187	124
NORTHEAST STATION, Moody sil yield goal 90 bu/a, 1974-81						
Ave. annual recommendation, lbs/a						--
N	68	86	70	112	63	
P	16	11	8	17	2	
K	24	9	6	6	--	
S	9	8	29	2	--	
Zn	1.5	1.4	4	1	.3	
Mn	--	--	1	--	--	
Fe	--	--	--	.8	--	
Cu	--	.1	.1	--	--	
B	--	--	.4	.1	--	
Ave. annual fertilizer cost, $/a	24.94	24.57	27.52	29.90	10.44	--
Ave. annual yield, bu/a	86	85	87	85	87	--

*Soybeans grown in 1980; no fertilizer applied in 1980 or 1981.

Table 2. Average soil test values for the four locations at the end of the 1980 crop season.

Nutrient	Lab A	Lab B	Lab C	Lab D	Lab E	Control
Profile NO_3-N, kg/ha	197	181	209	223	190	65
B & K #1P, ppm	43	31	27	45	26	18
Exch. K^+, ppm	419	383	387	389	377	377
Ext. SO_4-S, ppm	14.1	14.4	14.2	13.0	14.0	14.7
DTPA Ext. Mn^{+2}	21.5	20.5	21	21	19.5	19
DTPA Ext. Cu^{+2}	1.1	1.0	1.3	1.0	.9	.8
DTPA Ext. Fe^{+2}	30	28	26	28	24	22
HCl Ext. Zn^{+2}	9.5	8.8	16.1	6.5	7.1	5.3
Ext. B	.9	.8	.8	.8	.7	.6

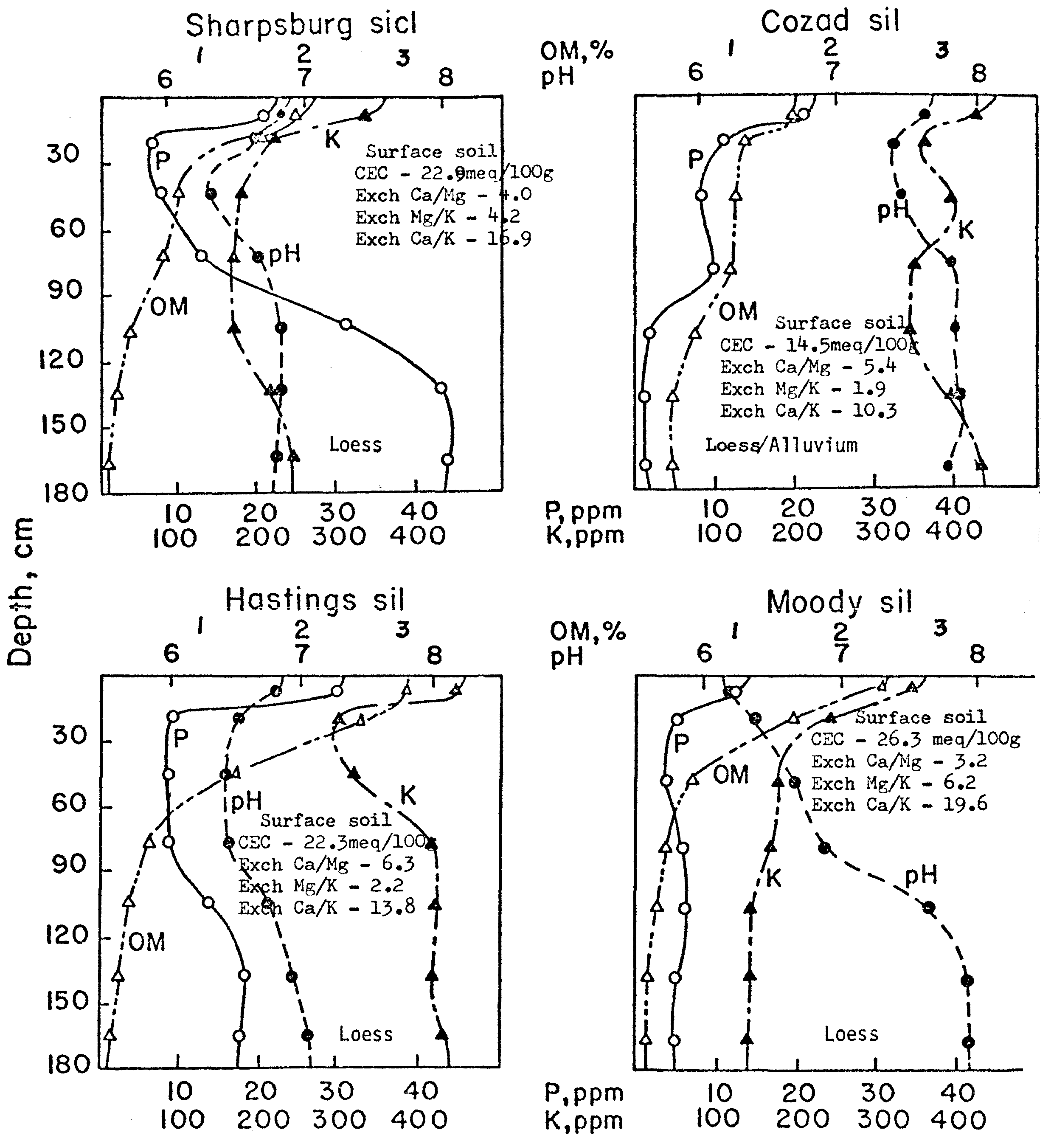

Figure 1. Chemical characteristics of the 180-cm profile of the control soil at the four experimental sites after the 1980 harvest.

PHYSICS OF WATER IN SOILS AND POROUS MEDIA

D. Swartzendruber

Objective:

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

Procedure:

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

Results and Discussion:

Experimental work has continued on downward water infiltration and upward capillary rise into initially air-dry fine quartz sand in the narrow size range 0.15 to 0.21 mm. Measurements have been obtained on very uniformly packed replicate columns in the laboratory, including water contents (by gamma-ray attenuation) as a function of time at various fixed positions. The apparent success of the Green and Ampt equation for downward infiltration, and the almost complete failure of its counterpart equation for upward capillary rise, have now been documented conclusively. The same studies have been conducted for the narrow-sized sand at initial water contents much higher than air dry, with the similar discrepancy between downward and upward water movement as already noted for the initially air-dry quartz sand. A new equation for capillary rise has been developed as a solution to the so-called Burgers partial differential equation. The new equation offers promise for moderate times of rise but not for very large times of rise. Still other equations are being sought, with promise of success for downward infiltration. What is ultimately desired is a simple equation that can be used to describe infiltration for practical purposes, and hence for water and irrigation management.

Downward infiltration of water into an initially air-dry 1:1 mixture of Wyoming bentonite and coarse quartz silt has been measured under conditions in which the top end of the mixture is free to swell upward as it wets with water. With reference to the initial level of the top end of the air-dry mixture, the top end moves upward about the same amount as the visual wet front infiltrates. Dual-gamma measurements of internal water contents and bulk densities are presently being analyzed.

A theoretical analysis has been made and verified for the trapping of flowing suspension particles in a porous medium. These results have possible relationship to the phenomenon of soil crusting.

SOIL NITROGEN CHANGES IN FALLOW SYSTEMS

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

Background:

Reductions in the soil's total C and N contents due to tillage are well documented (3, 6). Most experiments, where soils in a native grass condition were plowed and farmed conventionally, have shown a loss of 40 to 60% of the total C and N in their surfaces after a period of 35 to 50 years of cultivation. This represents an approximate loss of 1500 to kg of N/ha and 15,000 to 20,000 kg of C/ha from soils with average densities.

There are many more literature citations that could be made to document the above statements. However, most of these research reports deal with the change in C and N from an "after the fact" viewpoint. They made observations of soil changes in situations that "happened to be available" for study. Few are actual documentations of change in replicated experiments.

Soil N fractions from which the losses first occurred are also not well documented. Work by Meints and Peterson (4) attempted to address this problem in soils of the Ustoll suborder. They showed that cultivation decreased the concentrations of nonhydrolyzable N, hydrolyzable NH_4-N, hexosamine N and alpha amino acid N in the upper portions of the soils studied. In the lower portions of these soils, cultivation tended to decrease most fractions with the exception of hydrolyzable NH_4-N which increased in some cases. The latter finding was not explainable with the observational approach they used. Their approach, a paired comparison of cultivated and native soil situations, did not have true replicates and so testing of specific hypotheses was not possible. Since measurements were being made on soils after long periods of cultivation had occurred, the rate of change in each N fraction was not determinable. Furthermore, Meints and Peterson (4) could not determine differences due to tillage management. Obviously tillage systems which maintain residue on the soil surface throughout the year have potentially different N regimes in their surface soils compared to low or no residue systems. These differences in turn may even influence the distribution of soil N compounds in the subsoil.

Soil N budgets such as those reported by Peterson and Vetter (6) indicate large amounts of "lost" N. Where has it gone? This question cannot be answered from the data in the literature. It is of importance to get an answer because it may give a clue as to how to reverse or at least partially control future N losses.

The specific objectives of the project are to determine:

1. The N budgets under no till, stubble mulch and bare fallow systems at points in time following the cultivation of a native sod field site.

2. The changes and rate of the changes in the organic and inorganic N pools when a native sod is brought under cultivation.

3. The influence of tillage systems on the relative proportions of the total soil N in the hydrolyzable and nonhydrolyzable organic forms, in the nonexchangeable and exchangeable ammonium forms and in the nitrite and nitrate forms.

Procedure:

Fallow system experiments established in 1968-70 at the High Plains Ag Laboratory at Sidney, Nebraska have been sampled annually since established. Each year the soil has been sampled in 10 cm increments to 30 cm and in 30 cm increments from 30 to 180 cm total depth. One of the experiments was established on a soil that had been cultivated until 1957 and then was seeded to grass between 1957 and 1969. Treatments consisting of chemical, subtillage and black fallow were imposed in each experiment and have been used continuously since establishment. The native sod experiment has a replicated sod strip which is maintained as a control.

A historical record of the N regimes in these experiments is now represented by the soil samples on hand. The total N in each sample will be fractionated into various organic and inorganic constituents. They are nitrate, nitrite, exchangeable and fixed ammonium, nonhydrolyzable organic N, hydrolyzable ammonium N, hexosamine N, hydroxyamino acid N, and alpha amino acid N. Procedures described by Bremner (1, 2) are available for this fractionation. Appropriate statistical analyses will be used to summarize treatment effects.

Results and Discussion:

Peterson et al. (5) reported the N budget shown in Table 1. Total N losses for the plow tillage are close to what is predicted by Jenny's N loss equation; 25% in 10 years. Crop removal explained about 35% of the total loss, leaving over 360 kg/ha of "unaccounted for N". No-till, however, showed a low amount of loss, < 100 kg/ha, and yet crop renewal was almost 200 kg/ha. This left a positive amount of "unaccounted for N".

Where is the N that was lost from the plowed system? Obviously crop removal does not explain it. In these experiments erosion is not likely due to their landscape position and the narrow strip orientation of the plots. This leaves leaching of NO_3^--N and/or denitrification as avenues of loss.

Data in Table 2 represent an updated budget (1981) and include a measurement of NO_3^--N below the root zone. Note that within the errors of measurement, the NO_3^--N below the root zone explained the N losses. No-till presented an even more positive N balance when deep NO_3^- was included. Table 3 displays the balance sheet in another fashion using total NO_3^--N in the entire surface 15 m of soil. Figure shows the distribution of the NO_3^--N in the 15 m of soil.

Future Plans:

Periodic sampling of the root zone for NO_3^--N content throughout fallow is underway. This will provide the pattern of NO_3 accumulation and should help explain the NO_3^- accumulation results observed thus far.

Why does the no-till system have a positive N balance? This question needs to be pursued. First to determine if it is real and then if it is real what its source is.

Soil density measurements need investigation because balance sheets are quickly altered with only small changes in density.

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Table 1. Nitrogen budget for the 0-30 cm depth as affected by tillage system in 1979. (Tillage D)

		Soil N				
Years	Tillage	1970	1979	ΔN	Crop Removal	Unaccounted For N
1970-79		kg/ha				
	Plow	4178	3629	-549	188	-361
	No-Till	4178	4096	-82	194	+112

Table 2. Nitrogen budget as affected by tillage system in 1981. (Tillage D)

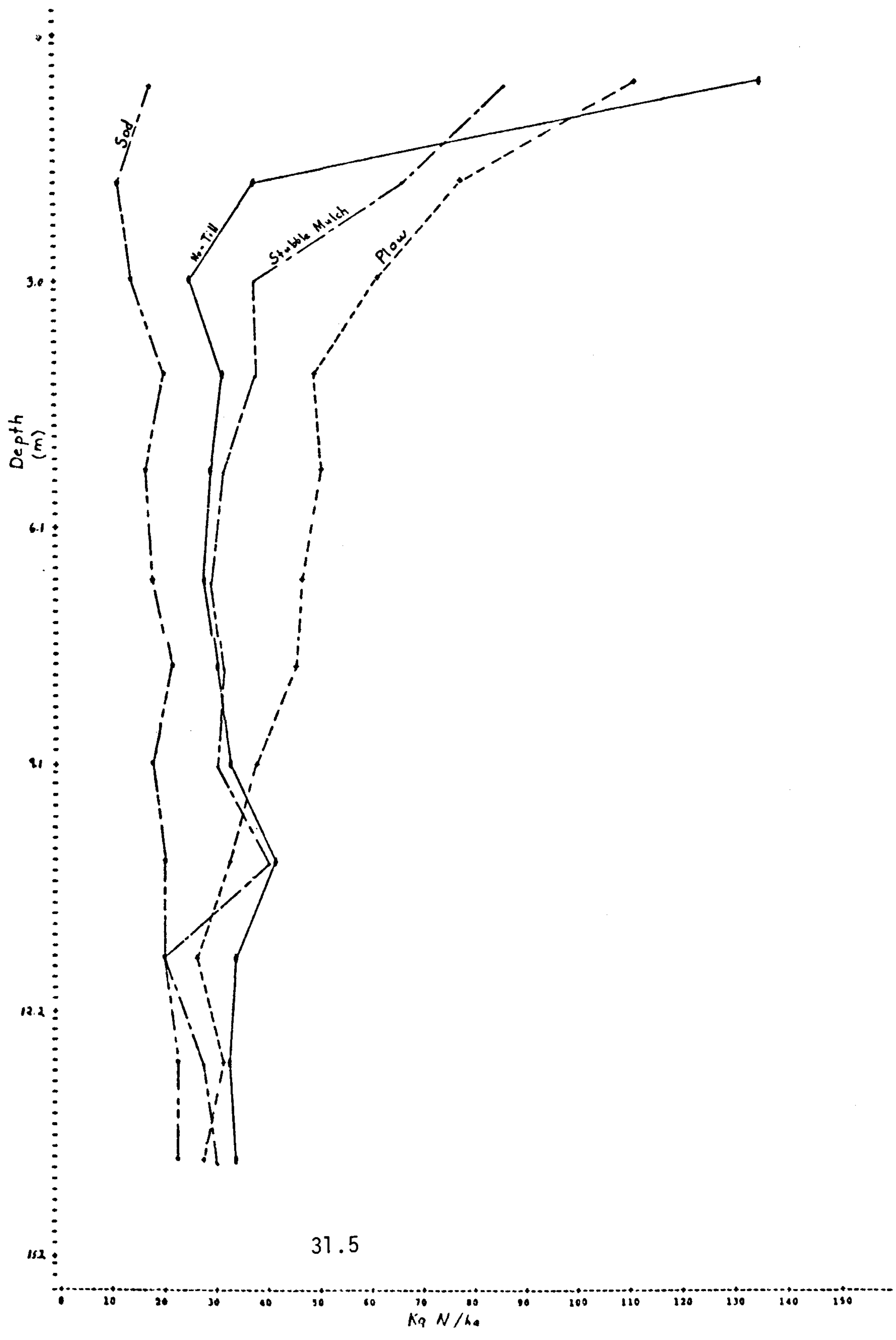
	Soil N					
Tillage	Initial Total In 1970 (0-30 cm)	Spring 1981 (0-30 cm)	ΔN	Crop Removal	Unaccounted For N	(NO_3^--N In 15 (Sod NO_3^--N
	kg/ha					
Sod Control	4134	4134	0	0	0	-
No-Till	4134	3987	-147	251	+104	267
Stubble Mulch	4134	3660	-474	295	-179	247
Plow	4134	3527	-607	288	-319	374

Table 3. Nitrogen budget as affected by tillage system in 1981 and including NO_3^--N in the surface 15 m of soil.

Tillage	Spring 1981 Total N (0-30 cm)	Crop Removal	NO_3^--N In 15 m of Soil	Total
No-Till	3987	251	488	4726
Stubble Mulch	3660	295	468	4423
Plow	3527	288	595	4410
Sod	4134	0	221	4355

Figure

Nitrate-N accumulation to 15 m as affected by tillage in 1981. (Tillage D)



31.5

NITROGEN MANAGEMENT FOR IRRIGATED CORN AND GRAIN SORGHUM

R. A. Olson and M. P. Russelle

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 kind, time and rate of N applied.
3. Compare the two crops in response to P at the varied N levels.

Procedure:

High yielding varieties or hybrids of the two crops are grown side by each with identical tillage and irrigation practices applied. N 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 12-18" tall. A sidedress treatment of anhydrous ammonia is made at the same three rates, and beginning for the 1981 corn crop was a fall anhydrous ammonia application at those rates.

Check plots of corn and those receiving 240 lbs N/a through the years were sampled by deep drilling to the water table (around 60 feet) in the fall of 1980 and samples were analyzed for NO_3-N contents.

Results and Discussion:

Grain and stover yields for this study were reported in detail in the 1980 Soil Science Research Report. Accordingly, only average grain yields through 1981 are reported here along with data from the deep drilling study of plots which had been receiving the 240 lb N rate through 1980.

Table 1 portrays the superiority of grain sorghum over corn under limited N growth conditions but capacity for utilizing only 80 lbs N/a in contrast with the response of corn up to 160 lbs under the conditions of this study. It further shows an advantage of around 8 bu/a of summer sidedressing over planting time N applications within the 80-160 response range for corn, 5 bu/a with grain sorghum at the 80 lb rate. Sidedressed anhydrous ammonia averages about 8 bu/a better than UAN for corn at the 80 lb rate with little difference apparent at higher rates. Fall applied anhydrous ammonia gave essentially the same results as with summer sidedressing in this first year's comparison. Applied P has increased corn yield an average 3 bu/a and grain sorghum about 1 bu/a.

NO_3-N data from the deep samples collected in corn plots are summarized for the top 30 feet only. Pure white sand was encountered at this depth with little capacity for holding water or N. Figure 1 demonstrates that substantial quantities of NO_3-N have built up in the soil material above sand to at least the 24-foot level with this excessive N-rate for yield, ranging from 13 to 22 percent of the total 2880 lbs N applied through 1980. Around 10 percent remains in the surface 6 feet where possibility exists for its recovery by a subsequent crop if little fertilization of the surface soil were done. Note that approximately 150 lbs more N remains in the deep profile with sidedressed over planting time UAN treatment and that sidedressed anhydrous ammonia has about 260 lbs more.

Table 1. Yield response of irrigated corn and grain sorghum to N fertilizer as influenced by time, rate and method of application, long term average.[1/]

Treatment	N Rate	Corn 0 P	Corn 20 P	Grain Sorghum 0 P	Grain Sorghum 20 P
	lb/acre	bu/acre[2/]			
Control	0	92	95	100	101
32% N solution at planting	80	127	127	121	121
	160	139	141	124	123
	240	142	141	122	121
32% N solution sidedressed	80	135	136	126	126
	160	145	148	125	126
	240	144	144	124	123
NH_3 fall-applied 1981 crop only	80	143	144	--	--
	160	153	155	--	--
	240	141	147	--	--
NH_3 sidedressed	80	141	146	125	128
	160	142	150	125	126
	240	147	152	125	128

1/Corn: 1969-1981; Grain sorghum; 1969-1981. Fall NH_3 applications begun in fall, 1980.

2/Corn: 15.5% moisture; Grain sorghum: 14% moisture.

Project: Distribution of Mineral Nitrogen under Native Range and Cultivated Fields in the Nebraska Sandhills

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

Objectives:

1. Determine the distribution of soil water, NH_4^+-N, NO_3^--N and Cl from the soil surface to the water table under cultivated irrigated fields and adjacent native range sites at the UNL-Sandhills Ag. Lab.

2. Determine the time required to move nitrate from the soil surface to the water table.

3. Use the information with soil lithological and physical properties to develop or refine existing computer models describing nitrate movement and predicting loading to the aquifer.

Procedure: Soil samples were taken in 1' increments (undisturbed core) in 1979 and spring 1980 with a 3" Giddings probe using a 150# drop hammer on a drilling rig. After spring 1980 a screw-type auger was used to take samples in 2.5' increments. Comparison of data from undisturbed cores vs. screw auger samples showed little difference. Time for one hole to a 100 feet depth was 2 days for augering vs. 5 days for undisturbed cores. Three holes per site were taken and samples analyzed for gravimetric water content, pH, nitrate-N, ammonium-N, and chloride (not completed). Variability of parameters between holes was small so values were averaged. Sites sampled were irrigated alfalfa (6 year old stand), orchard grass, and corn.

The irrigation and N fertilizer history for the sites is given in Table 1. Native range sites have never received any N or irrigation. Alfalfa received 30# N/acre during the year of establishment and received 33-36 inches of rainfall plus irrigation each year. N application on the grass was split into three times each season - 1/3 early, 1/3 mid-season, and 1/3 near the end of the summer. The grass plot study was discontinued in 1978 and the area received no irrigation or N after this.

Nitrate Distribution with Depth

Only slight differences between nitrate-N under alfalfa and its adjacent native range were found. Most of the N fixed by the alfalfa should still be in the organic form although some mineralization could occur to enrich the soil under alfalfa with nitrate-N compared to the native range. (Figure 1).

A substantial difference between nitrate-N distributions under the irrigated grass and its adjacent native range was found. Evidence of nitrate movement to 22 feet was shown. Since the area was only irrigated for 3 years, the bulk of this movement probably occurred during 1976-78. Natural recharge does occur in the sandhills and further downward movement of the nitrate bulge is not precluded even though the area has reverted to dryland. Assuming that the nitrate moved downward most significantly during the years of irrigation, rate of movement is estimated to be nearly 7 feet per year. (Figure 2).

Project: Distribution of Mineral Nitrogen under Native Range and Cultivated Fields in the Nebraska Sandhills

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

Objectives:

1. Determine the distribution of soil water, NH_4^+-N, NO_3^--N and Cl from the soil surface to the water table under cultivated irrigated fields and adjacent native range sites at the UNL-Sandhills Ag. Lab.

2. Determine the time required to move nitrate from the soil surface to the water table.

3. Use the information with soil lithological and physical properties to develop or refine existing computer models describing nitrate movement and predicting loading to the aquifer.

Procedure: Soil samples were taken in 1' increments (undisturbed core) in 1979 and spring 1980 with a 3" Giddings probe using a 150# drop hammer on a drilling rig. After spring 1980 a screw-type auger was used to take samples in 2.5' increments. Comparison of data from undisturbed cores vs. screw auger samples showed little difference. Time for one hole to a 100 feet depth was 2 days for augering vs. 5 days for undisturbed cores. Three holes per site were taken and samples analyzed for gravimetric water content, pH, nitrate-N, ammonium-N, and chloride (not completed). Variability of parameters between holes was small so values were averaged. Sites sampled were irrigated alfalfa (6 year old stand), orchard grass, and corn.

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Figure 3 shows the nitrate distribution under corn in 1980, the same area in 1981, and adjacent native range. Definite nitrate enrichment is noted. The 1980 and 1981 data indicate enrichment to a depth of 50 feet. The other interesting point from figure 3 is the downward movement of the nitrate bulge between the spring of 1980 and 1981. The average movement was about 7 feet. Movement of nitrate during 7 years of cropping by 7 feet per year should show enrichment to 50 feet and the data do indicate this.

Data are still being analyzed and attempts at predicting nitrate-loading have not been completed.

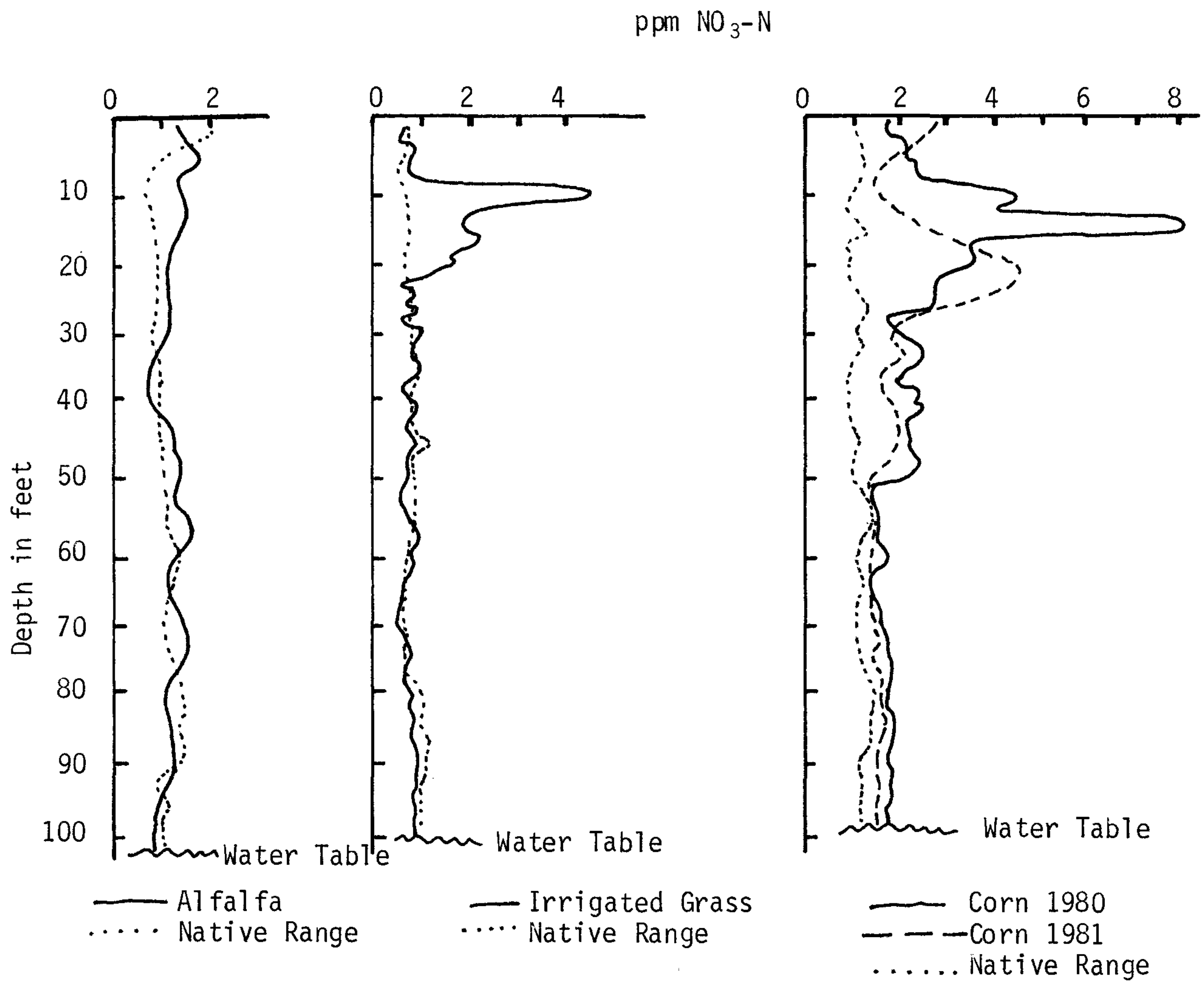
Some nitrate leaching will occur in all soils that are farmed. The amount of nitrate lost and the rate of downward movement are influenced by (1) rate of nitrogen fertilizer applied, (2) overwinter precipitation and (3) irrigation management. Soil sampling for residual soil nitrate to 3 or 4 feet can improve N recommendations to reduce nitrate leaching if it is combined with improved irrigation practices.

Table 1. Nitrogen fertilizer and irrigation applications to the various sites during the growing season.

Year	Nitrogen*	Rain + Irrig**	Nitrogen*	Rain + Irrig**
	Corn		Grass	
1973	150	30.8	Sod	
1974	150	29.7	Grass established	
1975	150	31.1	300	24.4
1976	210	16.0	300	26.2
1977	220	23.4	300	24.5
1978	210	24.5	0	7.8
1979	0	21.5	0	12.2
1980	0	23.5	0	5.0

*lb/A

**Inches during the growing season, Full ET usually 22 to 24"



ppm NO_3-N
0
2
0
2
4
0
2
4
6
8
10
20
30
40
50
60
70
80
90
100
Depth in feet
Water Table
Water Table
Water Table
Alfalfa
Native Range
Irrigated Grass
Native Range
Corn 1980
Corn 1981
Native Range

High Yield Corn-Soybeans-Wheat Rotation Experiment

M.P. Russelle and R.A. Olson

Objective:

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

Procedure:

This is a new experiment initiated in 1981 that involves a rotational sequence of corn-soybeans-wheat in three separate blocks such that each crop is produced annually. Treatments include varied rates of N, P and K along with singular rates of manure, S, Zn, B and Cu. Nitrogen rates are greatest for irrigated corn, intermediate for wheat, and least for soybeans. Only corn was harvested in 1981 but all three should be harvested in 1982. A separate adjoining plot will grow continuous corn with identical treatments to the rotational corn.

Experimental Results:

The 1981 corn gave promise of excellent yields, however, a short period of moisture stress in early summer and an unfortunate choice of hybrid resulted in lower yields than expected. Even so, the average 170 bu/A yields were notably better than average irrigated farm yields in eastern Nebraska during 1981 (Table 1). Something between 80 and 160 lbs N/A was needed for optimum yield with no response detectable from applied P, K, S and the micronutrients employed. Twenty tons manure was not equivalent to 80 lbs mineral N in this first year of the study.

Not only will nutrient responses be measured in the years to come, but the economic significance of wheat and soybeans in the rotation with their lesser nutrient and irrigation requirements should become apparent.

Table 1. Corn grain moisture, yield and nitrogen content as affected by fertilizer applications, high yield rotation experiment, 1981.

Treatment[1/]	Moisture	Dry Matter	Yield[2/]	Nitrogen	
	%	lb/acre	bu/acre	%	lb N/acre
1. Control	19.9	6880	145	1.19	82
2. 20T manure	19.4	7420	157	1.40	104
3. 80+0+0	19.7	7960	168	1.37	107
4. 160+0+0	19.6	8140	172	1.40	114
5. 160+40+0	19.1	8200	173	1.44	118
6. 160+40+40	19.3	8210	174	1.40	115
7. 160+40+40+20S+ 10 Zn+1 B+0.5 Cu	19.3	8480	179	1.41	119
8. 320+80+80	19.4	8170	173	1.43	117
9. 160+40+40+20T manure	19.1	8000	168	1.47	117

WASTE RESOURCE RECYCLING IN SOILS

Leon Chesnin
Agronomy Extension Waste Management Specialist

Waste resources are growing in importance in agricultural utilization programs. These resources include items that were considered to be disposable wastes and even hazardous wastes, but are in fact valuable sources of organic matter and, or plant nutrients. Some of these resources include plant residues, animal manures, sewage sludges and slurries, paunch manure from slaughterhouses, paper and cardboard, food source garbage, animal bedding, leaves, grass clippings, cheese whey, alcohol plant distillers solubles, spent acids from galvanizers, battery breakers and lead resmelters, and the wastewaters of seed, meat and sugar processors.

With the high and increasing cost of energy sources, interest rates and inflation, fertilizer prices seem to be "tagging along" on an upward cost spiral. The prediction of $500/ton for anhydrous ammonia seems to be realistic. These circumstances have increased the interest of farmers and fertilizer formulators in finding lower cost sources of plant nutrients, even from non-traditional sources. At the same time livestock feeders, municipalities and industries are trying to reduce their high cost of waste disposal and regulation by environmental agencies.

Animal Wastes: The total production of livestock manure in Nebraska was determined to be 88.4 million tons in 1971. This manure contained 433,949 tons of nitrogen. There were 5,898,000 acres of corn planted that year. If all the manure had been collected, there would have been enough to apply 147 pounds of nitrogen on every acre of corn. It is estimated that only 216,352 tons of manure-nitrogen were potentially recoverable. This would have supplied 73 pounds of nitrogen per acre of corn in 1971. If all of the manure that was collectible would be composted, the total production of compost from the livestock would amount to about 8.5 million tons.

The chemical composition of animal manures and composted manures depend on the age of the animal, sex, ration fed, environmental conditions that the manure has been exposed to and the conditions and technology of composting. Frequent collection of manure results in higher nitrogen content due to reduced losses. Maintaining composting temperatures below 160°F also conserves the nitrogen content of the waste-resource. The value of the manure or composted manure depends on the specific nutrients required for optimum crop production on any soil. These requirements can only be established by calibrated soil tests and chemical analyses of the manure or composted manure. The greatest benefit from application of organic soil amendments, however, is from the improvement of soil physical properties which related to the soil's productivity. As of this time no dollar value can be assigned to the benefits derived from increasing a soil's organic matter content through such amendments. Even if organic soil amendments were devoid of plant nutrients, it would be desirable and beneficial to apply these waste-resources to agricultural and urban lands.

Composting reduces the water content of organic waste-resources. This in turn reduces the cost of hauling and spreading the amendment.

Table 1. Chemical composition and economic value of beef cattle feedlot manure and composted beef cattle manure (dry weight basis).[1/]

Nutrient	Manure (O. D.)			Composted Manure (O. D.)		
	Content %	Pounds /ton	Value[2/] $/ton	Content %	Pounds /ton	Value $/ton
Nitrogen (N)	1.3	26.	7.02	1.86	37.2	10.04
Phosphorus (P)	0.4	8.	- -	1.0	20.	- -
(P_2O_5)	0.92	18.4	5.89	2.29	45.8	14.66
Potassium (K)	1.2	24.	- -	3.0	60.	- -
(K_2O)	1.4	28.	3.36	3.6	72.	8.64
Sulfur (S)	0.3	6.	1.80	0.5	10.	3.00
Magnesium (Mg)	0.1	2.	0.74	0.2	4.	1.48
Zinc (Zn)	80 ppm	0.16	0.18	120 ppm	0.24	0.26
Iron (Fe)	60 ppm	0.12	0.08	50 ppm	0.1	0.07
Manganese (Mn)	44 ppm	0.09	0.08	33 ppm	0.07	0.06
Copper (Cu)	3 ppm	0.006	0.01	2 ppm	0.004	0.01

1/ Data from author's research and publications.

2/ 1980-81 prices which may vary according to location and source of nutrients:

Nitrogen	$0.27/lb	Zinc	$1.10/lb
Phosphates (P_2O_5)	$0.32/lb	Iron	$0.70/lb
Potash (K_2O)	$0.12/lb	Manganese	$0.90/lb
Sulfur	$0.30/lb	Copper	$2.50/lb
Magnesium	$0.37/lb		

Table 2. Chemical composition of various farm animal manures.[1/]

	Ash %	N %	P %	K %
Swine	28.8	2.0	0.6	1.5
Hen	17.2	4.3	1.6	1.6
Beef	10.2	3.5	1.0	2.3
Sheep	10.0	4.0	0.6	2.9
Dairy	10.6	2.7	0.5	2.4

Table 3. Nutrient elements excreted in manure of various animals during their respective production cycles.[1/]

Livestock Species	N	P (lb/cycle)	K
1000 broilers (10 weeks, 0 to 4 lb)	155	31	50
100 hens (365 days, 5 lb)	125	44	46
10 hogs (175 days, 30 to 200 lb)	115	29	33
2 beef (365 days, 400 to 1100 lb)	140	29	145
1 dairy cow (365 days, 1200 lb)	140	29	145

1/ B. Meek, Leon Chesnin, W. Fuller, R. Miller and Darrel Turner. 1975. Guidelines for manure use and disposal in the western region, USA. W-124 subcommittee on animal wastes. Bulletin 814, Washington State University, Pullman.

Municipal Sewage Wastes: For many years Nebraskans were unaware of the environmental problesm created by following programs of disposal of sewage wastes. Municipal sewage sludges have been buried in landfills. Sludge slurry has been discharged on the surface of non-agricultural land, in ditches and streams. Sewage effluent has traditionally been discharged into streams. These practices have contributed to contamination of ground and surface waters. This has led to the establishment of federal regulations designed to "clean up the mess" by prohibiting sewage waste disposal in landfills and streams, but encouraging application to agricultural land.

Land application of sewage wastes to benefit crop production is an ancient practice in oriental countries. It has been a standard procedure in many European countries since the beginning of sewage treatment technology. In the restaurants of many cities in western Europe, the salads served are grown on a sewage sludge fertilized farm.

The increasing costs of commercial fertilizers is to a large extent associated with the increasing cost of energy sources. Farmers with land relatively close to a municipality have the opportunity to reduce these costs and still produce good crops by following the practice of "sewerization".

"Sewerization": Is the word coined by the author meaning "fertilization with sewage source organic matter and plant nutrients from solids, slurries or effluents".

"Sewerigation": Is a word coined by the author meaning "irrigation with sewage effluent or wastewater". Pumping costs for sewerigation are low because of the reduced lift resulting from pumping from a free water surface as compared to costs for lifting water from a much deeper underground source. The idea of irrigating field crops with sewage effluent or wastewater is an established practice.

Sewage sludge solids, on a dry weight basis, contain about 1-6% nitrogen and phosphorus (Table 4). This would be 20-120 pounds of these important plant nutrients per ton of dry solids. Only 15% of the nitrogen is available to plants during the first year when the sludge is incorporated into the soil-nitrogen availability can be increased by composting prior to application. The dollar value of the nutrients in sewage sludge can be determined by comparison with commercial fertilizer prices. An extremely important contribution of sewage sludge applications to agricultural soils is the beneficial effect on soil physical properties. The increased organic matter increases the water infiltration rate of the soil, reduces soil density and compaction. Nebraska is extremely fortunate in that its sewage wastes are low in toxic heavy metal contents. The combination of a small number of metal plating businesses and strict control and monitoring of industrial discharges following pretreatment have resulted in sewage wastes that are suited for agricultural fields. Nebraskans produce enough sewage wastewater or effluent to irrigate 1 acre foot of this water on about 165,000 acres of corn. Each acre foot of sewage water contains about 54 pounds of nitrogen or a total resource of 4,455 tons of this plant nutrient. While these are estimates based on published data, the importance of recycling sewage solids and wastewaters in agricultural soils is obvious.

Upgrading Sewage Sludge Slurries: A growing number of municipalities are developing cooperative programs with farmers for the injection of sewage sludge slurry in their fields using a pressurized applicator tank truck. If the slurry contained 3% sewage solids which in turn had a 3% nitrogen content there would be about 7.5 pounds of nitrogen per 1,000 gallons of slurry applied to the soil. Only 15% of this nitrogen would be available to plants during the first year. It would take an application of about 89,000 gallons of this sludge slurry per acre to supply 100 pounds of available nitrogen to a corn or sorghum crop. This suggests that the farm should probably grow soybeans or alfalfa, or supplement the nitrogen requirement of a grain crop with another fertilizer source.

Table 4. Amount of total solids and nitrogen or phosphorus in dewatered (filtered) sewage sludges per ton.

	Percent Sewage Solids						
	10	15	20	25	30	35	40
	Dry Weight of Solids, lbs. per ton						
	200	300	400	500	600	700	800
Total Nitrogen or Phosphorus Percent of Solids	Total Nitrogen or Phosphorus Content of Solids, lbs. per ton						
1	2	3	4	5	6	7	8
2	4	6	8	10	12	14	16
3	6	9	12	15	18	21	24
4	8	12	16	20	24	28	32
5	10	15	20	25	30	35	40
6	12	18	24	30	36	42	48

Table 5. Amount of available nitrogen in soil during the first year after application of one ton of dewatered (filtered) sewage sludge.1/

	Percent Sewage Solids						
	10	15	20	25	30	35	40
Total Nitrogen Percent of Solids	Available Nitrogen in lbs. per ton of Dewatered Sewage Sludge						
1	0.3	0.4	0.6	0.7	0.9	1.0	1.2
2	0.6	0.9	1.2	1.5	1.8	2.1	2.4
3	0.9	1.3	1.8	2.2	2.7	3.1	3.6
4	1.2	1.8	2.4	3.0	3.4	4.2	4.8
5	1.5	2.2	3.0	3.7	4.2	5.2	6.0
6	1.8	2.7	3.6	4.2	4.9	6.3	7.2

1/ Multiply values in Table 3 by 0.06, 0.04, 0.02, and 0.01 to obtain the amount of nitrogen available during the 2nd, 3rd, 4th and 5th years respectively after the initial application of dewatered sludge.

One way proposed by the author to solve the problem is to add anhydrous ammonia to the sewage slurry as it is being loaded into the tank truck. An anhydrous ammonia tank could be connected to the inlet pipe of the truck or discharge pipe of the slurry storage tank. The ammonia would dissolve instantly into the slurry water to form aqua ammonia which can contain 16-25% nitrogen. This would add from 1,328-2,075 pounds of additional plant available nitrogen to the 1,000 gallons of sewage sludge slurry. The farmer would now have enough nitrogen to fertilize about 6-10 acres of irrigated corn at 200 pounds of nitrogen per acre. A nitrate inhibitor such as N-Serve could be added to the ammonia if needed. There would be the additional energy, time and labor savings of not having to make another trip over the field to apply additional nitrogen. The reduced field operations would also reduce soil compaction and reduce costly wear and tear on the equipment. The number of acres fertilized with the fortified slurry could be adjusted by controlling the amount of anhydrous ammonia added and the rate of application. These same procedures could be used with animal manure slurries, cheese whey or suspensions of organic, nutrient rich solids.

The use of zero or minimum tillage procedures along with chemical weed control would further reduce the cost of crop production and reduce the potential for soil compaction. If the sewage wastes contained the cysts of parasites harmful to man or domestic animals, then soil injection would prevent any possible contamination as the cysts would be below the soil surface. One important feature of using anhydrous ammonia in sewage slurry is that regulations require that land applied sewage wastes must have a pH of 11 or above. It is generally a costly procedure to adjust the pH of sewage wastes. However, using the ammonia fortifying procedure, the sewage sludge slurry would have a pH of about 14 and be in compliance with state regulations and guidelines.

While there are health hazards associated with the land application of sewage sludge, these risks can be reduced by following precautions of personal hygiene, incorporating sewage sludge below the soil surface, avoiding soils with high water tables, and pasturing animals on sludge applied fields after sufficient rain has removed the sewage solids from the plant's surface. Composting sewage sludge eliminates the health hazards.

Recycling municipal sewage wastes can be one way that fertilizer dealers, farmers and municipalities can cooperate to help achieve a better environment and improve the local economy.

There are about 400 industrial and municipal sewage lagoon systems in Nebraska and the number has increased considerably in recent years. Sewage lagoons vary in size from as small as 2.5 acres to as large as 127 acres. The lagoon is considered a desirable, low cost, low maintenance structure for processing sewage wastes.

Nebraska communities produce enough sewage effluent (wastewater) to apply one acre foot of this water on at least 165,000 acres of crops. These crops can include corn, sorghum, soybeans, wheat (in vegetative stage), alfalfa and pasture grasses. For health reasons, plants or portions of plants consumed directly by humans should not be in direct contact with sewage effluent. This would include grains, fruits and vegetables.

Most municipalities either discharge their sewage effluent into streams or merely allow the water to evaporate into the atmosphere. Under these conditions, the water and nutrients in the effluent are of no benefit to anyone. During the dry months of the summer, the flow of the Wood River consists largely of the discharge of the Grand Island wastewater treatment plant. This provides a habitat for fish as well as irrigation water for some farmers.

The contribution of sewage effluent to irrigation agriculture exists with other municipalities along the streams and rivers of Nebraska. An increasing number of farmers have taken advantage of the nearness of a municipal lagoon to obtain permission to use the water for irrigation of their crops.

Plant Nutrient Content: In addition to the benefits of abundant water supply at low pumping costs, there is a bonus in the form of valuable essential plant nutrients in the sewage effluent. The plant nutrient content of sewage effluent can vary over a wide range (Table 6).

It is possible to apply as much as 170 pounds of nitrogen, 18 pounds of phosphorus, 60 pounds of potassium, and 1.6 pounds of zinc with each acre 10 inches of sewage effluent during irrigation. Analyses of sewage effluent and soils before the irrigation season are very important. This will permit the irrigator to establish an inventory of nutrient application. Farmers should subtract the nutrients added in the sewage irrigation water from the commercial fertilizer application recommended for the field.

Salinity Problems: The practice of using home water softening units that are recharged with salt has grown in many areas of Nebraska. If a great many homes in a community have such water softening units, or if there is an industry located in the community that uses and discharges salt, the total salt content of the sewage effluent could be greatly increased. The use of such sewage effluent for irrigation (sewerigation) could result in soil salinity (alkali) and crop production problems developing (Table 7).

It is important to have a complete soil analysis to a depth of 5 feet before the initiation of a sewerigation project. This will provide information on the plant nutrient status of the field and the existence of any unusual circumstances, such as high sodium content.

It is also important to determine the electrical conductivity (salt content) and sodium adsorption ratio (SAR) of the sewage effluent in the municipal lagoon. Such data are needed to determine the potential for development of salinity problems in the soil.

Table 6. Essential plant nutrients in sewage effluents.[1/]

Nutrient	Concentration range, ppm	Pounds added/acre 10 inches
Nitrogen (N)	10.7 - 74.6	24 - 169
Phosphorus (P)	< 0.1 - 8.1	< 1 - 18
Potassium (K)	3.9 - 26.6	9 - 60
Calcium (Ca)	28.7 -187.5	65 - 424
Zinc (Zn)	0.75	1.6

[1/] North Central Regional Extension Publication No. 52. Utilizing Municipal Sewage Wastewaters and Sludges on Land for Agricultural Production. The UN-L Soil Testing Laboratory will analyze sewage effluents for plant nutrient contents.

Table 7. Sewage water electrical conductivity levels associated with yield decreases of 0, 10, 25 and 50%.[1/]

	Electrical Conductivity EC_w, mmhos/cm Yield Reduction			
Crop	0%	10%	25%	50%
Corn	1.1	1.7	2.5	3.9
Soybeans	3.3	3.7	4.2	5.0
Wheat	4.0	4.9	6.4	8.7
Barley	5.3	6.7	8.7	12.0
Sorghum	2.7	3.4	4.8	7.2
Alfalfa	1.3	2.2	3.6	5.9

1/ Based on data of U. S. Salinity Laboratory, assumes about a 15-20% leaching fraction and an average salinity of soil water uptake by crop of about 3 times that of sewage effluent applied.

Depending upon the extent of sodium content of the sewage lagoon water and soil chemical properties, the use of gypsum, controlled rates of application of the lagoon water, and leaching the soil with good quality well water or natural rainfall may eliminate problems caused by sodium salts. Annual soil and effluent analyses are desirable if the quality of the sewage effluent is marginal or poor with respect to sodium content.

Health Risks: Fortunately Nebraska's sewage wastes are relatively low in toxic heavy metal content. This is due to the strict enforcement of regulations of the Nebraska Department of Environmental Control. The toxic heavy metals include zinc, copper, nickel, cadmium, chromium, lead and mercury. Zinc and copper are essential plant nutrients. Heavy metals, if present, are associated with sewage sludge solids and are generally not in sewage effluent or wastewaters. Nevertheless, there are some human and animal health risks associated with land application of sewage effluent (sewerigation). Disease organisms, including tuberculosis and hepatitis, and parasites of both man and domestic animals are associated with communities with poverty areas, and migrant workers or immigrants from Southeast Asia or Central and South America. Most of the live pathogens and parasites in lagoon wastes will settle to the bottom with the organic solids. However, the lagoon water is not free of pathogens and parasites. Irrigation with sewage lagoon effluent using high pressure sprinkler irrigation equipment can create an aerosol effect. Prevailing winds can transport a mist containing pathogens some distance from the field where they can be inhaled by susceptible humans or animals. The use of gravity or low pressure irrigation equipment will minimize this problem. Fencing the perimeter of the lagoon to keep out children or livestock will prevent transmission of disease and parasites through oral contact with the wastewater. When lagoons are dredged free of sludge, composting the sludge will kill the pathogens and parasites. Farmers applying sewage effluent to fields should take the same health precautions used by sewage plant workers and follow standard procedures of personal hygiene. Municipalities cooperating with farmers on sewerigation should encourage farmers to follow these procedures. The municipality should take the precaution of fencing the perimeter of the lagoon to prevent use of the water by livestock and prevent accidents and health problems involving children or livestock.

Slaughterhouse Wastes: About 94,000 tons of paunch manure are disposed of annually on agricultural fields, in landfills or by incineration. The composition of paunch manure or composted paunch manure (Table 8) indicates that these are valuable organic amendments for agricultural soils.

Slaughterhouses simply must get rid of their paunch manure waste (stomach contents of slaughtered animals) to maintain their rigid schedule of processing meat. Approximately 10% of the weight of live cattle consists of paunch manure, which in turn consists of the ration consumed by the animals. The contents may be largely silage or grain in fattened cattle or grass in pastured animals. If paunch manure is not removed from the plant site on schedule, the packing plants would have to shut down.

Many large and small plants dispose of their waste on agricultural fields within 35 miles of the plant site. Other plants have their paunch manure buried in a landfill. Since the disposal of paunch manure is an all year round task, serious environmental problems can develop. Surface and ground water pollution can result from disposal of paunch manure in landfills. Even more incidents of obnoxious odors and invasions by flies have resulted from the careless dumping of piles of paunch manure on fields near towns with the expectation that farmers will incorporate the waste into the soil as soon as conditions permit. Unfortunately, weather and soil conditions may require prolonged delays in planned tillage operations. The result is the annoyance to the community by the strong odor of the paunch manure, which becomes an attractive breeding site for flies.

Composting procedures for paunch manure have been developed by the Agronomy Waste Management Project, which suppress its odor immediately, so it no longer serves as a breeding site for flies. The aerobic, thermophilic, microbial decomposition (composting) of the paunch manure results in a superior product for soil amendment than the original waste (Table 8).

Paunch manure and composted paunch manure were applied to Sharpsburg silty clay loam and Alda sandy loam soils at equal rates of nitrogen. After 40 days of incubation, increasing rates of application of paunch manure to the 2 soils resulted in decreasing amounts of nitrate-nitrogen. However, increasing rates of application of composted paunch manure resulted in increasing amounts of nitrate-nitrogen in the soils. Soil amendments with composted paunch manure resulted in higher levels of available phosphorus and zinc than obtained from amendments with paunch manure, after 40 days of incubation.

Cheese Whey: Nebraska's dairy industry produces about 350,000 tons of whey annually. Whey production has been increasing each year. Most of this by-product is being discarded in ways that cost the producer, processor and municipalities a great deal of money in either lost potential income or the direct cost of disposal. Disposal of whey has created environmental problems of bad odors and pollution of ground and surface waters.

Whey contains about 6.6% solids including 0.8% protein, 4.8% carbohydrate, 0.3% fat and 0.7% mineral constitutents. About 12% of the solids content could consist of Lactic Acid. While the greatest value of whey would come from its utilization in human and animal food products, land application of whey or composting whey for crop production make viable alternatives to disposal and environmental pollution (Table 9).

Application of whey to agricultural soils provides a means of recovery of the valuable nutrients for the growth of crops. This provides a savings on the fertilizer costs for crop production. The organic matter and carbohydrates added to the soil in the form of whey constituents will result in greater soil microbial activity and improved soil physical properties such as water infiltration rate. For the best results and to eliminate problems of odors, whey should be incorporated into the soil shortly after application or should be injected into the soil using the type of tank truck applicator used for soil injection of municipal sewage sludge slurry. To save the fuel, time and labor required to apply additional needed nitrogen fertilizer for the production of grain crops, anhydrous ammonia could be added to the whey as it is being loaded into the applicator truck. The ammonia would dissolve instantly into the whey to form aqua ammonia which can contain 16-25% nitrogen. The 350,000 tons of whey produced in Nebraska contain 326,900 tons of water which could contain an additional 52,304 to 81,725 tons of nitrogen in the form of anhydrous ammonia. The ammonia fortified whey could be capable of supplying 200 pounds of nitrogen to 523,040 to 817,250 acres of irrigated corn. A nitrogen inhibitor such as N-Serve could be added to the ammonia if needed.

Table 8. Chemical composition and economic value of paunch manure and composted paunch manure (dry weight basis).1/

Nutrient	Paunch Manure			Composted Paunch Manure		
	Content %	Pounds /ton	Value2/ $/ton	Content %	Pounds /ton	Value $/ton
Nitrogen (N)	0.8	16.	4.32	1.5	30.	8.10
Phosphorus (P)	.1	2.	- -	0.1	2.	- -
(P_2O_5)	.2	4.	1.28	0.2	4.	1.28
Potassium (K)	2.3	46.	- -	2.3	46.	- -
(K_2O)	2.8	56.	6.72	2.8	56.	6.72
Magnesium (Mg)	.5	10.	3.70	.5	10.	3.70
Zinc (Zn)	9 ppm	0.018	0.02	58 ppm	0.116	0.13
Iron (Fe)	21 ppm	0.042	0.03	38 ppm	0.076	0.05
Manganese (Mn)	3 ppm	0.006	0.0	15 ppm	0.03	0.03
Copper (Cu)	1 ppm	0.002	0.0	12 ppm	0.024	0.07

1/ Data from author's research and publications.

2/ 1980-81 prices which may vary according to location and source.

Table 9. Chemical composition and economic value of whey per 1,000 gallons.

Nutrient	Pounds/1,000 gallons	Value[1/] $/1,000 gallons
Nitrogen (N)	12.2	3.29
Phosphorus (P)	4.0	- -
(P_2O_5	9.16	2.93
Potassium (K)	14.6	- -
(K_2O)	17.5	2.10
Magnesium (Mg)	0.55	0.20
Manganese (Mn)	0.003	0.00
Copper (Cu)	0.006	0.01

1/ 1980-81 prices which may vary according to location and source.

Spent Acids: Sulfuric acid is used by the galvanizing industry as a pickling liquor and by the battery industry as a source of electrolyte. Typical sulfuric acid pickle liquor contains 10-15% sulfates, 5-10% iron and 3-6% zinc. Rejected galvanized products are stripped in the pickle liquor. This greatly increases zinc content.

EPA regulations require that spent acids be partially neutralized, that is up to a pH of 2.0. This is usually done with anhydrous ammonia. The ammoniated spent sulfuric acid, with a pH of 2.0 or higher is no longer classified as a hazardous waste. About 18,000,000 gallons of spent sulfuric acid is produced by the galvanizing industry each year. Battery breakers produce about 15,000,000 gallons of spent sulfuric acid yearly. The amount of lead in spent battery source sulfuric acid is very low. These ammoniated acids are a low cost, available source of valuable plant nutrients. Battery acid can be ammoniated up to pH 6.5-7.0 and applied to agricultural soils as an ammonium sulfate fluid fertilizer. Ammoniating spent galvanizers' sulfuric acid to pH 6.5-7.0 would result in precipitation of the iron and zinc contents as ammoniated sulfates. These precipitates can and have been made into granular fertilizers, or used in suspension fertilizers. At the present time the disposal costs of spent sulfuric acids costs from $.30-.60 per gallon. Utilization of these waste resource holds great promise for the future.