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Soil Science Research Report - 1979

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SOIL SCIENCE RESEARCH REPORT - 1979

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NITROGEN RATES ON CORN

Ed Penas, George Rehm, and Dick Wiese

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

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

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

Results and Discussion: These data are experimental results for the fourth and final year of a three-year study. Of the 7 sites harvested, 4 responded to the application of nitrogen. Two of these responsive sites were irrigated fine textured soils and both had low levels of soil nitrate-nitrogen. The non-responsive irrigated site in Colfax County was also a fine textured soil and did not contain a large quality of nitrogen in the soil (106 lbs); however, the previous crop had been soybeans. This may have influenced the results in this plot. The Platte County site is a sandy soil with a low level of soil nitrogen but the amount present along with that applied as a starter, herbicide carrier, and in the water was sufficient for maximum yields.

Two of the three non-irrigated sites responded to applied nitrogen. Both were very low in soil nitrogen. The other site had a higher level of soil nitrate-nitrogen (127 lbs) which was adequate for the corn crop which followed soybeans of the previous year.

These experiments complete this study for which the four-years of data are being summarized. A new study is being initiated in 1980 which will concentrate on the calibration of soil tests for nitrogen.

NITROGEN RATES ON CORN, 1979
SOIL TEST DATA

Location	Soil pH	Nitrogen lbs/ac 6 ft.	Phosphorus ppm	Potassium ppm	Zinc, ppm	Organic Matter, %
Butler	6.5	59	21 Med	431 VHi	2.8 Med	2.8
Colfax	6.1	106	32 Hi	477 VHi	5.1 Hi	3.0
Platte	6.1	70	41 Hi	279 VHi	6.7 Hi	1.3
Saunders	6.0	73	29 Hi	509 VHi	3.4 Med	2.7
Washington	5.6	127	11 Low	280 VHi	3.9 Med	2.7
Northeast I	7.6	38	2 VLo	144 VHi	5.7 Hi	1.8
Northeast II	7.0	37	3 VLo	171 VHi	5.1 Hi	2.6

NITROGEN RATES ON CORN, 1979

GRAIN YIELDS

Location: Nitrogen Rate, lbs/ac	Irrigated Sites: Butler	Colfax	Platte	Saunders
	Grain Yield, bushels per acre			
0	109	143	150	113
40	121	153	157	142
80	130	153	160	159
120	137	147	162	166
160	140	138	163	167
200	141	141	157	166
240	139	148	154	165
280	134	132	161	169
Response	Yes	No	No	Yes
Soil NO_3-N, lbs/ac 6 ft.	59	106	70	73
Starter N	---	10	18+90	---
N in Water lbs/ac ft.	15	5	14	0

Location: Nitrogen Rate, lbs/ac	Non-Irrigated Sites: Washington	Northeast I	Northeast II
	Grain Yield, bushels/acre		
0	133	78	106
25	128	83	121
50	132	86	128
75	130	88	131
100	128	88	130
125	132	87	130
150	136	84	129
175	136	--	---
Response	No	Yes	Yes
Soil NO_3-N, lbs/ac 6 ft.	127	38	37
Starter N	---	10	10

Title: Anhydrous Ammonia and N-Serve for Irrigated Corn

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

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

Procedure: Anhydrous ammonia with or without N-Serve was used in nitrogen rate studies on two soils. A furrow irrigated Cozad silt loam at the North Platte Station was used to compare fall and spring applied NH_3 with and without 0.5 lb N-Serve/A. Spring applied NH_3 with and without N-Serve was used on a sprinkler irrigated Valentine sand at the University of Nebraska Sandhills Agricultural Laboratory near Tryon, Nebraska.

Nitrogen rates for the Cozad silt loam were 0, 40, 80, 120, 160, 200, and 240 lbs N/A and were replicated three times. N rates of 0, 45, 90, 135, and 180 lbs N/A were used on the Valentine sand and were replicated four times. Other cultural practices are given in Table 1.

Table 1. Cultural practices on the Cozad silt loam and Valentine sand.

Experiment	N-Serve - Valentine sand	N-Serve - Cozad silt loam
Other fertilizer:	100# 10-27-0 + 0.8% Zn + 6% S row-applied	100# 10-34-0 row-applied
Planting date:	5/17/79	5/17/79
Variety:	Pioneer 3901	Golden Harvest 2450
Seed drop:	28,500	28,000
NH_3 applied:	4/19/79	10/27/78 and 4/5/79
Soil temperature:	54°F at 4"	49°F at 4" & 36°F at 4"

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

Table 2. Grain yields and AOV for the Valentine sand.

Nitrogen rate	N-Serve	without N-Serve
lbs/A	----bu/A----	
0	79	
45	111	123
90	144	140
135	146	145
180	149	151

Analysis of Variance

Source of Variation	F	Probability of F
N-Serve	0.29	NS
N Rate	12.59	0.01
N Rate x N-Serve	0.74	NS CV = 8.6%

Grain yields from the Cozad silt loam are shown in Table 3.

Table 3. Grain yields and AOV for the Cozad silt loam.

Nitrogen rate	Fall-applied NH_3			Spring-applied NH_3		
	N-Serve		W/O	N-Serve		W/O
lbs/A	bu/A					
0		100			96	
40	144		126	135		124
80	158		148	152		148
120	157		147	158		151
160	156		154	165		156
160 (¼# N-Serve/A)		161			156	
200	164		161	172		166
240	165		149	170		162

Analysis of Variance - Time x N-Serve x N Rate excluding the check

Source of Variation	F	Probability of F	
Time of Application	0.19	0.70	
N-Serve	11.84	0.03	
Time x N-Serve	.03	0.87	
N Rate	17.57	0.001	
Time x N Rate	0.72	0.61	
N-Serve x N Rate	0.36	0.87	
Time x Rate X N-Serve	0.24	0.94	CV = 6.5%

The N-Serve produced significantly more grain in both the spring and fall applications up to the 160 lb N rate. Since a response occurred with both the fall and spring-applied N, some N loss must have occurred in early summer.

The leaching/denitrification losses of N in treatments without N-Serve were large enough to produce significant yield differences at N rates up to 160 lbs. The average yields in the range of N-Serve (NI) response were:

	Fall NH_3		Spring NH_3	
	With NI	W/O NI	With NI	W/O NI
	bu/A			
Avg of 40, 80, 120 & 160 lbs N/A	154 a*	144 b	153 a	145 b

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

Corn grown on the Cozad silt loam is in a minimum tillage system. Stalks are chopped in the spring then a till planter is used to plant the corn. The old ridge is split pushing soil into the previous year's furrow covering the chopped corn stalks. The seed is then planted into the moist soil in the old ridge. Because of no preplant tillage operations soil moisture content at planting is always good. There is usually only one cultivation and one furrowing operation so disturbance of the soil is minimal.

There may be an effect of tillage method on N response. There are no comparisons of conventional tillage (needs to be defined) on this soil but more limited tillage and minimum tillage is being practiced in Nebraska. Comparisons of yields from a double-disc, surface planting vs a minimum tillage system including N rates with and without N-Serve would be interesting.

Placing Ammonia and APP Together for

Irrigated Corn Production 1978-79

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

Recent investigations in Kansas on winter wheat have shown excellent results from applying 10-34-0 (APP) phosphorus (P) solutions with ammonia. This system places the 10-34-0 into the ammonia band utilizing a single knife with a double outlet system - one for ammonia and one for the 10-34-0 liquid. On wheat this system has produced results at least equal to and even superior to seed placement. This sytem has great applicability because it would allow the use of "preplant" phosphorus fertilizer bands that could provide the effectiveness of row application without slowing planting, which is a major farmer objection to the use of row applied fertilizer. Such bands, ammonia + 10-34-0, could be preplanted in 15 to 20 inch bands which would provide a maximum band distance to seed placement of 7.5 to 10 inches. Such a system would provide limited soil-fertilizer contact and possibly provide the greater P fertilizer efficiency generally acknowledged for row application. The objective of these experiments is to determine the effect of different methods of P application on corn production especially ammonia + ammonium polyphosphate when applied separately and together.

A factorial design with six methods of application with three rates of P was used. Methods of application were as follows:

1. NH_3 and 10-34-0 applied together with the same knife at 30 inch spacings.
2. NH_3 and 10-34-0 applied separately. NH_3 was applied in 30 inch spacing and 10-34-0 was applied between making the 10-34-0 band 15 inches from the ammonia band.
3. NH_3 was applied and 10-34-0 was sprayed on the surface.
4. NH_3 was applied and 10-34-0 applied at planting 2 inches to the side and 1 inch below the seed.
5. NH_3 was applied and 10-34-0 dribbled at 30 inch spacing from the knives out the soil.
6. Same as treatment No. 1 plus N-Serve.

All plots were disked after application and planted May 11 in 1978 but poor stands dictated replanting May 22 at Mead and June 5 at Greeley. Hybrids were PV 76S at Mead and Pioneer 3780 at Greeley planted at 28,600 plants/A. All plots received 3 lbs/A atrazine, 8.7 lbs Furadan/A, and received a total of 200 lbs N/A applied as ammonia except for the amount of N applied in 10-34-0. In 1979, plots were planted May 28 because of the wet spring. Ear leaves were collected at early silk both years. In 1979 early plant samples were collected at the 7 leaf stage. Irrigation was by center pivot. Soil tests in 1978 are as follows:

Depth	pH	NO_3-N	Bray P	K	Zn	OM
inches		----------------	ppm	---------------		%
Greeley County						
0-1	7.4	2	7	230	5.8	1.3
1-2	7.9	3	2	168	3.6	0.5
2-3	8.0	3	4	242	3.0	0.3
3-4	8.1	16	4	256	3.3	0.4
4-5	7.9	17	5	315	2.4	0.3
5-6	8.1	21	4	342	2.2	0.2
Mead Location						
0-1	6.8	10	11	255	8.6	2.5
1-2	6.4	4	10	157	8.5	1.3
2-3	6.5	4	14	154	9.3	0.8
3-4	6.6	5	20	145	10.6	0.6
4-5	6.8	6	25	134	11.4	0.6
5-6	6.9	5	28	151	11.5	0.5

In 1979, the Greeley County locations was at the same site only 60 feet from the location in 1978. Soil pH was 7.8, Bray P = 3 ppm, K = 268 ppm, Zn = 4.8, and OM = 1.1. In 1978, corn appeared to be somewhat S deficient, therefore in 1979 18 lbs S/A was applied as $CaSO_4$ to the entire plot area. Corn was hailed severely in 1979 in the 3 or 4 leaf stage. Corn recovered but was set back about 10 days to 2 weeks.

In 1978, irrigated corn yields were significantly increased with applied P at the Greeley location, but no effect of applied P was found at the Mead location although 200 bu/A yields were achieved (Table 1 and 2). The Greeley soil was very P deficient. Yields were increased 36 bu/A with 30 lbs P/A, and ear leaf P was increased from 0.16 to 0.21%. However, even with this large grain yield increase from applied P, there wasn't any significant difference between methods of application. Increased soil-fertilizer contact from row applied to broadcast did not effect either grain yield or ear leaf P content and therefore apparently did not influence availability of applied P. There was no evidence in this study that knifing NH_3 and 10-34-0 together was better than any other method of application. The highest yield was achieved when N-Serve was applied with the ammonia but was not statistically different from other methods of P application. N-Serve had no effect on ear leaf P content or ear leaf N content at the Greeley location.

Since the soil in Greeley County was very low in P and corn yield response was good in 1978, the experiment was repeated in 1979 on an area near the 1978 experimental area. However neither corn yields or plant uptake were increased by applied P in 1979. Therefore the different methods of P application had no affect on corn yields or P uptake. It is not known why corn failed to respond to P application in 1979 since soil test show very low available P and corn responded to P application on essentially the same location in 1978. The 10-34-0 fertilizer contained the guaranteed amount of P.

Table 1. Effect of phosphorus rate and method of application on corn yield, grain moisture, and ear leaf P and N concentration. Greeley County 1978.

P Rate	Grain Yield	Grain Moisture	Ear Leaf P	Ear Leaf N
lb P/A	bu/A	%	%	%
0	84	19.0	.160	2.51
10	100	17.8	.181	2.46
20	110	17.2	.202	2.59
30	118	16.4	.212	2.65
$LSD_{.05}$	12	N.S.	.011	.05

Method of P application 1/	Grain Yield	Grain Moisture	Ear Leaf P	Ear Leaf N
(1) Knife together	98	18.3	.182	2.55
(2) Knife separate	104	16.2	.206	2.62
(3) Broadcast	116	17.2	.204	2.60
(4) Row (at planting)	100	17.4	.184	2.55
(5) Surface rows (dribble)	114	15.9	.211	2.68
(6) Same as (1) with N-Serve	118	17.7	.195	2.48
$LSD_{.05}$	N.S.	N.S.	N.S.	N.S.

1/ NH_3 applied at 200# N/A
All plots disked after application

Table 2. Effect of phosphorus rate and method of application on corn yield, grain moisture and ear leaf P concentration. Mead 1978.

P Rate	Grain Yield	Grain Moisture	Ear Leaf P
lb P/A	bu/A	%	%
0	206	23.5	.311
10	194	23.2	.312
20	200	23.0	.315
30	193	23.6	.316
$LSD_{.05}$	N.S.	N.S.	N.S.
Method[1/] of P application			
(1) Knife together	202	24.0	.315
(2) Knife separate	196	22.2	.317
(3) Broadcast	194	23.7	.313
(4) Row at planting	197	23.0	.313
(5) Surface rows (dribble)	193	23.0	.315
(6) Same as (1) with N-Serve	193	23.5	.316
$LSD_{.05}$	N.S.	N.S.	N.S.

1/ Refers to method by which NH_3 and 10-34-0 was applied.
Knife was at 20 inch spacing
All plots received 200 lb N as NH_3
All plots were disked after application

Table 3. Effect of phosphorus rate and method of application on corn yield and ear leaf and small plant phosphorus content, Greeley County, 1979.

P Rate	Small Plant (3 plants) Yield	Grain Yield	P Content Ear Leaf	P Content Small Plant
lb P/A	g	bu/A	--------%P	----------
0	81	87	.193	.213
10	76	90	.184	.222
20	82	94	.188	.217
30	81	90	.198	.226

Method[1/] of P application				
(1) Knife together	75	92	.188	.216
(2) Knife separate	82	97	.193	.226
(3) Broadcast	90	90	.196	.196
(4) Row (at planting)	77	94	.190	.190
(5) Surface rows (dribble)	79	88	.182	.182
(6) Same as (1) with N-Serve	76	86	.191	.226

1/ NH_3 applied at 200# N/A

All plots disked after application

Project: Nitrogen Rate and Source Studies for Corn Grown in an Ecofallow Rotation

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

Goal: Establish the relationship between the residual soil nitrate test, N rates, and N sources for this farming system.

Procedure: Two of four sites were harvested. Two plot areas were lost to severe hail damage. Ammonium nitrate (AN) was broadcast at planting on the Huebner site. Ammonium nitrate, anhydrous ammonia (NH_3), urea ammonium nitrate solution (UAN) and urea were used at the North Platte Station dryland farm site. Soil analyses for the two locations are given in Table 1.

Table 1. Soil analysis

	pH	% O.M.	P	K	lbs NO_3-N/6'
			-------ppm	------	
Huebner	5.8	1.3	65	510	102
NP Station	6.2	1.44	25	424	54

Nitrogen rates were 0, 25, 50, 75, 100, and 125 lbs N per acre. Fertilizer was applied at the North Platte site on April 9-10. Growing season rainfall at both sites was near 14 inches. Corn extracted soil water down to 6 feet at the North Platte site (Figure 1). A significant response ($p = .05$) to nitrogen occurred at both sites. Yields were maximized with 50 lbs of N at the Huebner site (Table 2). The regression equation for yield prediction was $\hat{Y} = 84 + 0.388x - 0.0023x^2$ with an $R^2 = 0.96$ and a standard error of estimate = 1.66.

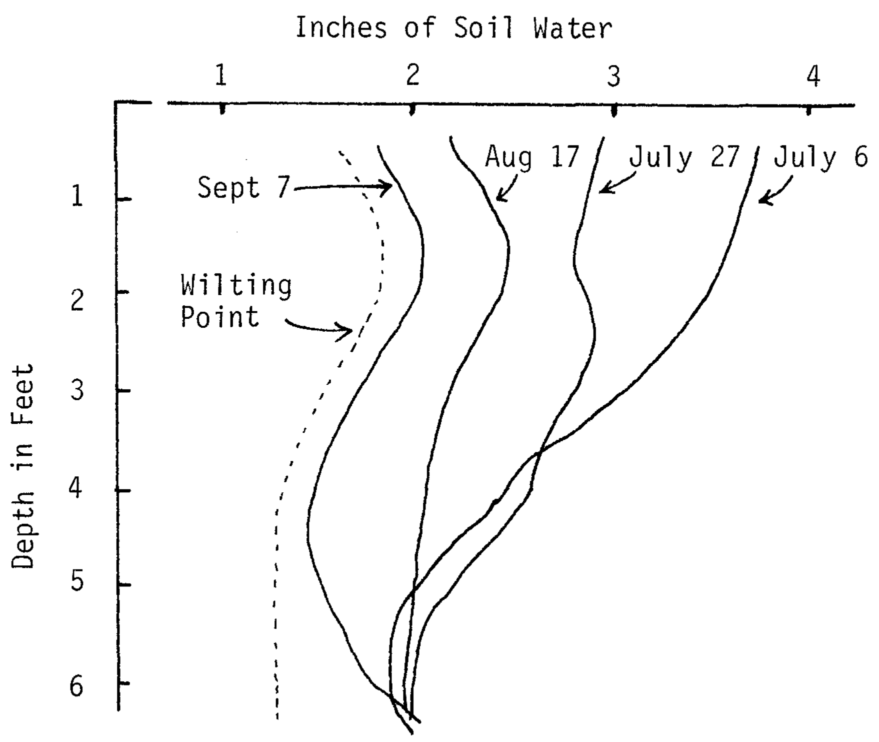

Figure 1. Moisture extraction by ecofallow corn.

Table 2. Grain yields at the Huebner site.

lbs N/A	Yields	$\hat{Y}$
	----------bu/A----------	
0	85	84
25	92	92
50	98	98
75	102	100
100	93	100
125	98	97

The magnitude of the yield increase from fertilizer N at the Huebner site was only 16 bu/A. This is a reflection of the high residual nitrate content of 102 lbs N/6' depth.

Grain yields at the North Platte Station Dryland Farm are given in Table 3. Yield regression equations are also given.

Table 3. Grain yields, North Platte Station Dryland Farm, 1979.

lbs N/A	Ammonium nitrate	UAN	Urea	NH_3
	----------------------bu/A----------------------			
0	71	71	71	71
25	97	87	87	86
50	103	93	90	98
75	100	103	90	98
100	101	101	90	103
125	102	97	95	95

$\hat{Y}_{AN} = 63 + 0.12x^{.5} - 0.515x$ $R^2 = 0.99$ Std. Err. Est. = 2.4

$\hat{Y}_{UAN} = 71 + 0.69x - 0.0039x^2$ $R^2 = 0.99$ Std. Err. Est. = 1.7

$\hat{Y}_{NH} = 71 + 0.71x - 0.0041x^2$ $R^2 = 0.97$ Std. Err. Est. = 2.4

$\hat{Y}_{Urea} = 67 + 4.69x^{.5} - 0.215x$ $R^2 = 0.97$ Std. Err. Est. = 2.5

Grain yields were maximized near 102 bushels per acre with 50 lbs N/A for ammonium nitrate and 75 lbs N from UAN and NH_3. A comparison of the grain yields at 25 and 50 pounds of N from ammonium nitrate and nitrogen solution did show a significant difference at the 5% level of probability. Soil samples were taken from all plots in the fall of 1979 to a 6' depth for NH_4-N and NO_3-N. Dry matter yields were taken and nitrogen content is being determined. The soil and plant analyses data will be used to determine nitrogen recovery and fertilizer N use efficiency.

The significant finding of this year's work was the poor performance of the urea. Even at the highest nitrogen rate it did not produce maximum yields. This soil is slightly acid in the surface (Table 1). However, there apparently was a problem with loss of nitrogen.

Comparison of Standard Nitrogen Fertilizers with Delayed Release and Nitrification Inhibiting Materials for Irrigated Corn on Sharpsburg/Butler sicl

R. A. Olson, R. W. Wesely and M. P. Russelle

Objectives:

1. Determine the value of sulfur coated urea and N-Serve in the annual production of irrigated corn over several years time on a Sharpsburg/Butler complex sicl.
2. Compare other conventional N carriers at varied rate and with varied application time on this soil bordering on claypan character.
3. Evaluate residual effects following several years of annual N treatment.

Procedure:

A high-yielding corn hybrid was planted each year with an Allis Chalmers planter equipped with fertilizer solution attachment. Planting time solid treatments were broadcast and disked in before planting. UAN with and without N-Serve (0.4% of N rate) was placed between the rows at planting or as sidedressing later to an approximate 3" depth. The sidedressed AN was applied by hand in furrows created by a hoe approximately 10" from the row.

Results and Discussion:

This was the third and last year residual effects were to be tested in this experiment. There was no significant difference in grain yield, grain N content, or total grain N uptake in 1979 (Table 1). Averages over all three years after treatments were discontinued showed a yield advantage for the high rates of N application. Highest average yields were obtained on plots that had previously received the 160 lb. N rate as SCU or ammonium nitrate. Applications of N as 32% N solution resulted in lower yield increases. Grain N content and uptake over the three years of residual effects responded like yields to previous treatment. Nitrapyrin had no effect at either time or rate of 32% N solution application, although an apparent phytotoxic effect was observed in some of the treatment years with planting time application of the higher N rate.

In view of the treatment effect over the course of this experiment, it is evident that nitrapyrin was not efficacious in reducing fertilizer N losses or increasing yields on this claypan-like soil. The use of SCU was generally no better in this regard than was the application of ammonium nitrate either at planting or as a sidedressing.

Total uptake of N in the grain over the treatment years (1971-76) and over all nine years was used to calculate the utilization of applied N (Table 2). Highest efficiencies for both periods were noted for the low N rates of SCU and ammonium nitrate. The utilization of 32% N solution was much lower than for the other carriers at the low N rate, but was similar at the high rate. Fertilizer use efficiency was increased a maximum of 6% by uptake during the years residual effects were measured. Nitrapyrin had no effect on the efficiency of fertilizer uptake by the grain. It is reassuring to note that 70% utilization is possible (by the difference method) on this claypan-like soil with denitrification potential by effective N management, but troublesome that 50% or more is lost with a heavier than required N rate.

Table 1. Response of irrigated corn to nitrogen from delayed release and nitrification inhibiting materials: residual effects in 1979 and average residual effects, 1977-79.

Treatment	N Rate	Grain Yield			Grain N			
		1971-76	1979	1977-79	1979	1977-79	1979	1977-79
	lb N/acre	bu/a (15.5% H_2O)			- - - % - - -		- - lb N/acre -	
Check	0	86	92	97	1.06	1.09	46	50
SCU	80	158	86	116	1.03	1.13	42	58
preplant	160	176	89	121	1.08	1.20	45	69
Ammonium nitrate	80	158	81	107	1.09	1.09	42	55
preplant	160	172	89	122	1.05	1.18	44	70
Ammonium nitrate	80	166	86	104	1.06	1.10	43	54
sidedress	160	175	86	122	1.06	1.17	43	69
32% N solution	80	136	84	104	1.05	1.08	41	53
at planting	80+NS	137	80	100	1.04	1.03	39	49
	160	171	84	113	1.06	1.14	42	62
	160+NS	161	81	109	1.04	1.10	40	58
32% N solution	80	141	81	96	1.06	1.07	40	49
sidedress	80+NS	138	78	103	1.06	1.05	39	51
	160	172	77	107	1.10	1.17	40	60
	160+NS	179	90	112	1.04	1.13	44	61

Table 2. Total uptake and percent utilization of applied N by irrigated corn grain during the years treatments were applied (1971-76) and for the duration of the experiment (1971-79), as affected by delayed release and nitrification inhibiting materials.

Treatment	N Rate	Total Grain N Uptake 1971-76	Total Grain N Uptake 1971-79	Utilization of Applied N[1/] 1971-76	Utilization of Applied N[1/] 1971-79
	lb N/acre	- - - lb N/acre - - -		%	%
Check	0	316	466	0	0
SCU	80	615	788	62	67
preplant	160	747	955	45	51
Ammonium nitrate	80	623	788	64	67
preplant	160	768	977	47	53
Ammonium nitrate	80	643	806	68	71
sidedress	160	744	952	45	51
32% N solution	80	504	663	39	41
at planting	80+NS	500	647	38	38
	160	697	882	40	43
	160+NS	622	796	32	34
32% N solution	80	533	679	45	44
sidedress	80+NS	533	687	45	46
	160	723	904	42	46
	160+NS	745	927	45	48

[1/]Calculated by difference from the control.

Nitrogen Balance Under Irrigated Corn Using ^{15}N-Depleted Fertilizer

M. P. Russelle, E. J. Deibert, and R. A. Olson

Objective:

The purpose of this study was to expand information on the uptake, utilization and loss of fertilizer N from soil with irrigated corn as influenced by time and rate of N and irrigation regime employed.

Procedure:

Corn was planted in level basins with water measured into the basins through water meters to provide increments of 2", 3" or 4" per irrigation. The same amount of water was applied to each plot, averaging 12" for the six years of the study. Nitrogen as ^{15}N-depleted ammonium sulfate was applied at rates of 80 and 160 lbs N/acre, either incorporated at planting or sidedressed in a band about 8" from the row at a 12-18" growth stage. The respective N treatments were made during 1974-76 followed by a 3-year residual study without further N applied. Porous cups for extracting portions of the soil solution were placed at a 6' depth under all plots. Measurements included grain yield, total N uptake, N derived from fertilizer by isotopic tracer method, and tagged N passing the 6' depth.

Results and Discussion:

Results from this 6-year N-balance study are summarized in Tables 1 and 2. It will be noted that the light, more frequent irrigation was decidedly superior to the same total quantity of water applied in larger increments during the years of N treatment. Response to N rate above 100 lbs/acre was slight, and there was only a small benefit in yield for summer sidedressing over planting time application. But utilization of fertilizer N as determined by ^{14}N tracer was decidedly greater with sidedressed N, especially at the lower N rates and particularly evident during the residual years when no N was applied. There were no significant differences in yields from prior N treatments in 1979, thus results for that year were omitted in developing the summary of fertilizer N utilization in Table 2.

It is quite encouraging to note that as much as 70% utilization in grain can be realized by the combination of light, frequent irrigation and sidedressing of the optimum N rate for yield. The low 40% $\pm$ utilization with the 200 lb rate, however, emphasizes the transitory nature of applied N. Soil solution extractors measured significant quantities of N at the higher rates passing the 6' depth, especially with the higher N rates and with the 4" irrigation routine.

Table 1. Grain dry matter yields as influenced by ^{15}N-depleted fertilizer time-rate and irrigation sequence.

Irrigation Sequence	N Application Time	N Rate	Treatment Years 1974	1975	1976	$\bar{x}$	Residual Years 1977	1978	1979	$\bar{x}$	All Years $\bar{x}$	Overall Average
in./application			lb/acre									
2	Planting	100	6200	7000	9500	7570	4340	5480	3770	4530	6050	
		150	6850	7130	9510	7830	5310	5830	3900	5010	6420	[illegible]
		200	7260	7370	9630	8090	5460	7460	3150	5360	6720	
	Sidedress	100	6940	6860	9140	7650	4490	6050	3560	4700	6180	
		150	7230	7440	9550	8080	5170	7170	3750	5360	6720	[illegible]
		200	7270	7260	9440	7990	5170	7600	3960	5580	6780	
3	Planting	100	6150	6940	8490	7190	5040	5980	3980	5000	6100	
		150	6340	7630	9060	7680	5010	6550	3260	4940	6310	[illegible]
		200	5900	7160	8660	7240	5120	7070	3020	5070	6160	
	Sidedress	100	5870	6920	9040	7280	5850	6240	3700	5260	6270	
		150	5760	6960	8900	7210	5410	6660	3140	5070	6140	[illegible]
		200	6090	6890	9200	7400	4760	7290	3270	5110	6260	
4	Planting	100	5740	6910	8350	7000	5090	4870	3230	4400	5700	
		150	6080	7080	8210	7120	5050	6410	3650	5040	6080	5845
		200	5180	7130	7350	6560	5240	6790	3320	5120	5840	
		200 + NS	5300	7290	7740	6780	5420	5540	3250	4740	5760	
	Sidedress	100	5180	7190	7920	6760	4750	6250	3820	4940	5850	
		150	6090	7430	8800	7440	3960	6190	3250	4470	5960	[illegible]
		200	5820	7820	8540	7400	5200	7310	4010	5510	6460	
		200 + NS	6250	7320	8770	7450	5140	7770	4070	5660	6560	
	Check	0	2550	2160	4610	3110	2450	4400	3290	3380	3240	

	Treatment Years	Residual Years
Overall Averages	PT 7355	PT 4932
	SD 7409	SD 51[illegible]8
	2" 7869	2" 5090
	3" 7333	3" 5075

Table 2. Nitrogen derived from [15]N-depleted fertilizer in corn grain as influenced by fertilizer time-rate and irrigation sequence. Averages for treatment years (1974-76) and for residual years (1977-78).

Irrigation Sequence	N Application Time	N Rate	Treatment Years				FNUE[1]	Residual Years			Total	Total FNUE[1]
			1974	1975	1976	x̄		1977	1978	x̄	1974-78	
in./application		-----------lb N/acre-----------					%	-------lb N/acre---------				%
2	Planting	100	42	41	59	47	47	7	5	6	154	51
		150	59	50	76	62	41	16	9	12	210	47
		200	74	68	88	77	38	29	14	22	273	46
	Sidedress	100	71	54	61	62	62	13	6	10	205	68
		150	68	70	65	68	45	26	15	20	244	54
		200	75	72	76	74	37	37	26	32	286	48
3	Planting	100	43	49	56	49	49	10	7	8	165	55
		150	50	60	75	62	41	19	12	16	216	48
		200	58	72	77	69	34	26	18	22	251	42
	Sidedress	100	62	62	54	59	59	21	8	14	207	69
		150	68	67	60	65	43	36	16	26	247	55
		200	68	75	68	70	35	27	31	29	269	45
4	Planting	100	40	49	52	47	47	10	5	8	156	52
		150	48	63	73	61	41	20	12	16	216	48
		200	50	69	67	62	31	26	16	21	228	38
		200+NS	45	74	66	62	31	25	12	18	222	37
	Sidedress	100	54	58	50	54	54	17	9	13	188	63
		150	66	73	61	67	44	26	16	21	242	54
		200	64	80	64	69	34	35	25	30	268	45
		200+NS	68	72	71	70	35	40	36	38	287	48

1. FNUE (fertilizer nitrogen use efficiency) = lb N from fertilizer in grain/lb fertilizer N applied.

Improving the Efficiency of Fertilizer N Use by Irrigated Corn

M. P. Russelle and R. A. Olson

Objective:

1. Investigate the physiology of N utilization by irrigated corn in relation to crop and fertilizer management practices employed.
2. Follow uptake and utilization of tagged fertilizer N as influenced by time and rate of N applied and by crop planting date.

Procedure:

Corn was planted by hand on Sharpsburg sicl on the three dates April 30, May 14 and May 25 to a perfectly uniform stand of 25,000 plants per acre. Ammonium sulfate depleted in ^{15}N was applied at rates of 80 and 160 lbs N/a at planting or at the 4-, 8- or 16-leaf stage for tracing N source in the plant. Rainfall and sprinkler irrigation water increments were measured with receptacles placed about the experimental area and neutron access tubes in individual plots measured soil moisture extraction.

Results and Discussion:

This experiment was initiated in 1978, however, its location was changed in 1979 due to a need for a larger plot size. The new plot area is very near the old. Preliminary results from 1979 again demonstrate the enormous potential for N supply by this Sharpsburg soil. Average grain yield of the non-fertilized plots was 173 bu/acre, while fertilized plots averaged 194 bu/acre (Table 1). Early plantings resulted in higher grain yield than late (Table 2). There was no difference in grain yield between the 80 and 160 lb N rates. Delayed N afforded an average 12 bu/acre benefit applied as late as the 16-leaf stage with the two earlier plantings but was disadvantageous after the 4-leaf stage with the late planting. Stover dry matter production was not influenced by planting date or N application. The grain-to-stover ratio was highest with sidedressed N compared to N applied at planting. Ear weight was influenced not only by time of planting and by N, but also by time of N fertilization. Highest dry ear weights were obtained with N application at the 4-leaf stage. Analyses of the plant and soil samples for N and ^{15}N content are underway, likewise calculations of water use efficiency.

Table 1. Dry matter production of irrigated corn as influenced by planting date, N application rate, and N application time, 1979.

Planting Time	N Rate	N Time	Grain Yield	Stover DM	Total DM	Grain: Stover	Ear wt.
	lb/acre		bu/acre[1]	- - - - - - lb/acre	- - - - - -		lb/ear
April 30	0	CK	173	7530	15740	1.09	.419
	80	PL	183	7330	16010	1.18	.423
		04	203	7680	17300	1.27	.467
		08	188	7130	16040	1.26	.434
		16	209	7920	17810	1.25	.453
	160	PL	194	7010	16170	1.31	.453
		04	196	7850	17130	1.19	.483
		08	209	7860	17750	1.29	.448
		16	198	7560	16910	1.25	.450
May 14	0	CK	176	7200	15550	1.16	.383
	80	PL	204	7640	17310	1.28	.426
		04	207	7280	17090	1.36	.440
		08	197	6530	15870	1.45	.415
		16	211	7560	17550	1.33	.451
	160	PL	189	7630	16570	1.18	.416
		04	208	7210	17050	1.38	.430
		08	202	7770	17320	1.24	.430
		16	215	7490	17670	1.39	.435
May 25	0	CK	169	7400	15420	1.09	.397
	80	PL	176	8690	17030	0.97	.399
		04	188	9020	17890	0.99	.448
		08	176	8480	16800	0.99	.409
		16	163	7370	15100	1.05	.407
	160	PL	183	7960	16600	1.08	.409
		04	186	8110	16940	1.09	.437
		08	182	7780	16390	1.11	.432
		16	178	8220	16640	1.03	.405

[1] On a 15.5% moisture basis.

Table 2. Summary of grain yield of irrigated corn as related to nitrogen application rate and time and planting date, 1979.

Planting	N Rate	N Application Time: Planting	4 Leaf	8 Leaf	16 Leaf	Ave.
	lb/acre	- - - - - - - - - - bu/acre (15.5% H_2O)	- - - - - - - - -			
April 30	0	-----------------	-----------------	173	-----------------	173
	80	183	203	188	209	196
	160	194	196	209	198	199
	Ave	188	200	198	204	195
May 14	0	-----------------	-----------------	176	-----------------	176
	80	204	207	197	211	205
	160	189	208	202	215	204
	Ave	196	208	200	213	201
May 25	0	-----------------	-----------------	169	-----------------	169
	80	176	188	176	163	176
	160	183	186	182	178	182
	Ave	180	187	179	170	178
	Ave	188	198	192	196	191

Project: Effect of Fertilizer Phosphorus Placement on **Corn** Yields in Sandy Soil

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

Objective: Compare effectiveness of row vs broadcast P for corn on newly developed sandy soil

Procedure: A native grass site at the Sandhills Agricultural Laboratory near Tryon, Nebraska was developed in 1976 for corn production. No fertilizer had been previously applied to the area. The soil at the experimental site is a Dunday loamy fine sand. Soil properties were:

pH	% O.M.	P	K	Zn
		-------------ppm-------------		
6.3	1.2	3	177	4.5 M

The fertilizer mixture was a combination of 80% 10-34-0 + 1% Zn and 20% 12-0-0 + 26% S with a final analysis of 10-27-0 + 0.8% Zn + 5.2% S. The three treatments applied in 1976 and 1977 were:

1. Check - no starter or broadcast + 200# N/A
2. Row applied - 100#/A of 10-27-0 + 200# N/A
3. Broadcast - 200#/A of 10-27-0 + 200# N/A

Treatments were replicated three times. Pioneer 3780 was planted in mid-May using the Buffalo till planter at a population of 23,000 in 1976 and 24,000 in 1977. Recommended herbicides and insecticides were used. The broadcast fertilizer was spread prior to planting then disked. All plots were disked 2-3" deep thus the tillage was the same for the check, row applied and broadcast plots.

Four dry matter harvests were taken during the growing season in 1976 and two in 1977 to note the effects of the broadcast and row applied starter on dry matter accumulation. In 1977 there was a significant difference ($p = 0.05$) indicating higher dry matter accumulation from the row fertilizer treatment. No significant differences occurred in 1976 (Table 1).

There was no significant difference in grain moisture content between row applied or broadcast phosphorus in either year (Table 2). In 1977 there was a significant difference ($p = 0.05$) in grain moisture content between the check and plots which received phosphorus.

Grain yields for treatments are shown in Table 3. In both years row applied fertilizer and broadcast P were not significantly different.

Since yields were not significantly different, using row applied fertilizer is more economical. Only 1/2 as much fertilizer is needed. This is a 50% saving to the producer on fertilizer expense. The extra work of handling the bagged or liquid fertilizer is a factor to consider. However, with the increased cost of energy, fertilizer costs will continue to increase.

Table 1. Dry matter production, T/A (kg/ha)

	1976	1977
Check	5.24 (11728) a*	3.29 (7389) a*
Row	7.03 (15753) b	5.94 (13330) c
Broadcast	6.72 (15053) b	4.95 (11096) b
	CV = 2.1%	CV = 11.9%

Table 2. Percent grain moisture at harvest.

	1976	1977
Check	17.6 a*	29.2 a*
Row	16.5 a	20.9 b
Broadcast	17.2 a	17.3 b
	CV = 3.0%	CV = 11.7%

Table 3. Grain yields, bu/A (kg/ha)

	1976	1977
Check	76 (4792) a*	89 (5582) a*
Row	128 (8053) b	144 (8980) b
Broadcast	127 (7972) b	155 (9666) b
	CV = 8.1%	CV = 10.0%

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

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

G. W. Rehm

Objective:

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

Procedure:

Two sites were selected for study in 1979. The soil at the Holcomb location is a Valentine loamy fine sand. The soil at the Frickel location is a Meadin sandy loam. Selected 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, 20, 25, 30, 35, 40 lb./acre) supplied as Mg $SO_4 \cdot 7H_2O$ with treatments selected to fit a central composite factorial design were broadcast in mid-April. All plots received 100 lb. P_2O_5/acre as 0-46-0, 10 lb. Zn/acre as $ZnSO_4$ and 53 lb. S/acre as a combination of $MgSO_4 \cdot 7H_2O$, granular gypsum and $ZnSO_4$. All fertilizer materials were incorporated with a disk before planting. Adequate N (a combination of (33-0-0, 82-0-0, 28-0-0 with the irrigation water) was used at both sites.

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

Results and Discussion:

A severe hail storm in mid-July eliminated harvest at the Frickel location. The influence of fertilizer K on grain yield and weight of corn plants at the 16-20 in. growth stage is summarized in Table 2. The grain yield as well as the early growth of corn was not affected by rate of applied K. Rate of applied Mg had no effect on yield and early growth (Table 3).

Because of the relatively low levels of soil K at both locations, some response to K was anticipated. Past research has shown that crops grown on soils in other states with similar K values will respond to the application of fertilizer K. The irrigation water is supplying low amounts of K (Table 4). Since the organic matter content of the soil is 1.5% or less, the amount of K supplied from this source should be relatively slow. The data collected in 1979 would indicate that this sandy soil is supplying adequate K to meet the K requirements of the 180 bu./acre corn crop.

Considering the Mg supplied with the irrigation water and the Mg content of the soil, the lack of a response to applied Mg could be anticipated.

Table 1. Soil properties of the experimental sites. Holt County, 1979.

	Soil Test						Exchangeable			
Depth	pH	NO_3-N	Bray-P	K	Zn	O.M.	CEC	Ca	Mg	K
in.	- - - - - - -	ppm	- - - - - - - -			%	- - -me/100 gm- - - -			
Holcomb:										
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
Frickel:										
0-6	5.9	.5	4.6	88	2.9	1.42	7.71	3.21	.71	.22
6-12	6.0	3.6	-	72	-	--	7.07	2.94	.66	.13
12-24	6.0	10.8	-	55	-	--	7.34	3.36	.86	.10
24-36	6.4	5.8	-	38	-	--	3.20	1.78	.49	.06
36-48	6.5	4.6	-	32	-	--	3.16	1.39	.36	.06
48-60	6.6	3.6	-	28	-	--	1.52	1.17	.29	.05
60-72	6.6	4.4	-	27	-	--	1.86	1.04	.28	.04

Table 2. Effect of rate of applied K on yield and early growth of irrigated corn grown on sandy soils. Holt County, 1979.

	Location		
	Frickel	Holcomb	
K Applied	plant wt.	Yield	plant wt.
lb./acre	gm/plant	bu./acre	gm/plant
0	14.0	178.9	15.6
30	13.7	181.0	15.0
60	13.4	182.5	14.6
90	13.2	183.4	14.4
120	13.2	183.7	14.4
150	13.3	183.4	14.6
180	13.4	182.5	14.6
210	13.7	181.0	15.5
240	14.1	179.0	16.3

Table 3. Effect of rate of applied Mg on yield and early growth of irrigated corn on a sandy soil. Holt County, 1979.

Mg Applied	Frickel Plant wt.	Holcomb Yield	Holcomb Plant wt.
lb./acre	gm/plant	bu./acre	gm/plant
0	14.8	181.0	14.3
5	14.2	181.3	14.7
10	13.7	181.4	15.1
15	13.4	181.6	15.3
20	13.1	181.7	15.4
25	13.0	181.9	15.4
30	13.0	182.0	15.3
35	13.2	182.1	15.1
40	13.4	182.2	14.8

Table 4. Nutrient content of the irrigation water at the Holcomb location. Holt County, 1979.

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

APPLICATION OF SULFUR FOR IRRIGATED CORN ON SANDY SOILS

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

Objective:

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

Procedure:

This study was conducted at two sites in 1978 and one location in 1979. Soil properties are listed in Table 1. In 1978, granular gypsum was broadcast at rates to supply 0, 12, 24, 36 lb. S/acre. In 1979, the rates were changed to 0, 6, 12, and 18 lb. S/acre.

The rate of S used in the row applied treatments was 0, 6, 12, 18 lb./acre in both years. The sulfur in the row applied fertilizer was supplied as 1) granular gypsum 2) Sol-U-Sul 3) a mixture of granular gypsum and Sol-U-Sul and 4) a mixture of granular gypsum and sulfur-coated urea (SCU). Both mixtures were formulated so that 50% of the applied S was supplied from each S source. All treatments received 15 lb. N, 46 lb. P_2O_5 and 10 lb. K_2O per acre in the starter fertilizer. Adequate rates of N were used at all sites.

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

Results and Discussion:

Application of S fertilizers had no effect on corn yield at the Lincoln County site. Broadcast application of S as well as the use of S in a starter fertilizer increased corn yields at the Antelope County sites in both 1978 and 1979 (Table 2). Relatively low rates were needed to achieve maximum yields in both years.

When applied in the row at planting as a starter fertilizer, S also increased production at the Antelope County sites (Table 3). The use of 6 lb. S/acre was sufficient in both years.

In both years, the source of S used had no significant effect on yield. This observation may be explained by the fact that rainfall in late spring and early summer was not excessive in either year thereby reducing the potential for leaching. This study will be repeated in 1980.

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

Property	Depth	Antelope (78)	County and Year Antelope (79)	Lincoln (78)
	in.			
pH	0-6	6.8	6.2	6.3
organic matter, %	0-6	.68	1.0	.70
phosphorus (Bray), ppm	0-6	22	5.4	17
potassium, ppm	0-6	143	108	153
zinc (HCl), ppm	0-6	6.2	3.6	-
SO_4-S, ppm	0-6	3.0	3.9	<3.0
SO_4-S, ppm	6-12	4.0	5.2	<3.0
SO_4-S, ppm	12-24	4.3	5.2	<3.0
SO_4-S, ppm	24-36	3.7	4.9	<3.0
SO_4-S, ppm	36-48	3.6	6.3	<3.0
SO_4-S, ppm	48-60	4.7	6.6	<3.0
SO_4-S, ppm	60-72	3.8	7.6	<3.0
NO_3-N, ppm	0-6	1.5	1.4	2.0
NO_3-N, ppm	6-12	1.7	1.1	1.0
NO_3-N, ppm	12-24	2.4	.6	1.0
NO_3-N, ppm	24-36	3.2	.9	1.0
NO_3-N, ppm	36-48	3.4	1.6	0
NO_3-N, ppm	48-60	3.3	1.8	0
NO_3-N, ppm	60-72	6.0	2.6	-

Table 2. Effect of broadcast rates of sulfur on corn yield.

S Applied	Antelope (78)	County and Year Antelope (79)	Lincoln (78)
lb./acre	- - - - - - - - - - - -	bu./acre	- - - - - - - - - - - -
0	178.4[1/] a	172.9 a	145.8 a
6	-	193.6 b	-
12	188.3 b	184.0 ab	135.3 a
18	-	172.9 a	-
24	192.2 b	-	143.0 a
36	191.5 b	-	133.3 a

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

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

S Applied	County and Year Antelope (78)	Antelope (79)	Lincoln (78)
lb./acre	bu./acre		
0	159.9[1/] a	153.7 a	143.5 a
6	170.8 b	173.9 b	139.9 a
12	173.3 b	179.4 b	143.2 a
18	174.2 b	180.1 b	142.8 a

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

Table 4. Effect of source of S applied in a starter fertilizer on yield of corn on an irrigated sandy soil.

S Source	County and Year Antelope (78)	Antelope (79)	Lincoln (78)
	bu./acre		
granular gypsum	168.4[1/] a	178.6 a	140.8 a
elemental S	171.6 a	177.7 a	144.3 a
50% granular gypsum + 50% elemental S	175.0 a	175.2 a	142.8 a
50% granular gypsum + 50% sulfur-coated urea	176.0 a	179.7 a	139.9 a

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

Project: Effect of Different Iron Products on Reducing Chlorosis in Corn

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

Objective: Evaluate several iron products for correcting chlorosis in corn on saline-sodic soils in west-central Nebraska.

Procedure: Two locations (Grabenstein and Nordquist sites) were selected for the experiments, both on a Cozad silt loam, saline-alkali. Treatments include a 3 x 3 factorial of Iron KeMin seed coating (0, 8%, 16%) and row-applied Ironsul (0, 90, 180 lbs/A). Three additional treatments were (1) row-applied urea phosphate plus iron (15-39-0 + 4% Fe) - 50#/A, (2) row-applied Iron KeMin at 2 lbs iron/A and (3) Eagle Iron foliar sprayed at 11 lbs material/A.

The Ironsul was row applied 2" to the side and 2" below the seed at planting time. The urea phosphate and Iron KeMin were applied after planting by hand. The fertilizer band was approximately 2" below and 2" to the side of the seed. The Eagle Iron was applied directly over the row with a hand sprayer at 30 psi pressure on June 27. Treatments were replicated three times at both locations. The seedcoat x Ironsul treatments extended the length of the field. Twenty feet of row was measured in June and plant counts were standardized to within 30 plants ±4 in all strips which would be harvested for grain in the fall.

Grain yields for the seed coating by Ironsul factorial are shown in Table 1 for the Grabenstein farm. The factorial breakdown showed a significant yield increase for the Ironsul treatments at the 10% level of probability. The seed coating showed no significant treatment effects.

Table 1. Grain yields for the Ironsul by KeMin treatments - Grabenstein site.

Seed coating	Ironsul - lb/A 0	90	180	Seed coating mean
	bu/A			
0	96	140	145	127
8%	117	116	123	119
16%	119	135	121	125
Ironsul mean	111	130	130	CV = 15.5%

The grain yields for the three additional treatments at the Grabenstein site were Eagle Iron - 133 bu/A, Urea Phosphate - 140 bu/A, and Iron KeMin 131 bu/A. Single degree of freedom comparison of the three additional treatments with the check showed significant yield increases at the 5% level for urea phosphate plus iron and Eagle Iron. A significant yield increase at the 10% level was shown for the Iron KeMin.

A second area in the Grabenstein field was harvested to determine the effects of the seed coatings and Ironsul because the Ironsul x seed coat treatments extended the length of the field. Aerial photos showed a uniform chlorotic area south of the plot area. Chlorosis was more pronounced in this area than the original plot area. Grain yields and plant stands in the 40 feet of harvested row were taken in this area. Ironsul significantly increased yields (p = 0.01) and seed coating significantly decreased yields (p = 0.01) in this part of the Grabenstein field (Table 2).

Table 2. Grain yield means and plant counts (Ironsul x KeMin) for the second plot area - Grabenstein site.

Seed coating	Grain yield means: Ironsul - lb/A 0	90	180	Mean	Final plant counts: Ironsul - lb/A 0	90	180	Mean
	bu/A				plants/40 ft			
0	70	107	131	103	59	68	68	65
8%	62	78	93	78	52	46	45	48
16%	60	74	99	78	42	41	42	42
Ironsul mean	64	86	108	CV = 13.0%	51	52	52	CV = 9.1%

The yield reductions from seed coating were caused by significantly lower final plant stands (Table 2). Seed plates were changed at planting to account for the larger seed size of coated seed but apparently not enough coated seed was dropped.

Data for the Ironsul by seed coating set in Table 3 from the Nordquist site showed a significant yield increase for the Ironsul (p = 0.05) but no effect of the seed coating. The analysis showed no significant treatment effects for the urea phosphate or the Iron KeMin (Table 3). The Eagle Iron showed a significant increase at the 10% level of probability, however.

Table 3. Grain yield means for the Ironsul by KeMin treatments - Nordquist site.

Seed coating	Ironsul - lb/A 0	90	180	Seed coating mean
	bu/A			
0	75	87	97	86
8%	94	78	100	91
16%	79	93	117	96
Ironsul Mean	83	86	105	CV = 16.2%
Eagle Iron	109	Urea P 81	Iron KeMin 89	

A second area in the Nordquist field was also picked. The soil in this part of the field generally produces better corn than the area where the first plot was located. Yield effects from the Ironsul were significant only at the 15% level of probability (Table 4). The seed coating again significantly reduced yields. Reduced stands were the reason (Table 4).

Table 4. Grain yield means and plant counts (Ironsul x KeMin) for second plot area - Nordquist site.

Seed coating	Grain yield means Ironsul - lb/A 0	90	180	Mean	Final plant counts Ironsul - lb/A 0	90	180	Mean
	---------bu/A---				-----plants/30 ft---			
0	133	147	140	140	42	44	40	42
8%	107	117	115	113	29	31	34	31
16%	113	128	133	125	33	34	31	32
Ironsul mean	118	131	129	CV = 9.8%	34	36	35	CV = 12.5%

The research with the various iron products was encouraging because treatments which gave yield responses can be applied with existing farmer technology and should not be too expensive to offset higher returns from increased yields. The Ironsul, urea phosphate, Eagle Iron, and Iron KeMin look very promising. The seed coating showed little effect. Plant populations need to be increased to be equal to other treatments. The seed does not flow well in a plate type planter and there seems to be some question about phytotoxicity of the coating to the seed. Research will continue in 1980.

EFFECT OF SALT CONTENT OF THE STARTER FERTILIZER AND DISTANCE FROM THE SEED ON THE GROWTH AND YIELD OF CORN.

G.W. Rehm and R.A. Wiese

Objective:

The placement of fertilizer in a band either to the side of and below or below the seed at planting time can be an important management tool in corn production. At the present time, the rate of fertilizer that can be applied in this manner is thought to be dependent on the "salt" content of the fertilizer and the moisture content of the soil at planting. The "salt index" of several fertilizer materials has been measured in a general way with past research. Yet, there has been very little field research to evaluate the effect of the "salt" content of a fertilizer and the distance between fertilizer and seed on corn emergence and yield.

Procedure:

This study was initiated at the Northeast Experiment Station in 1978 and continued in 1979. The soil is classified as a Judson silt loam with appropriate soil properties listed in Table 1. Fertilizer was used to apply 0, 15, 30, 45 lb. salt per acre. The amount of salt applied was computed from the percentage of N and K_2O in the fertilizer. Fertilizer placement was not the same in both years. In 1978, the fertilizer was placed .5 - .75 in., .75 - 1.5 in. and 3.0 in. from the seed. Fertilizers were placed 0 - .5 in., .5 - 1.0 in., and 3.0 in. from the seed in 1979.

In addition, the percentage of "salt" applied as either N or K_2O was evaluated. The percentages chosen were: 1) 100% as N, 0% as K_2O 2) 50% as N 50% as K_2O and 3) 0% as N, 100% as K_2O. The P_2O_5 content of the suspension fertilizers was such that all treatments received 15 lb. P_2O_5 per acre.

All treatments received N as 82-0-0 at a rate based on a measurement of residual N in the soil. Corn was planted in mid-May at a population of 20,000 plants per acre. Appropriate herbicides and insecticides were used at the recommended rates. Stand counts were taken approximately three weeks after emergence and whole plant weights were recorded at that time. Grain yields were measured in October.

Results and Discussion:

A 4x3x3 complete factorial design with four replications was used for this study. There were no significant interactions among the three factors. Therefore, main effects of the three variables are summarized in tables 2, 3, and 4.

The moisture content of the soil at planting was high in both 1978 and 1979. Although the moisture content was not measured in 1978, the moisture content of the soil in and around the seed at planting was 23.2% in 1979. With these moisture conditions, the amount of salt applied per acre had no significant effect on plant population, weight of young corn plants, and grain yield in both 1978 and 1979 (Table 2).

In 1978, the distance between fertilizer and seed did affect the population, measured three weeks after emergence, weight of young plants and grain yield

(Table 3). Placement of all fertilizer from .5 to 1.0 in. from the seed improved the plant population with a subsequent increase in yield. These observations are not in agreement with the experiences of several farmers who have found that high rates of clear liquid fertilizers placed too close to the seed will hinder germination and reduce yields. In 1979, the placement of 45 lb. "salt" per acre from 0 - .5 in. from the seed through an Accra-Plant runner had no harmful effect on both emergence and yield.

There are two possible explanations for the observation that the high rates of "salt" applied close to the seed had no harmful effect on yield. First of all, soil moisture was high in both years. With high soil moisture levels, the amount of "salt" applied may not be as harmful as when the same amount is applied in a dry seedbed. Secondly, suspension materials containing 2% clay were used in these studies. The clay in the suspensions may have "buffered" the "salt" effect of the N and K_2O in the fertilizer.

The percentage of "salt" applied as either N or K_2O had no significant effect on emerged plant population, weight of young corn plants, and yield (Table 4).

This study will be repeated in 1980.

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

Property	Year 1978	Year 1979
soil texture	silt loam	silt loam
pH	7.1	6.3
NO_3-N to 6 ft. (lb./acre)	55	100
P (Bray), ppm	17	33
K ($NH_4C_2H_3O_2$), ppm	331	393
organic matter, %	2.6	2.7

Table 2. Effect of rate of "salt" applied on the plant population after emergence, plant weight three weeks after emergence and grain yield.

"Salt" Applied lb./acre	Plant Population plants/acre	Plant Weight gm./plant	Yield bu./acre
1978:			
0	17,976 a[1/]	4.3 a	131.3 a
15	18,116 a	4.5 a	127.6 a
30	18,140 a	4.7 a	122.9 a
45	17,996 a	4.4 a	123.7 a
1979:			
0	17,351 a	3.8 a	162.4 a
15	17,170 a	4.5 a	161.5 a
30	17,170 a	4.1 a	164.5 a
45	16,880 a	3.8 a	159.3 a

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

Table 3. Effect of distance between fertilizer and the seed on plant population after emergence, plant weight three weeks after emergence and grain yield.

Distance from seed	Plant Population	Plant Weight	Yield
in.	plants/acre	gm./plant	bu./acre
1978:			
.5-1.0	18,492 a[1/]	4.7 a	133.5 a
1.0-1.5	17,964 b	4.5 ab	121.7 b
3.0	17,715 b	4.3 b	124.0 b
1979:			
0-.5	16,952 a	3.7 a	162.4 a
.5-1.0	17,189 a	4.5 b	163.0 a
3.0	17,288 a	3.9 a	160.4 a

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

Table 4. Effect of the percentage of "salt" applied as either N or K_2O on plant population after emergence, plant weight three weeks after emergence, and grain yield.

Percentage	Plant Population	Plant Weight	Yield
	plants/acre	gm./plant	bu./acre
1978:			
100% as N	18,179 a[1/]	4.6 a	126.0 a
50% as N, 50% as K_2O	18,191 a	4.6 a	126.5 a
100% as K_2O	17,802 a	4.3 a	126.6 a
1979:			
100% as N	17,088 a	4.1 a	160.5 a
50% as N, 50% as K_2O	17,333 a	4.1 a	163.2 a
100% as K_2O	17,006 a	3.9 a	162.0 a

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

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

G. W. Rehm

Objective:

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

Procedure:

This study is being conducted at the Northeast Experiment Station. The soil is classified as a Judson silt loam and appropriate properties are listed in Table 1. Nitrogen rates are based on results of analysis of soil for residual N. Anhydrous ammonia was used to apply the needed N. Corn was planted at several populations in mid to late May each year. Recommended herbicides and insecticides were used at appropriate rates throughout the study.

Water application was scheduled through computation of evapotranspiration. The amount of irrigation water applied was 5.0 in. 7.75 in. and 4.0 in. for 1977, 1978 and 1979 respectively.

Results and Discussion.

Throughout the study, the simulated pumping capacity of the irrigation well has had no significant effect on yield (Table 2). The rainfall distribution was such that corn yields were not affected by a pumping rate as low as 400 gal/min.

Yields, however, have been affected by the plant population (Table 3). In 1977, highest yields were produced with a plant population at harvest of 21,780 plants per acre. A harvest population of 23,958 plants per acre produced the highest yield in 1978. In 1979, the highest yield was produced with a harvest population of 25,265 plants per acre. There was a significant curvilinear relationship between plant population at harvest and yield in all three years of study.

The data to date indicate that there is no one plant population at harvest that will produce the highest yields in all years. Instead, there seems to be a range of plant populations that will result in optimum yields. The effect of plant population on yield seems to be modified by weather conditions through the growing season. Therefore, this study will be continued in 1980.

Table 1. Properties of the Judson silt loam. Northeast Station, 1979.

pH	6.3
pH (Buffer)	6.7
P (Bray), ppm	25
K ($NH_4C_2H_3O_2$), ppm	321
NO_3-N, lb./acre to 6 ft.	79
organic matter, %	3.2
Zn (HCl), ppm	3.9

Table 2. Effect of simulated pumping capacity on the yield of irrigated corn. Northeast Station.

Pumping Capacity	Year 1977	Year 1978	Year 1979
gal./min	bu./acre		
400	170.5 a[1/]	177.3 a	157.1 a
600	169.9 a	172.1 a	156.8 a
800	169.4 a	175.7 a	157.4 a

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

Table 3. Effect of plant population at harvest on the yield of irrigated corn. Northeast Station.

1977 Plant Population	1977 Yield	1978 Plant Population	1978 Yield	1979 Plant Population	1979 Yield
plants/A	bu./A	plants/A	bu./A	plants/A	bu./A
13,939	146.2	16,553	163.9	16,553	152.0
16,117	161.6	18,295	171.7	17,424	149.5
17,860	172.1	20,038	180.4	20,038	156.7
20,038	178.6	22,216	179.4	22,216	153.8
21,780	181.6	23,958	181.8	25,265	168.9
23,958	179.3	26,136	172.9	28,750	156.7

WHEAT FERTILIZATION PROGRESS REPORT 1979

D.H. Sander, G.A. Peterson, L.A. Daigger, C.R. Fenster
and M.L. Hooker

This report contains a data summary and a brief statement for each of the soil fertility experiments conducted with winter wheat in 1979 in western Nebraska. The following experiments are included: (1) Phosphorus fertilize experiments comparing row and broadcast methods of application. (2) Effect of residual nitrate -N on N fertilizer requirements of wheat. (3) Nitrogen source and fallow system experiment. (4) Soil test P levels in Rosebud-Canyon soils in relationship to various soil P fractions. (5) Phosphorus nutrition of winter wheat.

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

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

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

The year 1978-79 was not favorable in Nebraska for wheat production. While subsoil moisture was adequate at seeding, low precipitation the last months during fallow resulted in very dry surface soils. This made seeding into soil moisture difficult and wheat stands at several sites were minimal. In addition, late spring and early winter conditions resulted in loss of stands at several of the experimental sites. While thirteen experimental sites were selected and row vs broadcast experiments established, only seven were harvested. Grain yields were generally low because of poor stands although growing conditions from spring to harvest were generally favorable. Lack of stands resulted in excessive weed growth at several locations.

The results of the row vs broadcast P experiments are shown in Table 1 thru 7. A summary table for 1978 and 1979 is shown in Table 8. A range of soil phosphorus level and soil pH was selected for study. Soil P ranged from 4 ppm to 21 ppm and pH from 6.5 to 8.6. Grain yield was increased significantly with application of P on all soils except on one site where soil P level was 21 ppm. Row or seed applied P produced significantly higher wheat grain yields on 3 of the 7 soils studied. Broadcast P produced a higher grain yield on one soil. There were no significant differences in grain yields whether P was row applied or broadcast on 3 sites.

There wasn't any consistant relationship between soil pH or soil P level as to the relative effectiveness of row vs broadcast P. While in 1978, there appears to be a trend for row application to be superior on high pH-low P soils, nearly the reverse appeared in 1979. Clearly many more study locations are needed before reliable soil relationships can be determined which will predict relative effectiveness between row and broadcast methods of P application.

2. Effect of Residual nitrate-N on N fertilizer requirements of wheat.

Table 9 shows the effect of applied N on wheat yields from six locations that varied in residual nitrate-N. The objective of these experiments is to provide new calibration data relating residual nitrate level of the soil profile to N fertilizer needs. Present nitrogen recommendations would have called for 30 lbs N/A on site 6, and 40 lbs N/A on site 9 and site 19. Of the 3 soils where N would have been recommended, applications of N increased grain yields on only one. N recommendations would have been accurate on 4 of the 6 soils studied. These studies will be continued.

3. Nitrogen Source and Rate and Fallow System Experiment conducted at the High Plains Ag Lab in 1979.

Yield data are shown in Table 10, and the Analysis of Variance in Table 11. There was a response to N but several interactions affect the interpretation of the response data.

First there was a highly significant interaction of N rate and fallow system. Table 12a contains single degree of freedom comparisons which allow interpretation of the interaction effect. Notice that the primary response to N occurred under the chemical fallow system. The significant cubic term arises from the fact that the initial increment of N depressed yield and subsequent increments brought about a positive response. There was a tendency for this to occur under the tillage fallow as well, but yields never increased above the control yield in this system. Table 12b shows the N response means for each fallow system.

The second interesting interaction was the N source and fallow system. Table 13 contains single degree of freedom comparisons which display the significance of this interaction. Notice that ammonium nitrate strongly affected yield in the chemical fallow system. No other material caused a yield response in either system. Figure 1 compares the response to rates of N as ammonium nitrate for the two systems.

4. Soil test P levels in Rosebud-Canyon soils in relationship to various soil P fractions.

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

Nine experiments were established in the fall of 1972 and ten more in the fall of 1973 to study the problem of limited yield response to N fertilizer. These experiments had four P rates (25, 50, 100 500 kg P/ha) and five N rates (0, 30, 60, 90, 120 kg N/ha) in a split plot treatment arrangement. The P was broadcast in August of the establishment year and incorporated with farmer tillage prior to seeding. Yields were measured and plant samples collected the first two crop years after establishment 1/. The soils have been sampled in March or April every year since 1974. Soil test results with both Bray and Kurtz No.1 and the Olsen bicarborate extractants are reported in previous research reports 1/. In 1979, five of the 19 experiments were selected for detailed soil P fractionation. These locations ranged in calcium corborate equivalent (CCE) from 0.01 to 16.5%. Inorganic soil P was partitioned into Fe and Al phosphates, occluded Fe phosphates (CDB-P), Calcium phosphates (H_2SO_4) and water soluble P (NH_4Cl).

Table 14 lists the correlations of P fractions and the soil test extractants. This table indicates which fractions were most readily extractable using the two different extractants. Over all locations Bray and Kurtz No.1 extractable P was most highly correlated with Fe-Al-P ($r = 0.86$) and slightly less correlated with NH_4Cl-P ($r = 0.72$)(Table 12). A comparison of individual locations indicates that the correlation of Bray and Kurtz No.1 with Fe-Al-P became poorer as the CCE increased. This can be explained by a reduction in the effectiveness of the extractant by the high quantities of $CaCO_3$ present in the soil. The Bray and Kurtz No.1 extractant is 0.025N HCl and 0.03N NH_4F. Soils having greater than 1.25% CCE have the capability of neutralizing all of the HCl in this extractant thus reducing its effectiveness. The correlation of the Bray and Kurtz No.1 extractant with H_2SO_4-P increased as the pH decreased. This would be expected since the solubility of Ca-P (estimated by H_2SO_4-P) increases as the pH decreases. Thus the decreases in Bray and Kurtz No.1 estractable P can be accounted for by the shift of P from the Fe-Al-P and NH_4Cl-P fractions to the H_2SO_4-P and included apatite or "nonextractable" forms, as well as the factors mentioned above.

The Olsen-$NaHCO_3$ extractable P also correlated well with the NH_4Cl-P ($r = 0.88$) fractions (Table 12). The high correlation of the Olsen method with the Fe-Al-P fraction would be expected because of the greater solubility of Fe- and Al-bound P at higher pH levels. However, unlike Bray and Kurtz No.1 extractable P, the correlation coefficients for the $NaHCO_3$ method with these two fractions did not change with changes in soil CCE. This indicated that at the higher CCEs the Olsen method of extraction is more effective in removing the NH_4Cl-P and Fe-Al-P fractions. Based on these facts the Olsen $NaHCO_3$ method was judged to be superior to the Bray and Kurtz No.1 extractant for these soils.

5. Phosphorus nutrition of winter wheat. Pam Sutton.

Phosphorus has long been known to be an essential element in the nutrition of plants. It plays a key role in cellular energy transfer, respiration, and photosynthesis. Phosphorus is present in nucleic acids and nucleotides, phospholipids, and sugar-phosphates. The timeliness of P availability to the plant is extremely important for effective utilization and maximum plant growth. Its deficiency

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1/ Soil Science Research Reprints 1977, 1978.

causes immediate and severe disruptions of metabolism and development. It is generally assumed that plants such as cereals do not require a continuous supply of P during their life cycles. There is little information pinpointing the critical time in the life cycle of wheat at which P uptake is the most important for maximum growth response. It has been reported that P uptake in winter wheat reached a maximum by heading and decreased to a minimum at or about harvest, but spring wheat reached maximum P uptake by heading. Boatwright and Viets (1966), using spring wheat grown in nutrient culture, determined that having P available for only the first 5 weeks of growth (heading) still allowed maximum dry matter production.

The literature contains little information concerning the response of winter wheat to P availability during various stages of growth for the realization of maximum yield. Winter wheat differs from spring wheat, in that winter wheat requires a vernilization period for the transition from a vegetative stage to a reproductive stage. Because of this inherent physiological difference, conclusions concerning P availability during growth stages of spring wheat may not be relevant to winter wheat.

The objectives of this experiment were (1) to determine the effects of removing P from the growing medium during progressive stages of growth on dry matter production and P uptake of winter wheat, and (2) to compare the P demand pattern of winter wheat with that known for spring wheat.

Conclusion

The data presented in this study indicate that there is a difference between spring wheat and winter wheat in their critical growth stages for P uptake for maximum dry matter production (Table 15). Adequate P had been absorbed by the winter wheat plant by the Noding stage to ensure maximum mature tiller number at harvest. There was no significant increase in mature tiller number in treatments receiving P for additional weeks. These results differ from those reported by Boatwright and Viets (1966) for spring wheat. These researchers stated that maximum tiller number was reached only if P was supplied through heading. Phosphorus stress experienced by the winter wheat plant early in the life cycle, severely reduced mature tiller number.

Adequate P had been absorbed by winter wheat by the First Node stage to ensure realization of maximum mature dry matter production of the roots and tops. The removal of P after this growth stage did not significantly affect mature root and top development. Spring wheat is reported to reach maximum dry matter production when P was available until the heading stage (Boatwright and Viets, 1966). Winter wheat exhibited increasing P concentration in the mature roots and tops of treatments receiving additional weeks of P. This luxury uptake of P beyond the critical growth stage for maximum mature dry matter yields did not significantly affect the dry matter production of the roots or tops. Total P uptake of the mature roots and tops continued until maturity. Adequate P had been absorbed by spring wheat by the heading stage (Boatwright and Viets, 1966).

Adequate P had been absorbed by the Noding stage to ensure maximum mature chaff weight and the maximum mature P uptake in the chaff of winter wheat. Maximum mature P concentration in the chaff was reached when P was supplied for uptake until at least the 'Boot' stage.

Adequate P had not been absorbed by winter wheat until at least the Mealy-ripe stage of Ripening for realization of maximum mature grain yields. Spring wheat had absorbed adequate P by heading to allow maximum grain yields (Boatwright and Viets, 1966). By the Noding stage, adequate P had been absorbed by winter wheat to reach maximum mature P concentration levels in the grain. The continued increase in mature grain yield in winter wheat was not directly related to the actural P concentration in the grain but associated with the metabolic role of P in the production of assimilates by the plant and translocation of these assimilates to the grain during grain filling.

The roots and tops of winter wheat continued luxury uptake of P, although adequate P had been absorbed by the First Node stage to assure maximum mature dry matter production. The actural P concentration in the mature grain of winter wheat did not change significantly after P was supplied to the Noding stage. But to maximize mature grain yields, adequate P was not absorbed until the Ripening stage. It is possible that the amount of available P required for uptake by winter wheat for maximum grain yield after the Noding stage is dependent upon the amount of P participating in metabolic processes within the plant cells. This quantity of P may be very small but very critical for maximum plant response.

Adequate P had been absorbed by the Noding stage to ensure the development of the maximum number of kernels in the mature heads in winter wheat. Phosphorus deficiencies experienced by winter wheat during early growth stages significantly reduced the number of kernels found per head in the mature wheat plant. There seems to be a relationship between the critical growth stage of P uptake for maximum mature P concentration levels in the grain with the development of the maximum number of kernels per head.

This study provides a foundation for additional research aimed at maximizing winter wheat production by the timeliness and efficiency of P fertilization. Different P concentrations, in conjunction with interrupted application and availability of P during the early growth stages (Pre-vernilization through Noding stages) may lead to a more concise understanding of the effect P uptake has on the eventual yield response of winter wheat.

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Table 1

Frontier County
Location 26
SE¼, SE¼, Sec 12, T7N, R29W

P Rate	Yield Grain	Straw	Heading
kg P/ha	kg/ha x 10^{-2}		
0	23	26	39
	Seed Applied		
8	31	40	57
17	32	44	64
25	33	44	64
33	35	51	52
42	31	38	70
Mean	32	43	62
	Broadcast		
8	27	31	50
17	26	31	40
25	28	35	52
33	31	39	54
42	29	39	52
Mean	28	35	49
Statistics			
Rate	**	**	NS
Method	**	**	**
Rate x Method	NS	NS	NS
Linear	**	**	**
Quadratic	**	**	++

Soil Tests	pH	Bray P
cm		ppm
0-20	6.5	5
20-30	7.4	2

Table 2

Hitchcock County
Location 21
SW¼, NW¼, Sec 9, T1N, R35W

P Rate	Yield Grain	Straw	Heading
kg P/ha	kg/ha x 10^{-2}		
0	27	37	49
	Seed Applied		
8	33	43	58
17	36	45	61
25	33	43	59
33	39	51	69
42	35	46	68
Mean	35	45	63
	Broadcast		
8	34	42	52
17	36	45	55
25	36	46	58
33	39	47	63
42	42	53	57
Mean	37	47	57
Statistics			
Rate	**	**	*
Method	++	NS	++
Rate x Method	NS	NS	NS
Linear	**	**	**
Quadratic	NS	++	NS

Soil Tests cm	pH	Bray P ppm
0-20	7.0	6
20-30	7.7	5

Table 3

Hitchcock County
Location 19
SW¼, SW¼, Sec 11, T3N, R34W

P Rate	Yield Grain	Yield Straw	Heading
kg P/ha	kg/ha x 10^{-2}		
0	21	30	
	Seed Applied		
8	25	33	
17	25	32	
25	25	33	
33	25	34	
42	27	35	
Mean	25	33	
	Broadcast		
8	24	28	
17	25	33	
25	27	36	
33	26	35	
42	25	35	
Mean	26	33	
Statistics			
Rate	+	NS	
Method	NS	NS	
Rate x Method	NS	NS	
Linear	*	NS	
Quadratic	NS	NS	

Soil Tests cm	pH	Bray P ppm
0-20	8.4	4
20-30	8.6	0.1

Table 4

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

P Rate	Yield Grain	Straw	Heading
kg P/ha	kg/ha x 10^{-2}		
0	32	45	59
	Seed Applied		
8	32	43	67
17	35	49	65
25	35	48	66
33	39	48	62
42	35	47	61
Mean	35	47	64
	Broadcast		
8	35	48	61
17	33	44	66
25	34	47	67
33	34	46	66
42	27	37	70
Mean	33	44	66
Statistics			
Rate	*	NS	NS
Method	*	NS	NS
Rate x Method	*	NS	NS
Linear	NS	NS	NS
Quadratic	*	++	NS

Soil Tests cm	pH	Bray P ppm
0-20	6.6	12
20-30	7.4	4

Table 5

Hitchcock County 1979
Location 12
SW¼, NW¼, Sec 9, T1N, R35W

P Rate	Yield: Grain	Yield: Straw	Heading
kg P/ha	kg/ha x 10^{-2}		
0	24	33	47
	Seed Applied		
8	26	36	52
17	24	38	59
25	29	40	63
33	28	37	67
42	28	37	62
Mean	27	37	60
	Broadcast		
8	25	33	45
17	25	32	55
25	26	34	59
33	27	35	56
42	26	36	53
Mean	26	34	53
Statistics			
Rate	*	NS	**
Method	+	*	**
Rate x Method	NS	NS	NS
Linear	**	++	**
Quadratic	NS	NS	++

Soil Tests cm	pH	Bray P ppm
0-20	7.0	6
20-30	7.7	2

Table 6

Furnas County
Location 6
NW¼, NW¼, Sec 9, T1N, R23W

P Rate	Yield Grain	Yield Straw	Heading
kg P/ha	kg/ha x 10^{-2}		
0	26	37	50
	Seed Applied		
8	32	42	58
17	36	45	64
25	36	46	62
33	35	45	68
42	38	49	78
Mean	35	45	66
	Broadcast		
8	27	39	48
17	30	42	54
25	32	36	56
33	33	43	64
42	35	45	58
Mean	31	41	56
Statistics			
Rate	**	**	**
Method	**	**	**
Rate x Method	++	NS	NS
Linear	**	**	**
Quadratic	++	NS	NS

Soil Tests cm	pH	Bray P ppm
0-20	6.6	8
20-30	7.4	6

Table 7

Hitchcock County
Location 9
SW¼, SE¼, Sec 2, T1N, R35W

P Rate	Yield Grain	Straw	Heading
kg P/ha	kg/ha x 10^{-2}		
0	28	35	58
	Seed Applied		
8	33	34	55
17	30	33	54
25	31	35	60
33	31	38	58
42	29	37	58
Mean	31	35	59
	Broadcast		
8	28	30	55
17	27	33	54
25	26	33	60
33	31	33	58
42	30	34	58
Mean	28	33	57
Statistics			
Rate	NS	NS	+
Method	NS	*	NS
Rate x Method	NS	NS	NS
Linear	NS	++	++
Quadratic	NS	++	++
	Soil Tests	pH	Bray P
	0-20	6.9	21
	20-30	7.3	12

Table 8 Effect of row and broadcast P on winter wheat yields in 1978 and 1979.

Site No.	pH	Bray P	Yield Row vs Broadcast Grain	Straw	Heading	Grain Yield Response-row over check	Grain Yield Level-row Mean
		ppm	kg/ha x 10^{-2}				
			1978				
17	7.1	3	+5**	+9**	20**	8**	32
13	7.5	6	+7**	+9**	+16**	11**	37
7	8.0	6	+5**	+7**	--	14**	28
12	7.4	6	+4**	+8**	+5+	6**	30
18	7.2	6	0	+1	+5	5**	40
15	7.4	6	+2*	0	+3	5**	17
16	7.7	7	+1	0	-2	4**	28
3	6.7	7	+3**	+3**	+4	8**	35
4	6.5	10	0	+1	+3	7**	37
10	6.8	12	-1	-1	-3	7**	35
8	6.7	18	+4**	+5**	+8+	4*	37
			1979				
19	8.4	4	-1	0	--	4+	25
26	6.5	5	+4**	+8**	+13**	9**	32
21	7.0	6	-2++	-2	+6++	8**	35
12	7.0	6	+1	+3*	+7**	3*	27
6	6.6	8	+4**	+4**	10**	9**	35
17	6.6	12	+2*	+3	-2	3*	35
9	6.9	21	+3	+2*	+2	NS	31

** Significant 1% level
* Significant 5% level
++ Significant 10% level
+ Significant 20% level

Table 9 Effect of applied nitrogen on wheat yields as effected by soil nitrate-N levels. 1979[1/]

N Rate	Location-site number											
	Grain Yield						Straw Yield					
	6	9	12	17	19	21	6	9	12	17	19	21
lbs/A	bu/A						cwt/A					
0	48	38	39	52	27	52	34.1	28.7	28.9	41.3	20.7	38.2
30	49	40	43	58	37	58	38.0	24.9	32.3	48.0	29.8	42.1
60	47	40	43	60	30	48	35.6	28.9	34.4	51.4	25.2	44.4
90	54	50	42	54	38	48	43.7	32.8	33.5	43.8	30.5	36.7
120	52	48	38	57	39	54	41.0	26.3	28.1	46.7	30.3	38.3
$L.S.D._{.05}$	NS	NS	NS	NS	8	NS	NS	NS	NS	6.1	5.9	NS

1/ Location		NO_3^--N lbs N/A/6 ft.
Furnas Co. Site	6	98
Hitchcock Co. Site	9	54
Hitchcock Co. Site	12	152
Hitchcock Co. Site	17	125
Hitchcock Co. Site	19	40
Hitchcock Co. Site	21	121

Table 10: Grain yields as affected by source and rate of N and method of fallow at the High Plains Ag Lab in 1979.

Source	Rate kg/ha	Method of Fallow: Tillage	Method of Fallow: Chemical
		kg/ha	kg/ha
	0	3153	2901
Urea	22	2732	2486
	45	2845	3427
	67	3181	3360
	90	3114	2844
		$\bar{x}$ = 2968	$\bar{x}$ = 3030
Ammonium Nitrate	22	3158	2934
	45	2957	3539
	67	2957	3494
	90	2000	3696
		$\bar{x}$ = 2968	$\bar{x}$ = 3416
Solution 28% N	22	2889	2531
	45	2934	3606
	67	3136	3203
	90	2419	2733
		$\bar{x}$ = 2845	$\bar{x}$ = 3018
Anhydrous Ammonia	22	2822	2330
	45	2934	2890
	67	2957	3091
	90	2934	3270
		$\bar{x}$ = 2912	$\bar{x}$ = 2895

Table 11: Analysis of variance for grain yields for the source and rate of N and method of fallow experiment at the High Plains Ag Lab in 1979.

Source	d.f.	F values
Block	2	-
Fallow System	1	N.S.
Error A	2	-
Nitrogen Rate	3	**
Nitrogen Source	3	*
Source X Rate	9	N.S.
Source X Fallow System	3	+
Rate X Fallow System	3	**
System X Source X Rate	9	N.S.

** denotes significance at the 1% probability level
* denotes significance at the 5% probability level
++ denotes significance at the 10% probability level
+ denotes significance at the 15% probability level

Table 12a: Single degree of freedom comparisons of N rates within each fallow system.[(1)]

Fallow System	Comparisons	F values
Tillage	Nitrogen Linear	+
Tillage	Quadratic	N.S.
Tillage	Cubic	++
Chemical	Nitrogen Linear	**
Chemical	Quadratic	N.S.
Chemical	Cubic	**

(1) Degrees of freedom for the comparisons are a total of those for N Rate and the interaction of N Rate and Fallow System.

Table 12b: Nitrogen response means over all sources within each fallow system.

Rate N kg/ha	Fallow System Tillage	Chemical
	--------kg/ha----------	
0	3152	2901
20	2901	2570
40	2918	3366
60	3058	3287
80	2817	3136

Table 13: Single degree of freedom comparisons of N sources within each fallow system in the source and rate of N and fallow system experiment at the High Plains Ag Lab in 1979.[1]

Fallow System	Comparison of Sources	F values
Tillage	Ammonium Nitrate vs. others	N.S.
Tillage	NH_3 vs. Urea and Solution	N.S.
Tillage	Urea vs. Solution	N.S.
Chemical	Ammonium Nitrate vs. others	**
Chemical	NH_3 vs. Urea and Solution	N.S.
Chemical	Urea vs. Solution	N.S.

(1) Degrees of freedom for the comparisons are a total of those for Source main effects and the interaction of Source and Fallow System.

Table 14: Correlation coefficients for P in the various fractions and with Bray and Kurtz #1 and Olsen-$NaHCO_3$ extractable P.

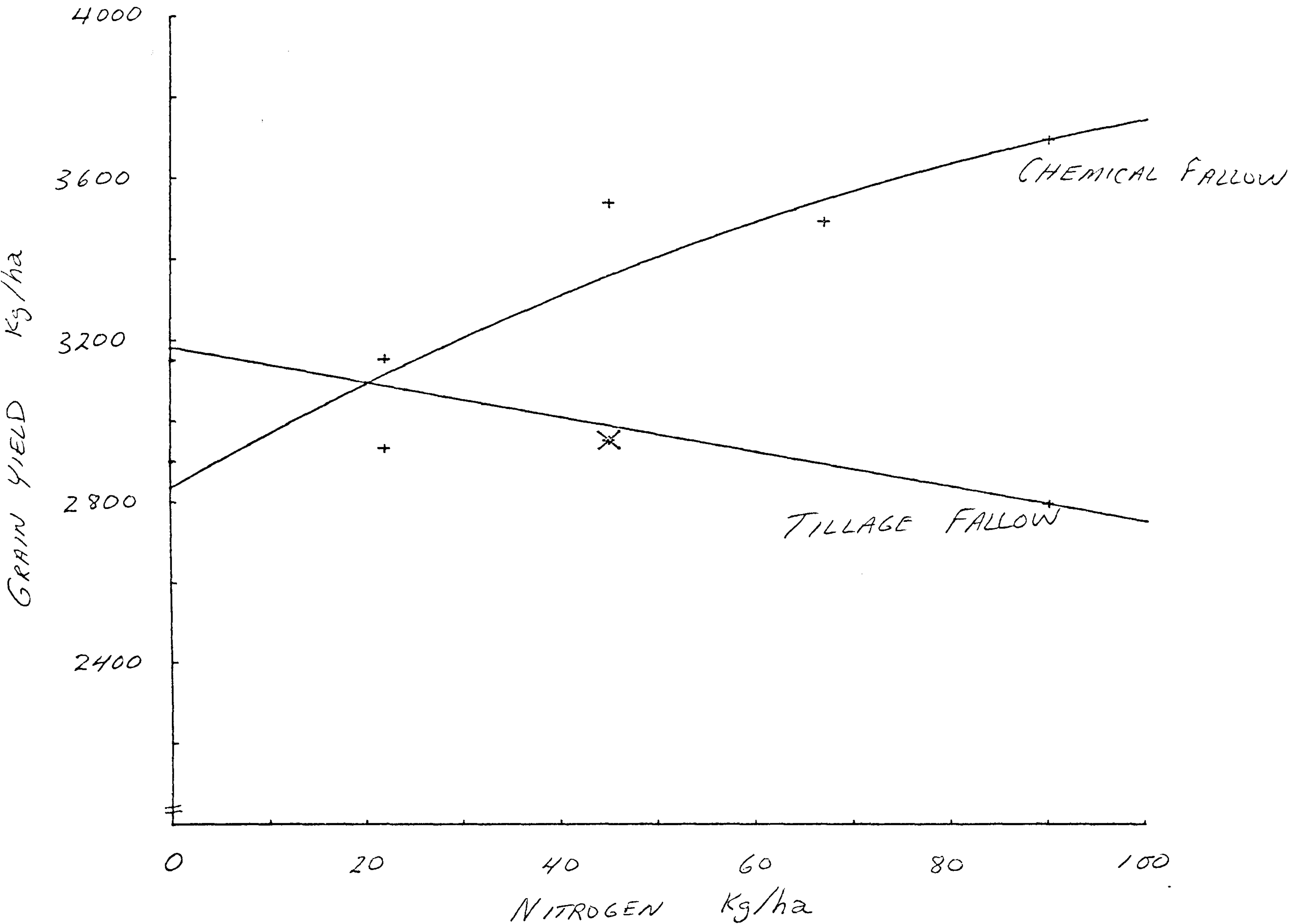
Location	CCE %	Extractant	Fe-Al-P	CDB-P	H_2SO_4	Bray #1	$NaHCO_3$
			r				
			as % of total inorganic P			as concentration	
1	.01	NH_4Cl	.84	-.54	-.92	.92	.96
		Fe-Al-P	-	-.79	-.96	.98	.98
		CDB	-	-	-.60	-.22	-.16
		H_2SO_4	-	-	-	.79	.79
2	.2	NH_4Cl	.72	-.08	-.88	.97	.93
		Fe-Al-P	-	-.40	-.92	.93	.94
		CDB	-	-	.05	.16	.25
		H_2SO_4	-	-	-	.45	.50
3	.1	NH_4Cl	.51	-.26	-.68	.89	.90
		Fe-Al-P	-	-.61	-.71	.87	.88
		CDB	-	-	-.06	-.05	-.28
		H_2SO_4	-	-	-	.73	.66
4	1.8	NH_4Cl	.07	-.18	-.17	.53	.87
		Fe-Al-P	-	-.32	-.71	.58	.58
		CDB	-	-	-.40	.21	.07
		H_2SO_4	-	-	-	.35	.81
5	16.5	NH_4Cl	.20	.13	-.68	.55	.87
		Fe-Al-P	-	-.62	-.66	.16	.76
		CDB	-	-	-.09	.09	.05
		H_2SO_4	-	-	-	.43	.60
Over all		NH_4Cl	.24	.06	-.61	.72	.90
		Fe-Al-P	-	-.45	-.78	.86	.88
		CDB	-	-	-.21	-	-
		H_2SO_4	-	-	-	.21	.31

Table 15 Comparison of the Critical Growth Stages at which Adequate P had been Absorbed for the Realization of Maximum Dry Matter Production and Maximum 'P' Uptake at Maturity for Spring and Winter Wheat.

	Critical Growth Stage of P Absorption by the Plant			
	Spring Wheat**		Winter Wheat	
	Weeks of Plant Growth	Growth Stage	Weeks of Plant Growth	Growth Stage
Maximum Dry Matter Production at Maturity				
Tiller Number	5	Heading	10-11	Noding (Feekes' 7-9)
Root Weight	5	Heading	7- 9	First Node (Feekes' 5-6)
Top Weight	5	Heading	7- 9	First Node (Feekes' 5-6)
Chaff Weight	-	--	10-11	Noding (Feekes' 7-9)
Grain Weight	5	Heading	17-18	Ripening (Feekes' 11.2)
Maximum 'P' Uptake at Maturity				
Roots	5	Heading	17-18	Ripening (Feekes' 11.4)
Tops	5	Heading	17-18	Ripening (Feekes' 11.4)
Chaff	-	--	12	'Boot' (Feekes' 10)
Grain	5	Heading	17-18	Ripening (Feekes' 11.2)

** Spring wheat data based on Boatwright and Haas (1961) and Boatwright and Viets (1966).

Figure 1: Grain yield responses to the application of nitrogen as ammonium nitrate in each fallow system in 1979.



PHOSPHORUS RATE X PLACEMENT ON
WINTER WHEAT IN SOUTHEAST NEBRASKA
1979

E. J. Penas and D. H. Sander

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

Procedure: Experimental plots were established in farmers fields in Pawnee and Polk Counties in the fall of 1978. The basis for site selection was a low level of soil phosphorus and an acid soil pH. These studies are to parallel studies being conducted in western Nebraska on neutral to alkaline soils.

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

Results and Discussion: Soil test characteristics are reported in Table 1. The Pawnee County site is very low in phosphorus, medium in nitrogen and potassium and slightly acid. The Polk County site is low in phosphorus, high in nitrogen and moderately acid.

Table 2 shows in influence of nitrogen, phosphorus and potassium on grain yields (nitrogen and phosphorus only in Polk County). Grain yield was increased markedly by phosphorus and slightly by potassium in Pawnee County. Nitrogen reduced grain yield where applied with potassium, but had no effect on grain yields when no potassium was applied. Grain yields were reduced by both nitrogen and phosphorus at the rates applied in Polk County.

A nitrogen rate study was included at both sites. Phosphorus was placed with the seed at the time of seeding at a rate of 46 pounds P_2O_5 (20 P) per acre. Nitrogen as ammonium nitrate was top-dressed in the spring at the rates shown in Table 3. Grain yields was increased by nitrogen in Pawnee County; however, 20 pounds of nitrogen per acre was sufficient for maximum yields. This soil is medium in soil nitrate nitrogen (75 pounds per acre 6 feet) and has a history of clover in the past year. The site in Polk County did not respond to applied nitrogen and at higher rates of nitrogen, yield was reduced due to lodging.

The influence of phosphorus on the growth of wheat was also studied at both locations. Phosphorus applied at various rates with the seed at planting time was compared to rates applied broadcast and incorporated prior to seeding. Nitrogen at 40 pounds per acre was top-dressed in the spring in Pawnee County (none in Polk County). Grain yields for these treatments are given in Table 4.

At Pawnee County, yields were increased markedly by phosphorus. Both application methods were effective; however, phosphorus applied with the seed was about four times as efficient as phosphorus applied broadcast.

At Polk County, yield increase from phosphorus was minimal. Yield was increased 4 bushels by 86 pounds of phosphorus applied broadcast. The application of 17 pounds of phosphorus with the seed increased grain yield 2 bushels per acre. Higher rates of phosphorus increased tillering which resulted increased lodging. The early lodging that occurred did reduce yields.

Table 1. Soil Test Characteristics of Winter Wheat Test Plot Sites, 1979

	Pawnee Co.	Polk Co.
Soil pH	6.3	5.3
Lime Requirement, tons/ac	---	3.5
NO_3-Nitrogen, lbs/ac 6 ft.	75	151
Phosphorus, ppm	2	11
Potassium, ppm	108	337
Organic Matter, %	2.0	3.0

Table 2. Winter Wheat Grain Yields, bu/ac, as Influenced by Nitrogen, Phosphorus and Potassium, 1979

Treatment	County	
N - P_2O_5 - K_2O	Pawnee Co.	Polk Co.
0 - 0 - 0	19	57
40 - 0 - 0	20	54
0 - 46 - 0	47	54
40 - 46 - 0	46	49
0 - 0 - 50	26	--
40 - 0 - 50	19	--
0 - 46 - 50	49	--
40 - 46 - 50	45	--

Table 3. Winter Wheat Grain Yields, bu/ac, as Influenced by Nitrogen Rate, 1979.

Nitrogen, lbs/ac	Pawnee County	Polk County
0	45	53
20	49	54
40	50	52
60	49	48
80	47	--
100	46	--

Table 4 Winter Wheat Grain Yields, bu/ac, as influenced by phosphorus Rate and Placement, 1979.

Phosphorus Rate	Pawnee County		Polk County	
P_2O_5, lbs/ac	P Bdct	P w/Seed	P Bdct	P w/Seed
0	34		56	
9		39		57
17	35	42	57	58
26		45		58
34	36	47	58	58
43		48		58
52	39	49	59	58
60		49		58
69	41	50	59	58
86	44	54	60	58
103	46		59	
120	48		59	
137	49		58	

DUAL PLACEMENT OF NITROGEN AND PHOSPHORUS ON WHEAT 1979

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: Experimental plots were established in farmers' fields. Sites were selected for a high probability of crop response to phosphorus fertilizer based on a low soil test for phosphorus.

Two studies were established in Lancaster County in the fall of 1978. The accompanying table shows the soil test characteristics of both sites. Both locations were low in phosphorus and had an acid soil pH. Both sites received a farmer application of nitrogen as anhydrous ammonia over the entire plot in addition to the ammonia and 10-34-0 that were applied at the time of the plot establishment.

The entire plot area received 40 pounds of nitrogen per acre. Ammonia was the source of 33.3 pounds of nitrogen (40 pounds for the ammonia alone plots) and 10-34-0 supplied 6.7 pounds of nitrogen per acre.

Phosphorus was applied at a constant rate of 23 pounds P_2O_5 (10#P) per acre. The method of applying 10-34-0 was the variable studied in these experiments. The 10-34-0 was knifed with ammonia in 12 inch bands using double tube knives, applied in 12 inch bands separate from the ammonia, broadcast sprayed on the surface of the soil and incorporated, dribbled in 12 inch bands on the surface and incorporated and applied with the seed at planting time.

Results and Discussion: The accompanying table shows the grain yields at both locations. The Talcott location sustained a considerable amount of root and crown rot. Some wheat stand was lost and grain yields were reduced and variable. There was no measurable effect of treatment on grain yields at this site.

At the Mocroft location, about one-third of the plot area was lost due to erosion and winterkill; however, the rest of the plot area did yield well and provided meaningful data. Only the treatments were 10-34-0 was knifed with the ammonia or applied with the seed increased wheat yields significantly. This would suggest that ammonium nitrogen improved phosphorus utilization where the two were applied together and that phosphorus placed with the seed performed well because of positional availability. Grain protein, which was quite high at both locations, was not influenced by treatment.

DUAL PLACEMENT OF NITROGEN AND PHOSPHORUS ON WHEAT
LANCASTER COUNTY, 1979

	Experiment Site			
	Mocroft		Talcott	
Treatment: 1/	Grain Yield, bu./ac.	Grain Protein, %	Grain Yield, bu./ac.	Grain Protein, %
Ammonia alone	34.4	15.6	32.6	14.9
Amm + 10-34-0 knifed together	41.7*	15.4	35.3	14.4
Amm + 10-34-0 knifed separately	35.2	15.6	35.2	14.7
10-34-0 Broadcast and Ammonia	33.4	15.5	32.0	14.7
10-34-0 Dribbled and Ammonia	32.2	15.2	33.1	14.6
10-34-0 with seed and Ammonia	40.3*	15.3	35.2	14.5

1/ Ammonia @ 40# N/ac and 10-34-0 @ 10#P (23#P_2O_5)/ac.

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

Soil Test Information	Mocroft	Talcott
Soil pH	5.4	5.5
Buffer pH	6.6	6.5
Phosphorus, ppm	13	11
Potassium, ppm	385	454
Organic Matter, %	3.0	3.0

RATE AND PLACEMENT OF PHOSPHATE FERTILIZER FOR SOYBEAN PRODUCTION

G.W. Rehm and R.A. Wiese

Objective:

Fertilizer use and management practices for corn production have received considerable emphasis. Less attention has been devoted to fertilizer use for soybeans in Nebraska. The number of acres devoted to soybeans in northeast and eastern Nebraska has increased substantially in recent years and will continue to increase in the near future. In addition, many of the soils in this area have low or very low levels of phosphorus. Therefore, effective and efficient use of phosphate fertilizers should be one of the first considerations in a fertilizer program for soybeans in these areas of Nebraska. The objective of this study is to measure the effect of rate and placement of phosphate fertilizer for soybean production on the silt loam soils of northeast and eastern Nebraska.

Procedure:

Two sites were selected in Cedar County for this study and appropriate soil properties are listed in Table 1. Five rates of P (0, 10, 20, 30, 40 lb. per acre) were either broadcast and incorporated with a disk before planting or applied in a band to the side of and below the seed at planting. Appropriate herbicides were used at the recommended rates. Amsoy 71 soybeans were seeded at a rate of ten seeds per ft. of row in 30 in. rows. The soybeans at both sites were irrigated as needed throughout the growing season.

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

Results and Discussion:

Application of fertilizer P had no effect on yield at the Dahlquist location. Yields at the Climer location were increased by both rate and placement of fertilizer P (Table 2).

Considering placement, yields were higher when the P was broadcast and incorporated rather than applied below and to the side of the seed in the row at planting. This observation is not consistent with the data generated from similar studies with corn. However, this study should be repeated at a number of sites below definite conclusions regarding placement can be derived from the data.

When averaged over both placements at the Climer location, highest yields were produced from the application of 30 lb. P/acre. This P rate produced a yield increase of approximately 8 bu. per acre. With a very low level of P in the soil (.6 ppm), a response to applied P would be expected.

Neither placement nor rate of applied P had a significant effect on the P content of the soybean leaf tissue (Table 3). Although there was a trend for increased P content with increasing rate of P, this trend was not significant. The lack of significant effects can be attributed, in part, to a large amount of variability in the data.

Table 1. Selected properties of the soils at the experimental sites. 1979.

Property	Location: Dahlquist	Location: Climer
pH	6.7	8.0
organic matter, %	2.69	1.53
P (Bray), ppm	27.0	.6
K ($NH_4C_2H_3O_2$), ppm	557	193

Olsen P?

Table 2. Effect of rate and placement of fertilizer P on soybean yields. Cedar County, 1979.

Location	Placement	P Applied (lb./acre) 0	10	20	30	40	Ave.
		bu./acre					
Dahlquist	Row	45.8	43.0	47.0	45.2	48.5	45.9
	Broadcast	43.6	42.3	42.9	46.5	42.5	43.6
Climer	Row	32.6	32.7	35.2	36.6	36.7	34.8
	Broadcast	34.7	41.9	42.5	45.9	43.0	41.6

Table 3. Effect of rate and placement of fertilizer P on P content of soybean leaves. Cedar County, 1979.

Location	Placement	P Applied (lb./acre) 0	10	20	30	40	Ave.
		% P					
Dahlquist	Row	.423	.415	.416	.424	.446	.425
	Broadcast	.420	.422	.432	.446	.453	.435
Climer	Row	.276	.285	.297	.306	.313	.295
	Broadcast	.272	.301	.320	.326	.334	.311

RESPONSE OF WARM-SEASON PRAIRIE GRASSES TO THE APPLICATION OF N AND P WITH AND WITHOUT THE USE OF ATRAZINE.

G.W. Rehm and R.S. Moomaw

Objective:

The warm-season prairie grasses can play a major role in the pasture management systems for northeast Nebraska. The major portion of the growth of these grasses occurs in the hot summer months of July and August when cool-season grasses go dormant. Past research has shown that fertilizer N and P applied at the proper time will produce substantial increases in yield. In addition, these grasses have the ability to withstand the application of atrazine. The objective of this study was to evaluate the combination of fertilization with N and P with and without the use of atrazine on the production of a seeded mixture of warm-season prairie grasses.

Procedures:

This study was initiated in Cedar County in 1974. The soil was classified as a Crofton silt loam. Five rates of N (0, 30, 60, 90, 120 lb./acre) and five rates of P (0, 5, 10, 15, 20 lb./acre) were combined into treatments necessary to fit a central composite factorial design. The treatment combinations were applied each year with and without the use of atrazine at 1 lb. a.i. per acre. The atrazine was applied in the initial year and on alternate years thereafter. In addition, the rates of N and P were doubled and applied with the atrazine in alternate years. These treatments were applied to a companion set of plots at the same site. Fertilizer was broadcast in late May. The atrazine was applied in early April.

Yields were recorded in early August and whole plant samples were collected from each plot for protein and forage quality analysis.

Results and Discussion:

Yields varied from year to year due to the variance in rainfall throughout the growing season. In general, there was a response to both N and P throughout the study. Highest yields resulted from the combinations of N and P.

The application of atrazine on alternate years appeared to improve overall production. Although statistical analysis is not complete, yields resulting from the use of both N and P appear to be greater where the atrazine was used (compare Table 3 to Table 1 and Table 4 to Table 2). This apparent yield increase is attributed to the absence of competition from weeds for moisture and plant nutrients.

Application of N and P at twice the annual rate on alternate years appeared to have no harmful effect on yield (compare Table 5 with Table 3 and Table 6 with Table 4). Completion of statistical analysis is needed before a conclusion regarding the frequency of fertilizer application can be reached.

Table 1. Effect of yearly applications of N without atrazine on the yield of warm-season grasses.

N Applied	1974	1975	Year 1976	1977	1978	1979	Total
lb./acre			ton dry matter/acre				
0	.58	.38	.32	.41	.33	.38	2.40
30	.72	.88	.59	1.05	1.07	.76	5.07
60	.87	1.23	.77	1.43	1.59	1.15	7.04
90	1.01	1.43	.85	1.56	1.89	1.53	8.27
120	1.16	1.48	.82	1.42	1.98	1.90	8.76

Table 2. Effect of yearly applications of P without atrazine on the yield of warm-season grasses.

P Applied	1974	1975	Year 1976	1977	1978	1979	Total
lb./acre			ton dry matter/acre				
0	.62	.60	.36	.62	.83	.37	2.80
5	.85	.89	.57	1.06	1.28	.90	5.55
10	.98	1.14	.72	1.34	1.55	1.30	7.03
15	.99	1.32	.82	1.45	1.64	1.54	7.76
20	.90	1.45	.88	1.39	1.55	1.61	7.78

Table 3. Effect of yearly applications of N with atrazine applied on alternate years on the yield of warm-season grasses.

N Applied	1974	1975	Year 1976	1977	1978	1979	Total
lb./acre			ton dry matter/acre				
0	.62	.38	.50	.34	.49	.31	2.64
30	.83	.88	.93	1.58	2.23	1.51	7.96
60	1.02	1.23	1.16	2.27	3.48	2.42	11.58
90	1.20	1.43	1.19	2.40	3.53	2.50	12.25
120	1.36	1.48	1.03	1.97	2.38	1.74	9.96

Table 4. Effect of yearly applications of P with atrazine applied on alternate years on the yield of warm-season grasses.

P Applied	1974	1975	Year 1976	1977	1978	1979	Total
lb./acre			ton dry matter/acre				
0	.57	.32	.80	1.32	2.08	1.31	6.40
5	.99	1.39	.85	1.46	1.86	1.31	7.86
10	1.21	1.92	.93	1.65	2.03	1.50	9.24
15	1.22	1.85	1.04	1.90	2.54	1.87	10.42
20	1.04	1.18	1.17	2.22	3.61	2.49	11.71

Table 5. Effect of the application of N and atrazine every other year on the yield of warm-season grasses.

N Applied	1974	1975	1976	1977	1978	1979	Total
lb./acre	- - - - - - - - - - -		ton dry matter/acre - - - - - - - - - - -				
0	.88	.69	.59	.79	.48	.49	3.92
60	.95	.96	.95	1.46	2.34	1.03	7.69
120	1.10	1.16	1.15	2.03	3.41	1.57	10.42
180	1.36	1.30	1.19	2.52	3.68	2.12	12.17
240	1.71	1.37	1.07	2.91	3.15	2.66	12.87

Table 6. Effect of the application of P with atrazine every other year on the yield of warm-season grasses.

P Applied	1974	1975	1976	1977	1978	1979	Total
lb./acre	- - - - - - - - - - -		ton dry matter/acre - - - - - - - - - - -				
0	.67	.88	.87	1.70	2.42	1.32	7.86
10	1.17	.97	.97	1.82	2.37	1.55	8.85
20	1.44	1.08	1.02	1.94	2.47	1.67	9.62
30	1.47	1.21	1.05	2.06	2.71	1.70	10.20
40	1.27	1.35	1.03	2.18	3.09	1.63	10.55

RESPONSE OF ALFALFA GROWN ON AN 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 have not been thoroughly researched. This study was conducted for the purpose of measuring the response of alfalfa grown on an irrigated sandy soil to the application of fertilizer P and S.

Procedure:

The experimental site is located in Pierce County. The soil is a Valentine loamy fine sand. Following collection of soil samples, several 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 arranged to fit a central composite factorial design were broadcast. All plots received 15 lb. N/acre as 33-0-0, 200 lb. K_2O/acre as 0-0-62 and 1½ ton lime per acre. All fertilizers were incorporated with a garden tiller. Alfalfa (Gladiator) was seeded in mid-August at a rate of about 15 lb./acre. Four harvests were taken in 1979.

Results and Discussion:

In the interest of brevity, total dry matter yields are listed in this report (Table 1). The application of both P and S increased yield. The response to S was small but linear. The response to P was curvilinear with maximum yield resulting from the application of 30 lb. P/acre. There was no significant P-S interaction. Considering the levels of P and S as measured by a soil test and the organic matter content (Table 2), a response to both P and S would be expected. Treatments will be repeated in 1980.

Table 1. Response of irrigated alfalfa grown on a sandy soil to rate of applied P and S. Pierce County, 1979.

	P Applied (lb./acre)							
S Applied	0	10	20	30	40	50	60	Ave.
lb./acre	ton dry matter/acre							
0	3.76	4.16	4.41	4.50	4.43	4.21	3.84	4.19
25	3.75	4.18	4.45	4.56	4.52	4.33	3.98	4.25
50	3.74	4.19	4.49	4.63	4.61	4.44	4.12	4.32
75	3.73	4.21	4.53	4.69	4.70	4.56	4.26	4.38
100	3.72	4.22	4.57	4.76	4.79	4.67	4.39	4.48
125	3.71	4.24	4.61	4.82	4.88	4.78	4.53	4.51
150	3.70	4.25	4.64	4.88	4.97	4.89	4.67	4.57
Ave:	3.73	4.21	4.53	4.69	4.70	4.55	4.26	

Table 2. Properties of the soil at the experimental site.

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

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

G. W. Rehm

Objective:

The potassium levels of some soil samples collected from irrigated fields in the Sandhills and bordering areas are considered to be in the medium or low range. Requirements for fertilizer K 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, and stand persistance of alfalfa grown on an irrigated sandy soil for a period of five years.

Procedure:

The experimental site is located in Pierce County. The soil is a Valentine loamy fine sand. The K content (extracted by $NH_4C_2H_3O_2$) of the surface soil was 89 ppm. The K concentration was 66, 49, 42, 35, 37, 38 ppm for the 6-12, 12-24, 24-36, 36-48, 48-60 and 60-72 in. depths respectively. Rates of fertilizer K_2O, supplied as 0-0-60, were broadcast and incorporated before planting and topdressed to the established stand with treatments arranged to fit a complete factorial design with four replications. Alfalfa was seeded in mid-August of 1978 at a rate of approximately 15 lb. per acre. Four cuttings were harvested in 1979. All plots received 1½ ton lime per acre and 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.

Results and Discussion:

Total yields, only, are included in this report (Table 1). The rate of K_2O applied either before planting (plowdown) or after establishment (annual) had no effect on total yield of alfalfa. This was also the case for the individual cuttings. The irrigation water contains enough K to supply approximately 6.5 lb. K_2O/acre ft. This is a relatively small amount of K_2O. With no response to fertilizer K in 1979, the alfalfa must have obtained sufficient K from the K supplied in the soil. This study will be continued for four more years in an attempt to measure the effect of K fertilization on stand persistence.

Table 1. Effect of rate of K_2O and time of application on total yield of alfalfa grown on an irrigated sandy soil. Pierce County, 1979.

K_2O Applied Plowdown	Annual	Yield
------lb./acre-------		ton dry matter/acre
0	0	4.87
0	40	5.42
0	80	5.30
0	160	5.14
0	320	4.99
0	640	5.52
80	0	4.95
80	40	5.36
80	80	5.02
80	160	5.09
80	320	5.35
80	640	5.42
160	0	4.98
160	40	5.09
160	80	5.08
160	160	4.94
160	320	5.09
160	640	5.56
320	0	4.77
320	40	5.22
320	80	5.17
320	160	5.36
320	320	5.34
320	640	5.28

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

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

Objective:

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

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

Procedure:

This study was initiated at the Mead Field Laboratory in 1973. In 1974, this study was expanded to sites at the North Platte Experiment Station, South Central Experiment Station and Northeast Experiment Station. Corn was the test crop at the above locations. This study was also conducted with wheat in Cheyenne County as well as potatoes and sugarbeets. The results of these trials are published in Agronomy Department Reports No. 33 and 18, respectively.

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

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

[1/] This article is a brief summary of Agronomy Department Report 33 by the soil fertility staff at the UN-L covering experiments conducted at the South Central Station, the North Platte Station, the Northeast Station, the High Plains Lab and the Mead Field Lab during 1973-1979. Copies of Agronomy Report #33 can be obtained from the Department of Agronomy, University of Nebraska, Lincoln, Nebraska.

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

Results and Discussion:

This report contains a summary of fertilizer recommendations from the various laboratories in 1979 as well as yields and the costs of the fertilizer programs from 1973 through 1979. Additional data is contained in Agronomy Department Report No. 33.

There was a wide variance in the fertilizer recommendations made for the 1979 corn plots (Tables 1, 3, 5, 7). This variation is consistent with the wide differences in fertilizer recommendations made from 1973 through 1978. This variance in fertilizer recommendations is reflected in the cost of the fertilizer applied (Tables 2, 4, 6, 8).

From 1974 through 1977 and in 1979, the fertilizer applied had no significant effect on yield at all locations. In 1978, yields at the North Platte and Northeast Station sites were affected by the fertilizer program used. At North Platte, lowest yields were produced by the recommendations from Laboratory C. Lowest yields at the Northeast Station were produced by recommendations from Laboratory B. Highest yields resulted from recommendations from Laboratories D and E. Recommendations from Laboratories A and C produced yields which were intermediate.

Table 1. Fertilizer recommendations from five soil testing laboratories for corn production at the Mead Field Laboratory, 1979[1/]

Nutrient	Laboratory A	B	C	D	E (UNL)
	-----------	-----------	lb/acre	-----------	-----------
Nitrogen	195	200	260	180	190
Phosphorus (P_2O_5)	55	30	0	0	40
Potassium (K_2O)	40	80	70	105	0
Magnesium (MgO)	0	0	0	0	0
Sulfur	18	15	90	15	0
Zinc	0	2	3	6	5
Iron	0	0	0	0	0
Manganese	0	0	0	0	0
Copper	0	0	1	0	0
Boron	0	0	0.5	0	0
Lime	0	0	0	0	0

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

Table 2. Corn yields and fertilizer costs at Mead resulting from fertilizer recommendations received from five soil testing laboratories (1973-1979).

Yield: Year	Laboratory A	B	C	D	E (UNL)
	-----------	-----------	bu/acre	-----------	-----------
1973	152	148	153	148	160*
1974	139	131	131	137	133*
1975	162	157	153	160	158*
1976	143	143	129	143	137*
1977	148	142	136	142	145*
1978	178	168	183	170	179*
1979	200	187	191	197	186*
Total	1122	1076	1076	1097	1098
Fertilizer Cost:					
	-----------	-----------	$/acre	-----------	-----------
1973	$ 42.00	$ 32.00	$ 41.00	$ 25.00	$ 17.00
1974	96.00	69.00	90.00	57.00	39.00
1975	95.00	74.00	83.00	46.00	46.00
1976	51.15	31.75	60.85	34.80	31.60
1977	37.80	55.05	67.85	50.50	22.80
1978	38.60	34.74	50.58	30.72	19.05
1979	51.16	51.75	77.65	48.60	42.70
Total	$411.71	$348.29	$470.93	$292.62	$218.15

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

Table 3. Fertilizer recommendations from five soil testing laboratories for corn production at the North Platte Station, 1979[1/]

Nutrient	Laboratory				
	A	B	C	D	E (UNL)
	lb/acre				
Nitrogen	120	190	260	190	120
Phosphorus (P_2O_5)	0	30	0	102	0
Potassium (K_2O)	0	30	0	0	0
Magnesium (MgO)	0	20	0	0	0
Sulfur	21	25	90	0	0
Zinc	2	0	5	0	0
Iron	0	0	0	0	0
Manganese	0	0	0	0	0
Copper	1	0.5	2	0	0
Boron	1.2	0	0.5	0	0
Lime	0	0	0	0	0

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

Table 4. Corn yields and fertilizer costs at North Platte resulting from fertilizer recommendations received from five soil testing laboratories (1974-1979).

Yield:	Laboratory				
Year	A	B	C	D	E (UNL)
	bu/acre				
1974	167	168	155	155	159*
1975	216	208	210	217	222*
1976	148	130	133	128	132*
1977	173	180	177	176	172*
1978	160 a	156 a	149 b	160 a	157 a[1/]
1979	158 a	167 a	163 a	155 a	154 a
Total	1003	1009	988	991	995
Fertilizer Cost:					
	$/acre				
1974	$ 53.40	$ 66.25	$ 81.65	$ 39.30	$ 28.90
1975	82.80	44.90	72.25	45.60	34.20
1976	57.82	64.85	74.67	38.86	29.00
1977	31.40	52.78	50.45	21.60	21.60
1978	44.36	52.26	54.60	30.37	17.21
1979	29.27	53.65	74.35	51.96	18.00
Total	$299.05	$334.69	$407.97	$227.69	$148.91

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

[1/] In 1978 and 1979, yields followed by the same letter are not significantly different at the .05 confidence level.

Table 5. Fertilizer recommendations from five soil testing laboratories for corn production at the South Central Station, 1979[1/]

Nutrient	Laboratory				
	A	B	C	D	E (UNL)
	lb/acre				
Nitrogen	75	80[2/]	80[2/]	190	100
Phosphorus (P_2O_5)	0	0	0	97	0
Potassium (K_2O)	30	30	0	0	0
Magnesium (MgO)	15	25	0	0	0
Sulfur	20	30	0	0	0
Zinc	0	0	0	0	0
Iron	0	0	0	0	0
Manganese	0	0	0	0	0
Copper	0	0	0	0	0
Boron	0	0	0	0	0
Lime	0	0	0	0	0

[1/] Yield goal for irrigated corn was 170 bu/acre in 1974 and 1975 and 250 bu/acre for 1976, 1977, 1978, and 1979.

[2/] No N recommended but lab suggested adding 80# if spring rains were excessive. Rains were heavy. N applied June 21.

Table 6. Corn yields and fertilizer costs at the South Central Station resulting from fertilizer recommendations received from five soil testing laboratories (1974-1979).

Yield:	Laboratory				
Year	A	B	C	D	E (UNL)
	bu/acre				
1974	186	189	187	189	184*
1975	203	206	196	201	194*
1976	188	186	186	196	199*
1977	154	155	156	154	166*
1978	197	203	189	199	199*
1979	181	179	183	194	193*
Total	1109	1118	1097	1133	1135
Fertilizer Cost:					
	$/acre				
1974	$ 81.65	$ 71.65	$ 79.20	$ 46.40	$ 37.65
1975	96.12	70.55	93.50	43.40	55.20
1976	71.19	49.61	65.70	26.36	36.30
1977	45.60	65.15	68.45	49.20	4.80
1978	60.20	40.43	46.89	23.88	24.36
1979	27.54	33.71	15.44	52.37	18.91
Total	$382.30	$331.10	$369.18	$241.59	$177.22

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

Table 7. Fertilizer recommendations from five soil testing laboratories for corn production at the Northeast Station, 1979[1/]

Nutrient	Laboratory A	B	C	D	E (UNL)
	---------------------lb/acre----------------------				
Nitrogen	80	100	100	120	80
Phosphorus (P_2O_5)	40	20	0	41	0
Potassium (K_2O)	20	10	20	0	0
Magnesium (MgO)	0	0	0	0	0
Sulfur	14	10	0	0	0
Zinc	0	0	0	0	0
Iron	0	0	0	0	0
Manganese	0	0	0	0	0
Copper	0	0.5	0	0	0
Boron	0	0	0	0	0
Lime	1	0	0	1.5	2.5

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

Table 8. Corn yields and fertilizer costs at the Northeast Station resulting from fertilizer recommendations received from five soil testing laboratories (1974-1979).

Yield: Year	Laboratory A	B	C	D	E (UNL)
	-----------------------bu/acre----------------------				
1974	--------------No yield because of drought-----------				
1975	59	60	56	52	59*
1976	9	11	14	10	15*
1977	144	145	149	144	142*
1978	120 ab	113 a	117 ab	123 b	124 b[1/]
1979	151 a	148 a	148 a	147 a	145 a
Total	483	477	484	476	485
Fertilizer Cost:					
	--------------------$/acre-------------------------				
1974	$ 37.59	$ 27.95	$ 49.05	$ 29.00	$ 11.90
1975	15.90	18.00	20.05	19.80	16.20
1976	29.70	29.20	49.00	12.00	10.80
1977	17.40	20.75	14.30	24.03	2.00
1978	17.30	9.14	13.37	33.70	14.40
1979	39.68	24.60	17.20	46.18	43.25
Total	$157.57	$129.64	$162.97	$164.71	$ 98.55

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

[1/] In 1978 and 1979, yields followed by the same letter are not significantly different at the .05 confidence level.

Crop and Soil Response to Applied P and K in a Long Term Buildup/Depletion Study

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

Objective:

1. The basic objective of this project is to determine the level of soil P and K required for effecting optimum crop yields.
2. Secondarily, the project over a long time interval will register rates of applied P and K required for maintaining an optimum soil test level for top yields.

Procedure:

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

Results and Discussion:

The results for 1979 along with average results for the seven years the study has been running to date are presented in Tables 1, 2 and 3. The environment was obviously excellent for corn production in 1979 with yields in the 200 bu/acre range by the irrigated corn at Mead and the 160 bu range by non-irrigated corn at the Northeast Station, likewise wheat in the 50 bu range at the High Plains Lab.

A significant yield improvement over the control was evidenced only with the annual 30 lb. P rate at the Mead location in 1979. Over the previous seven years, annual applications of at least 20 lbs. P/acre resulted in maximum yields. Potassium has had no beneficial effect on this soil and rather an apparent depressing effect with the higher K rate, even the lower rate when row applied. Through 1978, soil samples have shown an approximate doubling of P level with 20 lbs. applied annually and a tripling with 30 lbs. annually. There has been no effect of K application on extractable K level in this soil.

Non-irrigated corn on the Moody-Nora soil showed a grain yield response to as little as 10 lbs. P/acre/year with no significant improvement above this rate, although a trend toward response up to 20 lbs. P exists for both the 1969 and the 6-year average data (Table 2). There was no response to K on this soil other than an apparent reduction in yield with the higher rate, also apparent in the 6-year average. Soil test P without added P has declined measurably during the six years, while 20 lbs. applied P has more than doubled and 30 lbs. P tripled the control value. Soil test K has not changed perceptibly during the period the experiment has been run.

Grain yields at the High Plains Lab have been exceptionally good with the 3-year mean well above the 30-35 bu/acre average for this area (Table 3). Rates of 30 lbs P/acre annually or 60 lbs biennially on the Keith soil resulted in higher yields than the control. On the Rosebud soil, annual applications of 20 lbs P/acre are apparently sufficient to maximize yield. Potassium treatment has been indeterminate on the Keith soil, but the same trend of yield decrease with the higher rate is apparent on Rosebud as with the corn studies. Extractable soil P has increased 50% or more with the higher rates after three years' treatment of the Keith soil while 20 lbs P/acre has doubled soil test values and 30 lbs has more than tripled soil test P on the Rosebud. Exchangeable K has not changed perceptibly.

Table 1. Response of irrigated corn to applied P and K fertilizers in a long-term P and K buildup/depletion study on Sharps burg sicl, Mead Field Lab, Nebraska, 1973-79

Treatment* P	K	Application Schedule	Grain yield 1979	7 yr. ave.	Soil test P** (Surface) 1973	1975	1977	1979	Soil test K** (Surface) 1973	1975	1977	1979
			bu/a		ppm P				ppm K			
0	0	Control	192	165	15	12	14	14	320	350	320	333
10	0	Every year@	188	167	15	15	18	20	311	301	347	337
20	0	Every year@	198	172	16	16	24	28	310	323	337	349
30	0	Every year@	208	173	19	27	34	36	300	286	334	318
20	0	Every other year	187	164	16	20	30	27	300	321	391	326
30	0	Every 3rd year@	182	167	25	12	21	22	288	297	360	291
60	0	Every other year	192	165	22	41	51	41	283	307	402	302
60	0	Every 6th year@	189	162	30	14	19	40	288	285	377	299
20	25	Every year@	190	172	16	16	30	25	296	316	389	319
20	50	Every year@	182	162	14	20	24	27	296	304	326	327
10	25	Every other-row@	182	160	11	14	18	18	268	285	420	338
LSD (.05)			16									

* Uniform N application made to all plots for optimum yield (200 lbs N/A in 1979); P and K treatments broadcast before final tillage (except for indicated row application); grain yield on 15.5% moisture basis.

An @ indicates application in 1979.

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

Table 2. Response of non-irrigated corn to applied P and K fertilizers in a long-term P and K buildup/decline study on Moody-Nora sil, Northeast Station, Nebraska, 1973-79.

Treatment*		Application	Grain yield**		Soil test P***(surface)				Soil test K***(surface)			
P	K	Schedule	1979	6 yr. ave.	1973	1975	1977	1978	1973	1975	1977	1978
0	0	Control	147 a	113	10	10	9	6 a	223	185	195	192
10	0	Every year@	160 bcde	122	9	11	13	10 ab	220	179	179	197
20	0	Every year@	164 cde	125	12	12	16	14 bc	228	177	187	200
30	0	Every year@	167 de	123	22	20	27	20 cd	234	175	198	211
20	0	Every other year	159 abcde	117	9	11	12	7 ab	218	179	196	200
30	0	Every 3rd year@	158 abcde	119	17	9	12	8 ab	224	178	190	205
60	0	Every other year	167 de	122	11	13	22	25 d	213	173	202	197
60	0	Every 6th year@	150 ab	119	11	12	11	10 ab	202	166	189	208
20	25	Every year@	156 abcd	120	10	12	16	12 ab	220	181	204	203
20	50	Every year@	154 abc	117	11	14	19	13 ab	238	210	218	228

* Uniform N application made to all plots for optimum yield (80 lbs N/A in 1979); P and K treatments broadcast before final tillage; grain yield on 15.5% moisture basis. An @ indicates application in 1979.

** No yield in 1974 due to drouth.

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

Table 3. Response of winter wheat to applied P and K in the long-term P and K soil buildup/depletion study on the High Plains Ag Lab, Nebraska, 1975-79.

Treatment*		Application	Grain yield **				Soil test P*** (surface)				Soil test K*** (surface)			
			Keith sil		Rosebud fsal		Keith		Rosebud		Keith		Rosebud	
P	K	Schedule	1979	3-yr ave	1979	3-yr ave	1977	1979	1977	1979	1977	1979	1977	1979
			bu/A				ppm P				ppm K			
0	0	Control	43	52	31	40	22	25	8	11	525	582	447	560
10	0	Every year@	45	54	38	44	18	20	10	16	496	526	431	545
20	0	Every year@	44	50	41	47	16	34	12	23	487	613	527	629
30	0	Every year@	54	59	40	45	29	41	18	44	547	549	403	534
20	0	Every other year	46	56	32	41	19	28	11	13	455	569	452	535
30	0	Every 3rd year	48	56	37	40	26	44	18	18	520	602	480	468
60	0	Every other year	50	57	46	47	33	53	36	25	565	598	454	529
60	0	Every 6th year	51	56	42	47	34	60	15	38	513	524	516	522
20	25	Every year@	51	58	40	45	23	37	16	20	507	603	529	553
20	50	Every year@	49	58	34	41	32	44	13	21	612	687	495	560
LSD (.05)			6		8									

* Uniform N application to all plots for optimum yield; P and K treatments broadcast before final tillage; grain yield on 14% moisture basis; an @ indicates application in 1979.

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

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

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

Results and Discussion:

Instrumentation has been completed for measuring water content and bulk density of porous material simultaneously and nondestructively in vertical laboratory columns 6.2 cm in diameter and up to 2.0 m in length. The measurements are based on the attenuation of a dual-energy beam of gamma rays, emanating from suitably positioned sources consisting of 300 mCi of Cs-137 and 410 mCi of Am-241. Collimation provides a beam about 3.0 cm wide and 1.0 mm high, thus sampling a very narrow vertical increment of the laboratory column. Individual measurements can be obtained in as little as 5 sec, but a period of 20 to 60 sec is preferable. Measuring accuracy is on the order of 0.01 cc/cc or g/cc in water content or bulk density, respectively. Operating characteristics are in excellent conformity with, and slightly superior to, similar types of apparatus constructed previously. Immediate experiments are planned for water entry into a highly swelling clay material, and for downward water infiltration and upward rise in nonswelling soils.

A theoretical study of ponded water infiltration into uniform, rigid unsaturated soil has produced an improved equation for describing the cumulative quantity of water that infiltrates vertically downward as a function of total elapsed time. The new equation appears to have improved accuracy, is of relatively simple mathematical form, and offers promise that its constants can be utilized to characterize the infiltration characteristics of soils, whether in the laboratory or in the field. Further assessment of these aspects is planned for the near future.

TILLAGE SYSTEMS FOR IRRIGATED CORN PRODUCTION

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This report summarizes the results from the first four years of our tillage study. The purpose of this study is to determine the effect of tillage practices on furrow irrigation management, corn grain yield, production costs, energy requirements, and disease, insect, and weed control and fertilizer management problems.

The study is being conducted on a Hastings silt loam soil. The average field slope is 0.4 percent. Furrow lengths are 1,285 feet. The field is irrigated with an automatic gated pipe system with reuse. The experiment includes six tillage systems or treatments. The field operations involved in each system are summarized in Table 1. Each plot is 24 rows (30-inch rows) wide and 1,285 feet long. Each treatment is replicated three times.

Planting dates were May 11, April 28, April 28, and May 19, 1976, 1977, 1978, and 1979, respectively. There has been less than a 2-3 day difference in emergence date between treatments. This can be explained by the similarity in soil moisture and soil temperatures at planting time between treatments as shown in Tables 4 and 5.

The planned planting rate was 27-30,000 plants per acre. Final plant populations are shown in Table 2. Plant populations are averaging over 25,000 plants per acre and do not appear to be affected by tillage practices. One item that has been noticeable is the difference in volunteer corn between systems. The year 1978 was good for volunteer corn because of the hail we received on September 11, 1977. Table 3 shows the relative volunteer ratings that were observed in 1978. All treatments which involve some tillage with surface soil mixing such as disking had higher volunteer problems than the till-plant and slot-plant systems.

Surface residues are of interest and concern from the standpoint of retarding flow down irrigation furrows and problems associated with knifing in anhydrous ammonia. Table 6 shows residue measurements taken in 1979 at various dates. Disking reduced surface cover to less than five percent after hilling while the systems which minimize tillage trips (till plant, rotary till, and slot plant) resulted in surface covers of about 20 percent after hilling. However, net infiltration measurements taken during irrigation (Table 7) indicate that the residues have not resulted in large changes in water infiltration and excessive irrigation amounts (greater than 3 inches) have been avoided with all systems. However, it should be noted that none of the measurements were taken during the first irrigation.

To date there have not been any major differences in disease, insect, or weed control problems between tillage systems. Stalk rot incidence is reported in Table 8. Chemicals used for weed control have been the same for all systems for all years except that paraquat was applied to the slot plant system at a rate of one-half pound per acre in 1976 and 1977.

Grain yields were determined by harvesting and weighing 9 rows from each plot and correcting yields to 15.5 percent moisture. Yield results are shown in Table 9. There are no significant statistical differences between treatments.

The energy requirements for field operations were estimated for each system. The requirements are shown in Table 11. The lowest energy requirements are for the slot and till plant at about four gallons of diesel fuel per acre, while the chisel system is approaching seven gallons per acre.

Production costs which include costs for land, equipment, supplies, labor, and management are shown in Table 10. The average estimated cost per acre per year exceeds $300 with about a $13 per acre spread between systems. This accounts for the cost of the extra three tillage operations between the minimum tillage systems and the chisel system.

SUMMARY

After **four** years of study, no significant differences in grain yield resulted from the various tillage systems used in this study. Measurements of soil moisture and temperature at planting, and water infiltration have supported the yield results. That is, we would not expect any yield differences between systems if we are able to establish good plant populations, maintain nearly equal soil moisture, and do not have pest control problems because of the tillage system used. However, there is up to a 40 percent difference in energy requirements and a $13 per acre difference in production costs between the various systems.

Table 1. Normal field operations for each tillage system, Tillage Study. University of Nebraska South Central Station.

Treatment	Fall Operations	Spring Operations
T1 - Disk and List	Shred, Tandem Disk	Apply anhydrous, tandem disk, harrow, list, spray herbicide, cultivate, hill, combine
T2 - Disk and Surface Plant	Shred, Tandem Disk	Apply anhydrous, tandem disk, harrow, surface plant, spray herbicide, cultivate, hill, and combine
T3 - Till Plant	None	Shred, apply anhydrous, plant, spray herbicide, cultivate, hill, combine
T4 - Rotary Till (sidewinder)	None	Shred, apply anhydrous, plant, spray herbicide, cultivate, hill, combine
T5 - Chisel and Surface Plant	Shred stalks Chisel 6-8" deep	Apply anhydrous, tandem disk twice, harrow, surface plant, spray herbicide, cultivate, hill, combine
T6 - Slot Plant	None	Shred stalks, apply anhydrous, plant, spray herbicide, cultivate, hill, combine

Table 2. Mean plant populations (plants/acre) for Tillage Study. University of Nebraska South Central Station

Treatment	1976	1977	1978	1979	4-Year Average
T1 - Disk and List	29,911	23,624	30,951	26,339	27,706
T2 - Disk and Surface Plant	28,749	22,259	26,252	24,423	25,420
T3 - Till PLant	28,474	21,504	25,439	25,206	25,155
T4 - Rotary Till	25,860	24,089	26,717	23,697*	25,091
T5 - Chisel	27,878	20,996	26,891	24,393	25,039
T6 - Slot Plant	27,588	21,141	27,472	22,970	24,793
Average	28,078	22,269	27,287	24,504	25,534

* Rep 1 only, Reps 2 and 3 had seed coverage problem.

Table 3. Relative volunteer corn ratings* taken on May 22, 1978, Tillage Study. University of Nebraska South Central Station.

Treatment	Rep 1	Rep 2	Rep 3	Mean
T1 - Disk and List	3	3	3	3
T2 - Disk and Surface Plant	3	3	3	3
T3 - Till Plant	0	0	0	0
T4 - Rotary Till	3	5	5	4.33
T5 - Chisel	3	3	3	3
T6 - Slot Plant	0	0	0	0

* Ratings are 0-5 where 5 is high and 0 means no observed volunteer.

Table 4. Soil temperature (°F) at planting time--taken at 4" depth in row. Tillage Study. University of Nebraska South Central Station.

Treatment	1977	1978	1979	3-Year Average
T1 - Disk and List	66.0	59.3	59.3	61.5
T2 - Disk and Surface Plant	69.0	58.0	63.7	63.6
T3 - Till Plant	66.0	59.0	62.3	62.4
T4 - Rotary Till	70.0	56.0	64.7	63.6
T5 - Chisel, Disk & Plant	67.7	55.0	63.7	62.1
T6 - Slot Plant*	74.0*	57.5*	71.0*	67.5*
Average	68.8	57.5	64.1	63.5

* Soil temperature at planting time for the slot-plant system are usually higher because this treatment was planted later in the day than the other treatments.

Table 5. Percent soil moisture at planting time--top 6" in the row. Tillage Study. University of Nebraska South Central Station.

Treatment	1977	1978	1979	3-Year Average
T1 - Disk and List	25.1	33.0	25.4	27.8
T2 - Disk and Surface Plant	22.7	33.2	22.7	26.2
T3 - Till Plant	26.2	33.9	24.1	28.1
T4 - Rotary Till	24.3	34.1	24.3	27.6
T5 - Chisel	24.6	33.4	25.9	28.0
T6 - Slot Plant	23.0	32.8	24.2	26.7
Average	24.3	33.4	24.4	27.4

Table 6. Percent cover of soil surface by crop residue, Tillage Study. University of Nebraska South Central Station.

Treatment	Prior to Planting (and final disking)	After Planting May 23, 1979	After Hilling July 9, 1979
T1 - Disk and List	20	6.9	2.7
T2 - Disk & Surface Plant	24	15	4.0
T3 - Till Plant	58	22	17
T4 - Rotary Till	55	19	19
T5 - Chisel and Plant	31	12	3.1
T6 - Slot Plant	72	49	24

Table 7. Average net infiltration during irrigation for various tillage systems, Tillage Study. University of Nebraska South Central Station.

Treatment	Irr. 2 7/7/77	Irr. 3 7/21/77	Irr. 4 8/1/77	Irr. 2 7/18/78	Irr. 3 8/1/78	Avg.
T1 - Disk and List	1.9	1.9	1.8	1.4	1.6	1.7
T2 - Disk and Surface Plant	2.6	1.6	1.2	1.6	1.5	1.7
T3 - Till Plant	1.9	1.7	1.5	1.6	1.5	1.6
T4 - Rotary Till	2.6	2.0	2.1	1.6	1.7	2.0
T5 - Chisel and Plant	2.7	1.6	1.5	1.8	1.7	1.9
T6 - Slot Plant	2.7	2.1	2.3	1.4	1.6	2.0
Average	2.4	1.8	1.7	1.6	1.6	1.8

Table 8. Incidence of stalk rot in tillage study. South Central Station.

Treatment	% Stalk Rot			
	1976	1978	1979	3-Year Avg.
T1 - Disk and List	26	47	5.3	26
T2 - Disk and Surface Plant	16	28	26	23
T3 - Till Plant	21	21	16	19
T4 - Rotary Till	13	34	8	18
T5 - Chisel and Plant	18	37	17	24
T6 - Slot Plant	16	36	10	21

Table 9. Corn grain yields (bu/ac @ 15.5%) for tillage study. University of Nebraska South Central Station.

Treatment	1976	1977*	1978	1979	4-Year Average
T1 - Disk and List	181	133	187	171	168
T2 - Disk and Surface Plant	181	137	185	163	167
T3 - Till Plant	179	121	188	164	163
T4 - Rotary Till	177	128	188	159	163
T5 - Chisel & Surface Plant	180	130	183	157	163
T6 - Slot Plant	185	122	183	161	163
	n.s.	n.s.	n.s.	n.s.	

n.s. -- No significant difference between mean yields.

* -- Hail damage on September 11.

Table 10. Estimated production costs for various tillage systems, Tillage Study. University of Nebraska South Central Station.

Treatment	Year			3-Year Average
	1976	1977	1978	
T1 - Disk and List	306	317	317	313
T2 - Disk and Surface Plant	306	316	317	313
T3 - Till Plant	298	307	308	304
T4 - Rotary Till	301	313	313	309
T5 - Chisel and Plant	310	320	320	317
T6 - Slot Plant	311	319	307*	312

* Paraquat was not used on this treatment in 1978.

Table 11. Energy requirements for field operations for each tillage system*, Tillage Study. University of Nebraska South Central Station.

Tréatment	Diesel Fuel Requiremnt (gal/ac)
T1 - Disk and List	5.86
T2 - Disk and Surface Plant	5.83
T3 - Till Plant	3.99
T4 - Rotary Till	4.97
T5 - Chisel and Plant	6.88
T6 - Slot Plant	3.99

* Based on operations listed in Table 1 and data from "Fuel Use Survey and Energy Management and Conservation for Production in Agriculture in Nebraska," Agricultural Engineering Report No. 3. University of Nebraska-Lincoln, May, 1979.

Energy requirements for individual operations based on data from the reference above are shown below:

Operation	Diesel Fuel Requirement (gal/ac)
Shred stalks	0.55
Tandem disk	0.74
Chisel plow	1.05
Apply anhydrous	0.60
Spike harrow	0.28
Plant - surface	0.52
- list	0.55
- till	0.44
- rotary till	1.42
Spray	0.23
Cultivate	0.43
Hill	0.49
Combine	1.25

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

G. W. Rehm

Objective:

The rapid rise in energy costs as well as the renewed interest in soil erosion have stimulated farmer interest in tillage systems appropriate for corn production on the silt loam soil of northeast Nebraska. Part research in Nebraska as well as throughout the Corn Belt shows that tillage system should be matched to soil texture. This study is designed to evaluate three tillage systems which may be used for continuous corn production on silt loam soils.

Procedure:

This study was initiated in the fall of 1976 and continued through the 1979 growing season. Three tillage systems were compared. These were: 1) fall chisel, 2) spring plow and 3) tillplant. Nitrogen at rates recommended from a soil test was applied as 82-0-0 before planting. The recommended rate of P_2O_5 was applied below the seed at planting as 10-34-0. Recommended herbicides and insecticides were used throughout the study. The planted population was approximately 17,700 plants per acre each year.

Results and Discussion:

Tillage system had no significant effect on yield throughout the study (Table 1). These observations are in general agreement with much of the other tillage research conducted in the western Corn Belt. In general, this research has shown that the use of reduced tillage systems on silt loam soils has not reduced corn yields. Although yields varied among systems each year, the three-year averages show that yields for the three tillage systems were nearly equal.

The plant population at harvest also varied from year to year (Table 2). Tillage system, however, had no significant effect on the plant population at harvest throughout the study.

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

Tillage System	Year			
	1977	1978	1979	Ave.
	- - - - - - - - - - - bu./acre - - - - - - - - - - -			
tillplant	123.4 a	114.9 a	129.3 a	122.5
fall chisel	124.1 a	108.3 a	133.4 a	121.9
spring plow	133.7 a	107.7 a	122.5 a	121.3

Table 2. Effect of tillage systems on the plant population at harvest of corn grown on a silt loam soil. Northeast Station.

Tillage System	Year			
	1977	1978	1979	Ave.
	- - - - - - - - - - plants/acre - - - - - - - - - -			
tillplant	14,375	15,246	16,662	15,428
fall chisel	14,810	14,375	16,008	15,064
spring plow	15,464	13,068	15,246	14,593

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 tillage techniques.

Procedure:

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

A sandy site was selected in Pierce County. After application of glyphosate, intermediate wheatgrass was seeded with the John Deere Powr-Till drill in the fall of 1976. Rates of N (0, 40, 80, 120, 160 lb./acre) with rates of P (0, 12, 24, 36, 48 lb./acre) were broadcast to the established stand in mid-April of both 1978 and 1979. Forage yields were measured in mid-June.

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

Results and Discussion:

Yield of both grass-legume mixtures in Knox County was increased by the application of N (Table 1). Addition of fertilizer P increased the yield of the bromegrass-cicer milkvetch mixture but had no effect on the yield of the intermediate wheatgrass-cicer milkvetch combination (Table 2).

The yield of the intermediate wheatgrass seeded with reduced tillage techniques in Pierce County was increased by the use of both N and P (Table 3). The response to N was linear while the response to P was curvilinear. In 1979, the rate of 24 lb. P/acre produced maximum yield. There was a significant N-P interaction in 1979.

The production of both intermediate wheatgrass and switchgrass at the Dixon County site was increased by both N and P (Table 4). The interaction between N and P was significant in all cases. When yields from all treatments are considered, the method of seedbed preparation had no effect on the yield of either intermediate wheatgrass (t = 1.705) or switchgrass (t = 1.045).

Table 1. Effect of rate of nitrogen on the production of grass-legume mixtures seeded with reduced tillage techniques. Knox County. 1979.

	Mixture	
N Applied	Bromegrass + Cicer Milkvetch	Intermediate wheatgrass + Cicer Milkvetch
lb./acre	ton dry matter/acre	
0	.96 a	2.20 a
40	1.68 b	2.48 b
80	2.04 bc	2.69 c
120	2.25 c	3.08 d

Table 2. Effect of rate of phosphorus on the production of grass-legume mixtures seeded with reduced tillage techniques. Knox County. 1979.

	Mixture	
P Applied	Bromegrass + Cicer Milkvetch	Intermediate wheatgrass + Cicer Milkvetch
lb./acre	ton dry matter/acre	
0	1.33 a	2.32 a
40	1.96 b	2.76 a
80	1.91 b	2.76 a

Table 3. Effect of rate of N and P on yield of intermediate wheatgrass seeded with reduced tillage techniques. Pierce County. 1979.

	N Applied (lb./acre)				
P Applied	0	40	80	120	160
lb./acre	ton dry matter/acre				
0	.39	.38	.60	1.06	1.75
12	1.45	1.53	1.84	2.38	3.17
24	1.88	2.05	2.45	3.08	3.95
36	1.69	1.94	2.43	3.15	4.11
48	.87	1.21	1.79	2.60	3.65

Table 4. Effect of rate of N and P on yield of intermediate wheatgrass and switchgrass seeded with conventional and reduced tillage techniques. Dixon County. 1979.

Fertilizer Applied		Species and Seeding Method			
		Intermediate Wheatgrass		Switchgrass	
N	P	Conventional	Reduced	Conventional	Reduced
lb./acre		- - - - - - - - - -ton dry matter/acre- - - - - - - - -			
0	0	.54	.24	1.11	2.42
0	20	.62	.23	2.29	2.53
0	40	.67	.44	2.32	3.10
40	0	.87	.64	2.47	2.74
40	20	1.69	1.38	3.15	3.20
40	40	1.91	1.26	3.97	2.98
80	0	1.16	.81	1.75	2.74
80	20	2.21	2.13	4.29	3.83
80	40	2.53	1.77	3.83	3.90
120	0	1.12	.97	2.00	3.90
120	20	2.49	2.09	4.08	4.05
120	40	2.77	2.62	4.93	4.01

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 chosen as a 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.

The data are shown in the following tables with their accompanying descriptions.

Table 1: Compaction effects where no plowing or chiseling was used.

Compaction	Root Yield	Sucrose	Sucrose Yield	Continous Infil.
None	25.0 T/A	15.3%	7618 #/A	.13 in/hr
Noble Blade	23.2	15.6	7217	.41
Sheeps Foot	5.2	15.1	1990	.00
Truck Tracks	15.7	15.7	4911	.00

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 an equal infiltration problem but a much higher yield. Stand reductions occurred with the sheep foot treatment because of large clod formation, thereby reducing yields.

Table 2: The effect of plowing without chiseling.

Compaction	Plowing (No Chiseling)	Root Yield	Sucrose	Sucrose Yield	Continous Infil.
None	Yes	25.3 T/A	14.6%	7349 #/A	.47 in/hr
	No	25.0	15.3	7618	.13
Noble Blade	Yes	20.4	15.0	6143	.69
	No	23.2	15.6	7217	.41
Sheeps Foot	Yes	16.0	14.5	4630	1.17
	No	5.3	15.1	1990	.00
Truck Tracks	Yes	20.3	15.2	6200	1.56
	No	15.7	15.7	4911	.00

One of the original hypotheses was that plowing alone was a very good compaction correction implement. These data bear that out in the yield and water infiltration results. Note that plowing the truck and sheep foot compacted plots resulted in higher infiltration rates than plowing non-compacted soil. This is due to the very large clods created in the plowing of these compacted soils. With the larger clods the surface pores were much larger and remained open to allow continous rapid infiltration.

Table 3: The effect of chiseling without plowing.

Compaction	Chiseling (No Plowing)	Root Yield	Sucrose	Sucrose Yield	Continous Infil.
None	Yes	21.7 T/A	15.4%	6849 #/A	.35 in/hr
	No	25.0	15.3	7618	.13
Noble Blade	Yes	22.1	15.9	7027	.44
	No	23.2	15.6	7217	.41
Sheeps Foot	Yes	6.8	14.1	1948	.68
	No	5.2	15.1	1990	.00
Truck Tracks	Yes	18.6	14.1	5256	.30
	No	15.7	15.7	4911	.00

Chiseling was not capable of removing compaction problems to the same degree as plowing. This can be seen by comparing Tables 2 and 3. For example Plowing the Sheep's Foot compacted soil increased sugar yield 2640 #/A while chiseling only, did not change it at all. Plowing also improved infiltration more than chiseling.

Table 4: The effect of chiseling with plowing.

Compaction	Chiseling (Plowed)	Root Yield	Sucrose	Sucrose Yield	Continous Infil.
None	Yes	24.5 T/A	15.2%	7444 #/A	.92 in/hr
	No	25.3	14.6	7349	.47
Noble Blade	Yes	21.4	15.3	6574	1.11
	No	20.4	15.0	6143	.69
Sheeps Foot	Yes	18.0	15.1	5396	1.80
	No	16.0	14.5	4630	1.17
Trucks Tracks	Yes	19.8	15.2	5981	2.02
	No	20.3	15.2	6200	1.56

A second hypothesis was that chiseling would provide little added benefit if the soil were plowed. This hypothesis was supported by the data in Table 4 except in the severely compacted sheep's foot treatment where chiseling caused an increase of 766 #/A of sugar over and above the increase due to plowing alone. The very high infiltration rates in the plowed and chiseled sheep's foot and truck compacted treatments were due to the "cloddiness" created by the combination of the operations. The large surface pores remained open even after five hours of water infiltration. Cultivations later in the season may have decreased this clod size and reduced infiltrations. We have no further information regarding this point.

INFLUENCE OF TILLAGE METHODS ON SOIL CHEMICAL PROPERTIES

J.S. Schepers and W.W. Wilhelm
(USDA-SEA-AR)

Objective:

The interest in labor and energy saving tillage systems has lead to a wide variety of reduced tillage options. These new systems are often unacceptable due to a lack of consistent and predictable yield responses. The failure of such tillage systems is frequently attributed to some mechanical or physical phenomena; however, the problems may also be associated with the modified management which results in a chemical change in the soil profile. Therefore, this study was conducted to examine changes in the chemical properties of the surface soil due to modified-tillage systems.

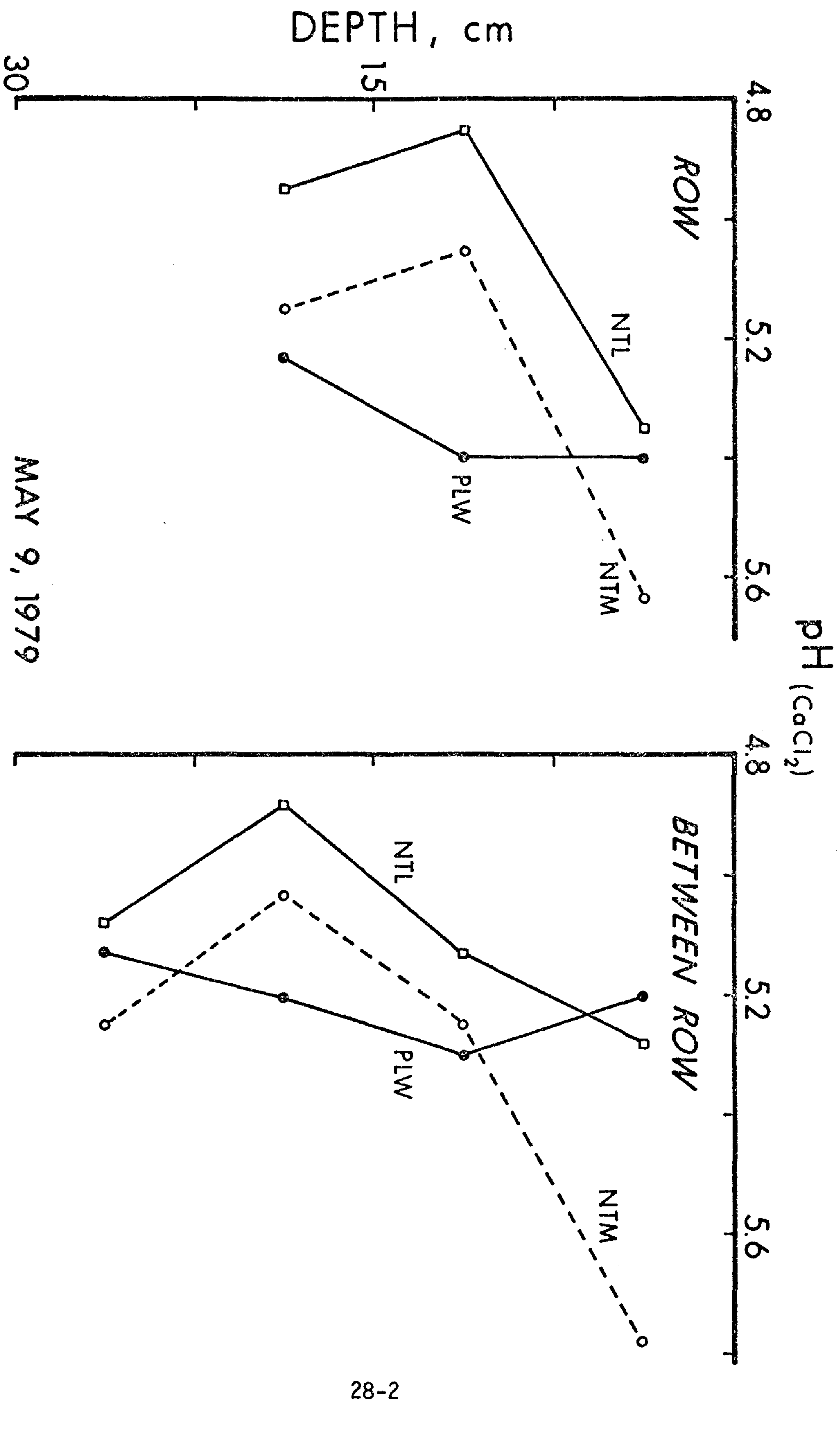
Procedure:

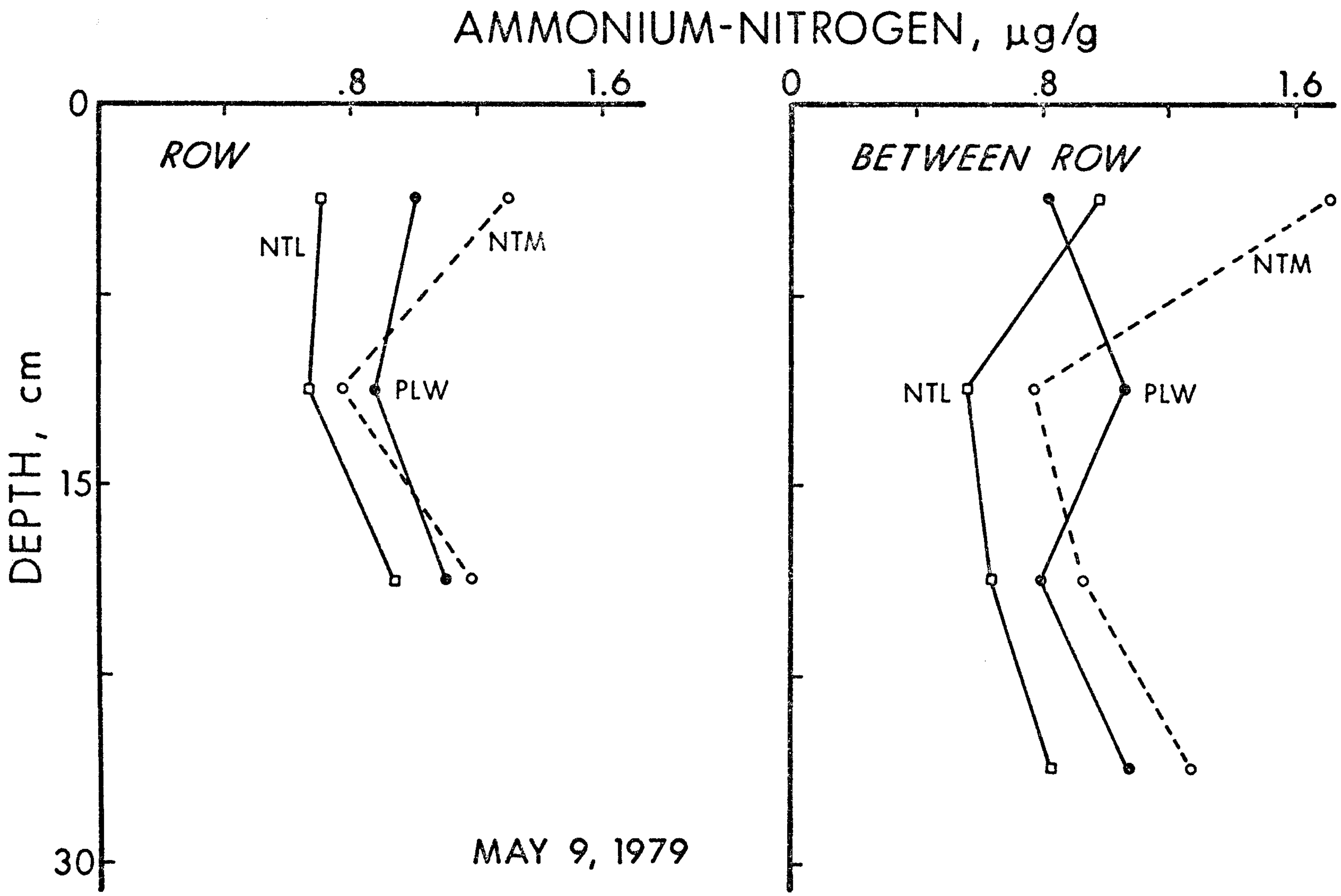
This study was initiated in 1975 on the Agronomy Farm at Lincoln. Rainfall during the first 3 years was below normal, therefore yields of the dry land corn were low and establishment of a reasonable level of crop residue was not realized until 1978. Tillage treatments included plowing plus double disking, double disking, chiseling plus disking, till planting (no-till), double disking plus manure and till planting plus manure. Subplots were established having 0, 70 and 140 Kg N/ha applied as NH_4NO_3. Fertilizer was applied prior to the last disk operation in each tillage treatment, but was not incorporated in the till-plant treatments. Samples of the surface soil were collected in the spring and fall from the within and between row areas in 7.5 cm increments. Soil samples were analyzed for NO_3-N, NH_4-N and pH.

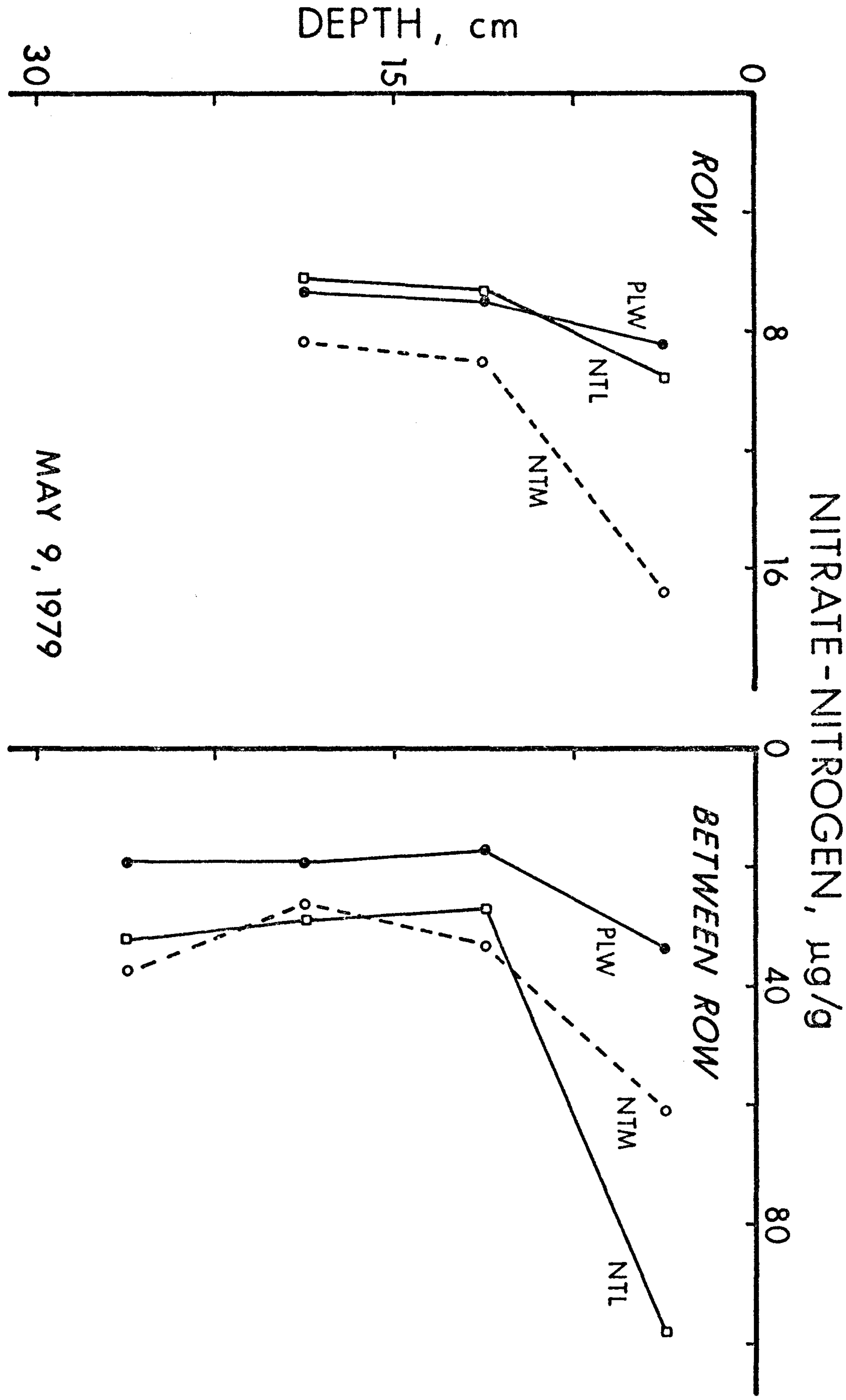
Results and Discussion:

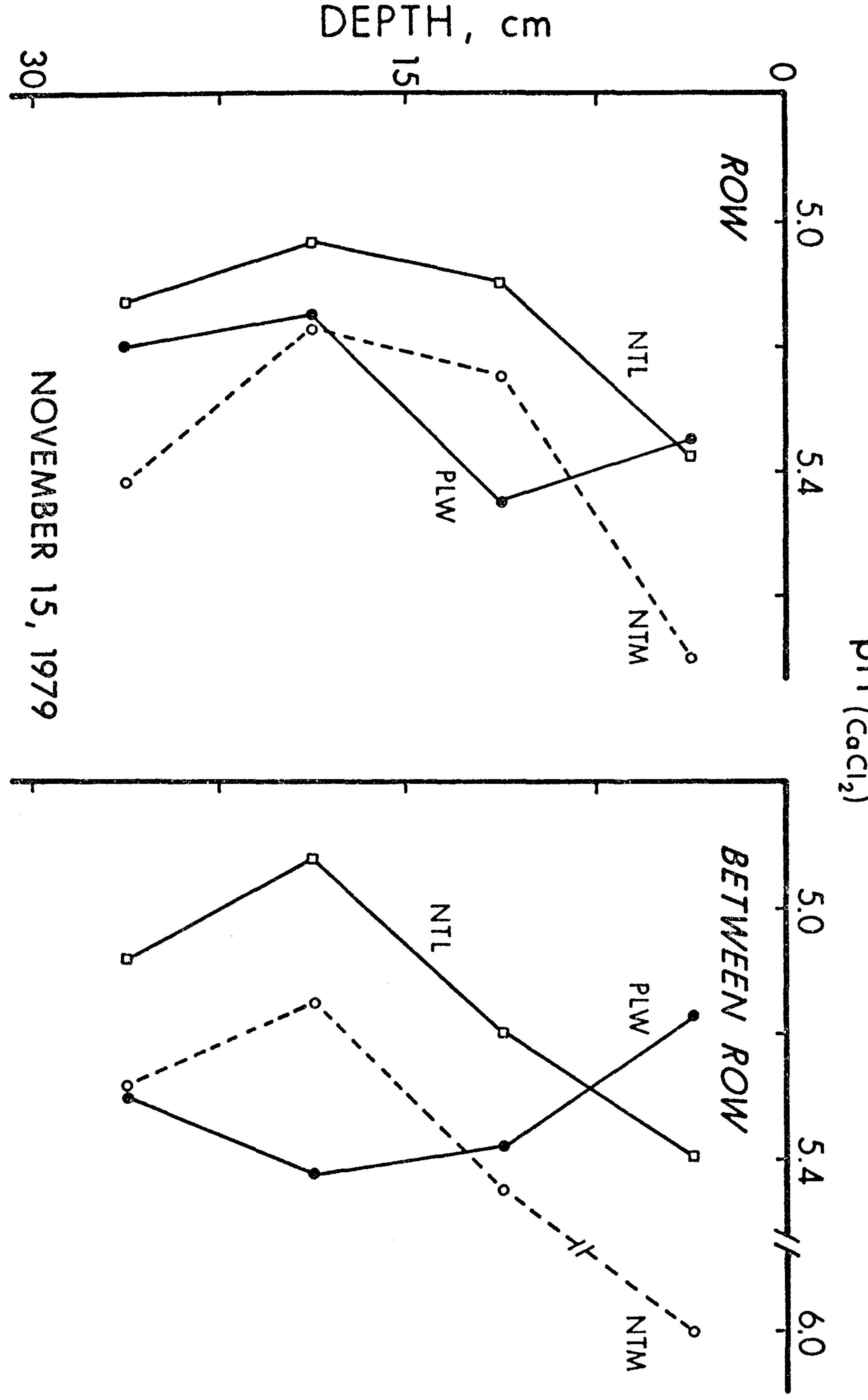
Average corn yield was 6133 Kg/ha (98 bu/A) in 1979. Yield from the plow treatment (4689 Kg/ha) was significantly lower than the other treatments due to problems with seedling establishment. When the plow treatment was removed from the comparison, there was no significant difference in yield due to tillage treatment; however, the 70 Kg/ha N rate resulted in a significantly higher yield (6777 Kg/ha) than the 0 or 140 Kg/ha N rate. The tillage X N rate interaction was not significant for yield.

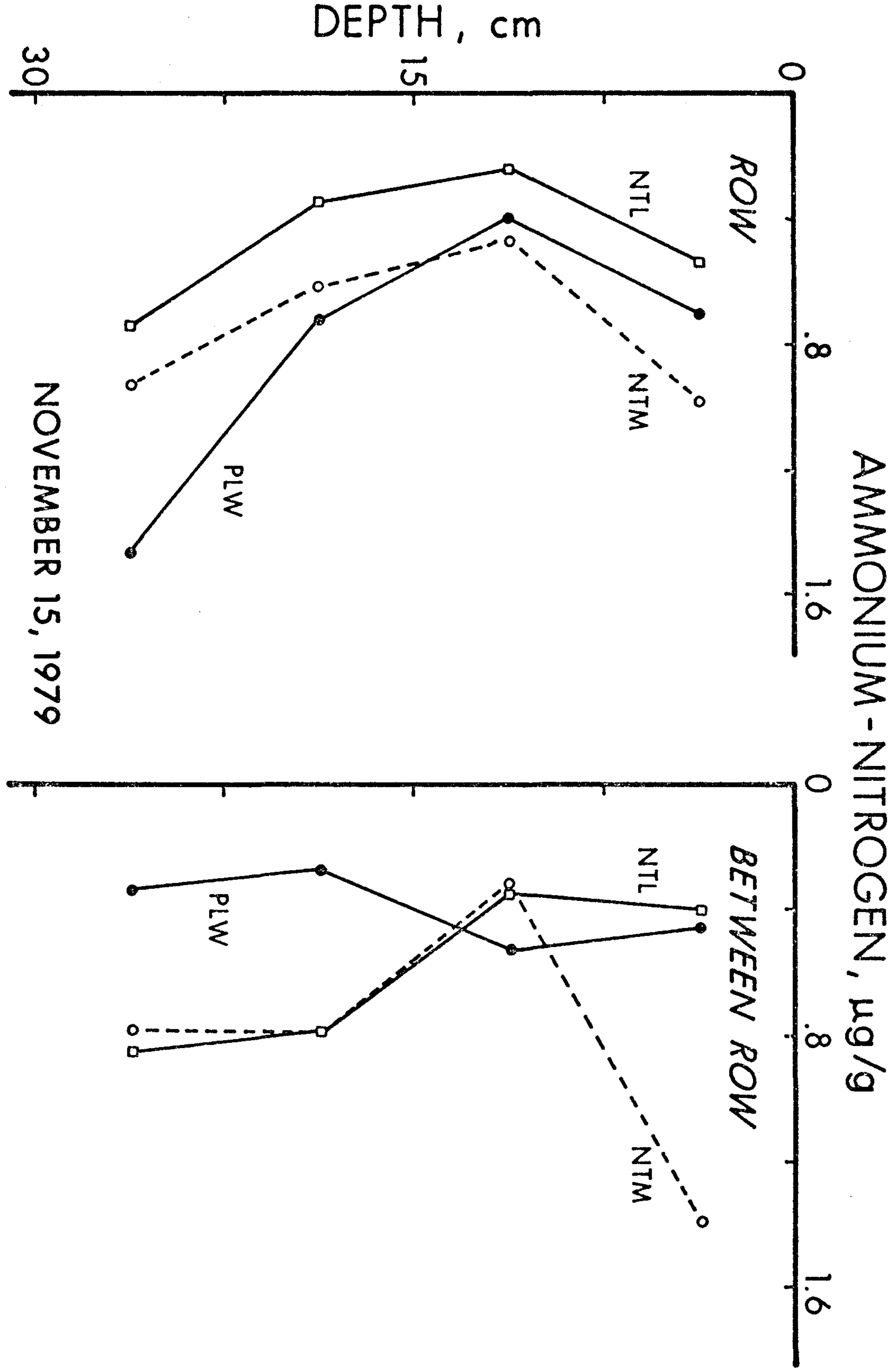
Nitrate and ammonium concentrations and pH values within the surface 7.5 cm of soil were usually significantly greater for the till plant plus manure treatment. At deeper depths, differences were usually not significant except in the case of pH. The plow (PLW) treatment showed the least variation in NO_3-N, NH_4-N and pH with depth while the till plant (NTL) and till plant plus manure (NTM) treatments had the greatest variation. Data shown below are limited to these three treatments fertilized at the 70 Kg/ha N rate.


DEPTH, cm
30
15
4.8
5.2
5.6
pH (CaCl2)
ROW
BETWEEN ROW
NTL
NTM
PLW
MAY 9, 1979

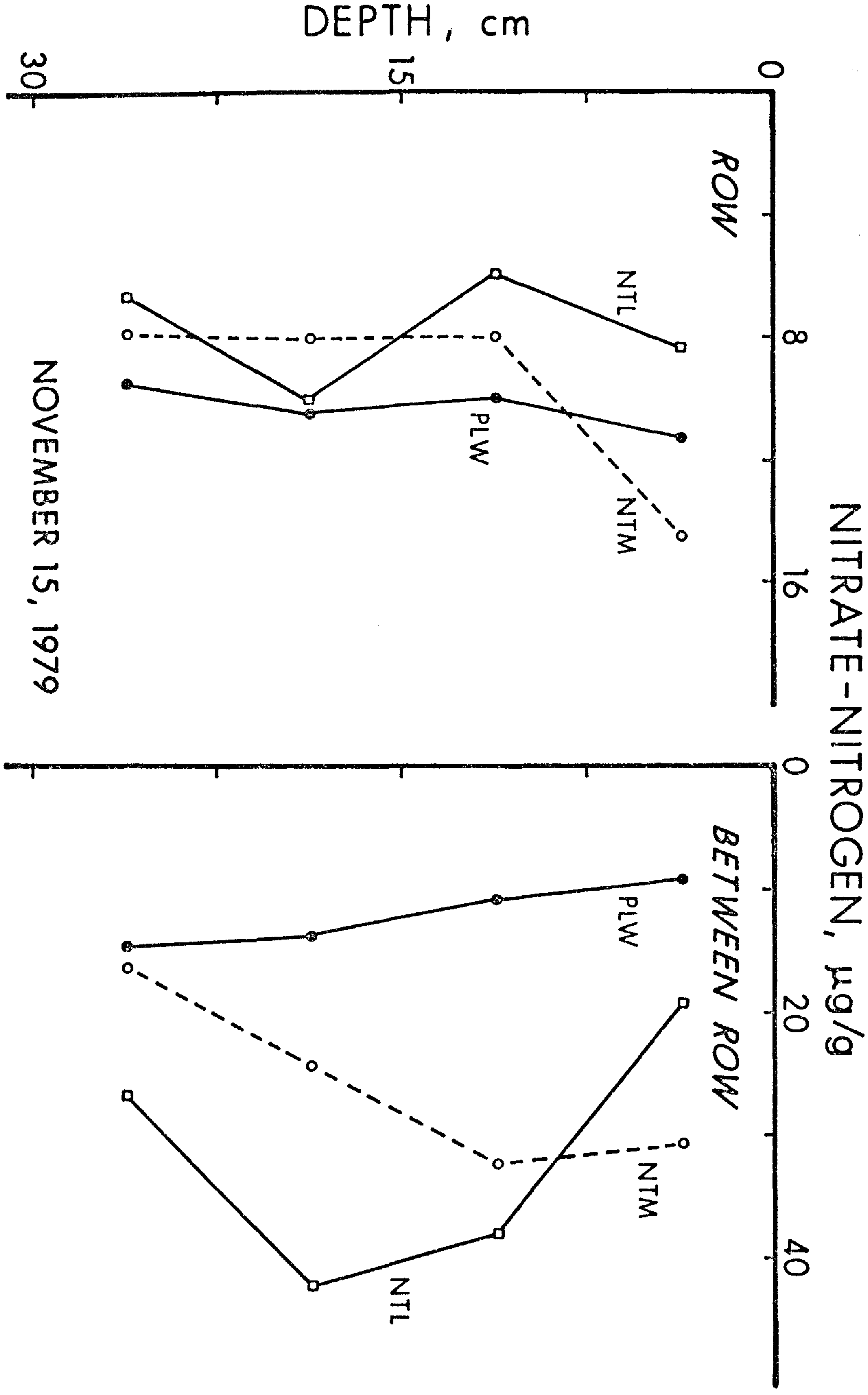

AMMONIUM-NITROGEN, µg/g
DEPTH, cm
0
15
30
.8
1.6
ROW
BETWEEN ROW
NTL
NTM
PLW
NTL
NTM
PLW
MAY 9, 1979


DEPTH, cm
NITRATE-NITROGEN, µg/g
ROW
BETWEEN ROW
PLW
NTL
NTM
PLW
NTM
NTL
0
15
30
0
8
16
0
40
80
MAY 9, 1979


DEPTH, cm
0
15
30
pH (CaCl$_2$)
5.0
5.4
6.0
ROW
BETWEEN ROW
NTL
PLW
NTM
NOVEMBER 15, 1979



DEPTH , cm
0
15
30
AMMONIUM-NITROGEN, µg/g
.8
1.6
ROW
BETWEEN ROW
NTL
NTM
PLW
NOVEMBER 15, 1979


NITRATE-NITROGEN, µg/g
DEPTH, cm
0
8
16
20
40
15
30
ROW
BETWEEN ROW
NTL
NTM
PLW
NOVEMBER 15, 1979

DIFFERENCES IN SOIL N BETWEEN NO-TILL AND PLOWING AS RELATED TO SOIL MICROBIAL POPULATIONS

J.W. Doran (USDA-SEA-AR)

Objective:

Reduced tillage of soil decreases soil erosion, conserves water for greater crop production, and reduces petroleum fuel and labor inputs. Soils managed with reduced or no-tillage are generally wetter, cooler, and more compact than plowed soils. Plowed soils usually have higher rates of N mineralization and NO_3^--N levels than no-till soils. The objective of the present study was to compare the microbial and biochemical environments in no-till and plowed soils to aid predictions of N availability to crop plants with reduced tillage.

Procedure:

Surface soils from long-term (3 to 10 yrs) no-till and conventional tillage plots at seven U.S. locations were characterized for microbial and biochemical components. The seven locations represented a range in climatic, soil, and cropping systems. Soil samples were taken once, at depths of 0 to 7.5, 7.5 to 15, and 15 to 30 cm, at each location either during June or July of 1978. The time of sampling occurred during the crop growing season and at least one month after primary tillage. Microbial analysis were made on fresh soils and potentially mineralizable N was determined using the autoclave method on soil which had been stored at -18°C until analysis.

Results and Discussion:

The changes in microbial numbers and the relative predominance of certain microorganism with tillage practices are shown in Table 1.

Table 1. Relative change in microbial populations between no-till and plow at two soil depths.*

Microbial Groups	Relative change (%) No-till versus plow	
	0 to 7.5 cm	7.5 to 15 cm
TOTAL AEROBES (Fungi + actinomycetes + bacteria)	+32	-27
AEROBIC NITRIFIERS (NH_4^+ & NO_3^- oxidizers)	+3	-51
FACULTATIVE ANAEROBES	+59	+18
DENITRIFIERS	+170	+92

*Averages changes for 7 U.S. locations.

The large increases in all microbial groups in the surface 0 to 7.5 cm of no-till is apparently related to an environment which is more compatable for microbial proliferation than plowed soils. This is related to the higher water content, and C and N levels in the surface of no-till soils. Deeper in the plow layer (7.5 to 15 cm), however, populations of aerobic microorganisms and nitrifiers with plowing are higher than no-tillage. This is a reflection of the greater availability of organic residues at this depth and better aeration resulting from plowing. The biological environment of no-till soils is less oxidative with depth than that for conventional tillage. Facultative anaerobes and denitrifying microorganisms not only occur in greater numbers for no-till soil but represent a larger proportion of the total microbial counts than in plowed soils.

The change in nitrogen availability with tillage is largely influenced by differences in soil microbial populations. Lower levels of nitrate-N are related to decreased nitrification and increased denitrification potentials in no-till as compared to plowed soils. More nitrogen fertilizer is often required with no-till soils to achieve yields comparable to those of plowed soils. This results from lower mineralization of organic N and a greater immobilization of surface applied fertilizers by higher populations of microorganisms present in the surface 0-7.5 cm of no-till soils. As shown in Figure 1 the surface 0 to 7.5 cm of no-till soils contained from 20 to 100 Kg/ha ($\sim$ 18 to 90 lbs/A) more potentially mineralizable N than plowed soils. Changes in tillage and fertilizer management practices for no-till soils should reflect the increased potential for immobilization of surface applied N and potentially lower levels of plant available NO_3^--N as compared to those of plowed soil.

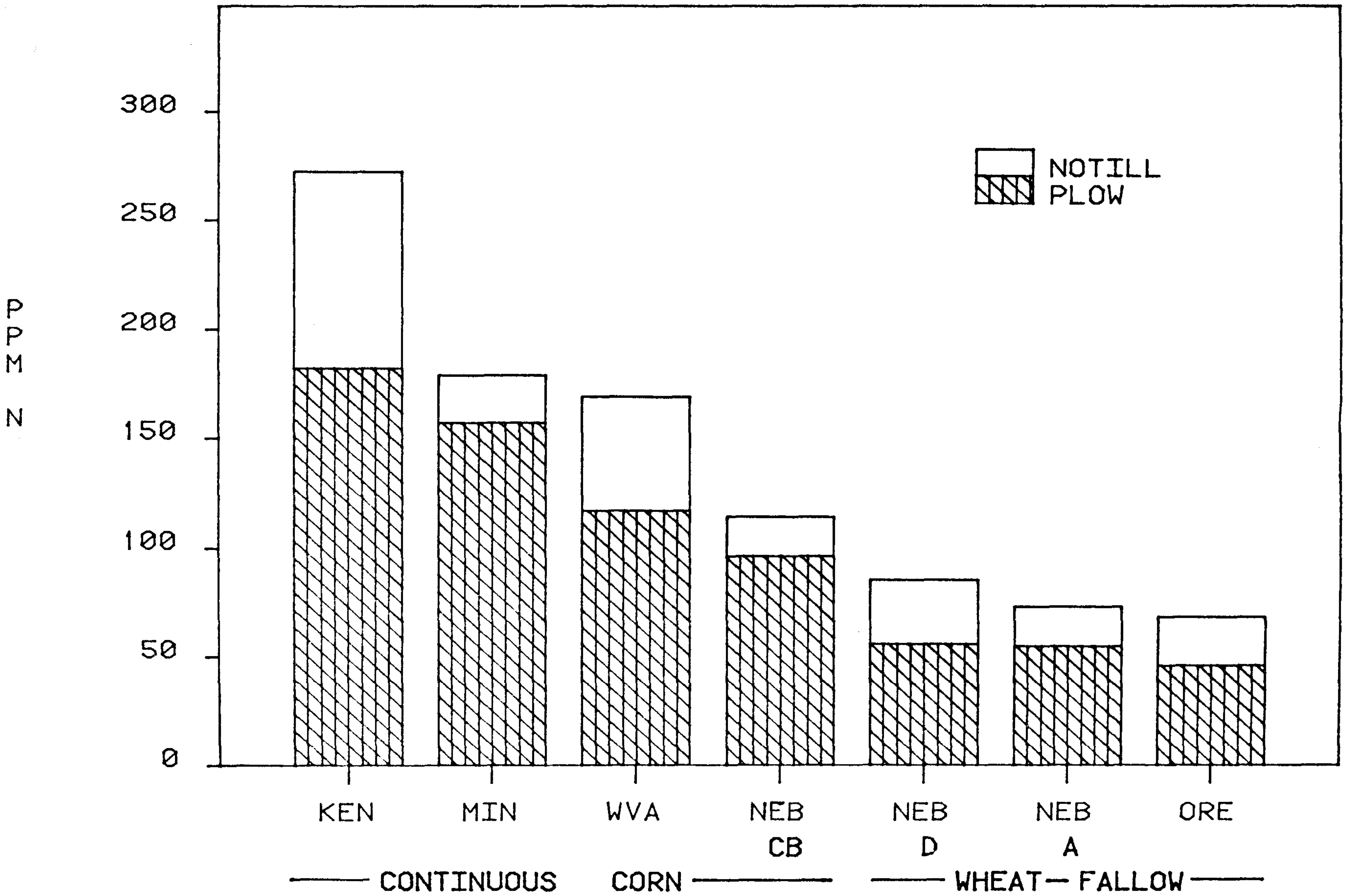


Figure 1. Potentially mineralizable N in the surface (0-7.5 cm) of no-till and plowed soils at 7 locations in the U.S.

CHEMICAL AND BACTERIOLOGICAL QUALITY OF RUNOFF FROM GRAZING LAND

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Objective:

The environmental impact of runoff from agricultural lands is ill-defined and is one of the most difficult problems to study due to the diversity of nonpoint source pollution. An estimated one-third of the water pollutants in the United States comes from such nonpoint sources. Animal wastes are often cited as a major source of pollution since over one-third of the land area in the Continental United States is used for grazing livestock. These same lands receive an estimated 50% of all livestock wastes (USDA Agricultural Statistics, 1977). The impact of livestock-grazing operations on the quality of runoff waters depends on many management and climatological factors, and thus is not well defined. The objective of this study was to evaluate the impact of a seasonal cow-calf grazing operation in south central Nebraska on the chemical and bacteriological quality of rainfall runoff water.

Procedures:

Runoff was collected, either automatically or manually, from a 40-ha cow-calf pasture located at the Roman L. Hruska U. S. Meat Animal Research Center near Clay Center in south central Nebraska. Since the 1940s, the watershed has been planted to a combination of warm- and cool-season grasses and was instrumented in 1975. The average annual precipitation for the area is 66 cm. Animal stocking rate (45 to 55 cow-calf pairs) and management practices were typical of a controlled-grazing system. Fertilizer was applied each spring at 67 kg N/ha as ammonium nitrate. A small, fenced, ungrazed area of 0.11 ha was used to represent an ungrazed pasture. The control area was clipped periodically to maintain vegetative cover similar to the main pasture area. The principal soil types are Crete (Pachic Argiustolls) and Hastings (Udic Argiustolls) silt loams. Most of the watershed ranges in slope from 0 to 3%. Small areas adjacent to the grassed drainageway range in slope from 3 to 11%.

Results and Discussion:

Little runoff occurred in 1976 because the previous 2 years were relatively dry, and the rainfalls were numerous but small in intensity and amount. However, 1977 was a very wet year with several high-intensity rainfall events. Most of the runoff from the pasture area occurred during 1977.

Table 1. Total precipitation, runoff, and animal stocking rates for 1976 through 1978.

Year	Total precipitation (mm)	Total runoff (mm)		Animal stocking (AUM)*
		Grazed pasture	Control area	
1976	561	0.21	0	44
1977	1,020	105.37	121.22	42
1978	567	36.74	17.17	57

*Animal unit months for the entire pasture area (36 ha).

Runoff samples were automatically collected from 12 events while livestock were grazing and from 10 while they were not grazing. Since fertilizers can serve as a potential pollutant of streams and rivers if runoff occurs shortly after application, data from one runoff event while livestock were grazing and occurring 1 day after spring fertilization were not included in the formulation of Table 1. In these samples, nitrate nitrogen (NO_3-N) and ammonium nitrogen (NH_4^+-N) concentrations were unusually high and reached 12 and 6 µg/ml, respectively, from the grazed area, but 26 and 10 µg/ml, respectively, from the control area. Existing water-quality standards recommend an upper limit of 10 µg/ml NO_3-N in drinking water.

The concentrations of sediment and most chemical constituents were greater in the runoff water collected while the cattle were grazing, as compared to when they were not grazing (Table 2); however, the total Kjeldahl nitrogen (TKN) concentrations were lower. Examination of data from individual runoff events suggests the quality of runoff water from grazing land may be influenced to a large extent by season of the year, rainfall intensity, and water content in the soil at the time of rainfall. Runoff from the small, ungrazed, control area had higher concentrations of all measured parameters than did that from the grazed area with livestock present. These increased concentrations could have been caused by differences in hydrology between the two areas, as indicated by the fewer number of runoff events but similar depth of total discharge. However, bacteriological analyses indicated that animal wildlife of ungrazed areas have a significant impact on runoff water quality.

Table 2. Chemical characteristics of runoff from a pasture with and without grazing livestock at the time of runoff and ungrazed control area (1976-1978)*.

Parameter	Off	On	Ungrazed control
	-----------µg/ml-----------		
NH_4N	.31	.33	.63
NO_3-N	.29	.42	3.31
TKN	4.11	3.33	9.20
Sol-P	.54	.80	4.15
Total P	.92	1.26	4.72
TOC	19.7	21.9	44.9
COD	46.3	49.4	117.1
Cl^-	1.86	3.32	6.05
Total solids	118.0	179.0	181.9
Events (No.)	11	12	7
Total runoff (cm)†	4.54	4.74	9.36
Precipitation (cm)†	36.69	43.69	32.69
Percent runoff	12.4	10.8	28.6

*Chemical concentrations represent the average concentration weighted proportionately to the volume of discharge from each runoff event.
†Precipitation and percent runoff are based only on precipitation received from those events resulting in runoff.

Fecal coliform counts in rainfall runoff from the grazed pasture were tenfold higher than those in runoff from the ungrazed control (Table 2). However, the FC counts in over 95% of the runoff events from both areas exceeded the recommended water-quality standard (200 organisms/100 ml). The FS counts in runoff from the ungrazed pasture, unlike those for FC, were threefold higher than those from the grazed pasture. This implies a greater relative contribution from wildlife for the ungrazed area, since the relative proportion of FS in wildlife feces is higher than that of cattle, whereas FC counts are generally lower. The FC/FS ratios in runoff from the grazed and ungrazed areas averaged 0.401 and 0.015, respectively, which confirmed our conclusions that the fecal organisms in runoff from the unstocked grassland area originated from wildlife.

Table 3. Bacteriological water quality indicators in rainfall runoff from pasture for 1976 to 1978.

Indicator	Runoff sampling area	
	Grazed pasture	Ungrazed control
Fecal coliforms*	121,000	11,000
Fecal streptococci*	360,000	1,061,000
FC/FS ratio	0.401	0.015

*Bacterial counts expressed as organisms per 100 ml. Values represent means for the 3-year period.

The relatively high impact of wildlife on the bacteriological quality of runoff from grassland was confirmed by data collected during 1979. Cattle were kept off the pasture area during 1979. As shown in Table 4, there was very little difference between FC counts in runoff samples from either the unstocked grazing pasture or the ungrazed control area. However, the average FC counts from both areas still exceeded the recommended water-quality standard (200 organisms/100 ml). Counts of FS were higher in the ungrazed control area. The FC/FS ratio in runoff from both areas was very similar and was characteristic (0.03) of the ratio for wildlife feces.

Table 4. Bacteriological water quality indicators in rainfall runoff from pasture for 1979*.

Indicator	Runoff sampling area	
	Ungrazed pasture	Ungrazed control
Fecal coliforms†	1,160	1,390
Fecal streptococci†	49,000	79,000
FC/FS ratio	0.030	0.025

*No livestock on pasture since fall of 1978.
†Bacterial counts expressed as organisms per 100 ml. Values represent arithmetic means for 1979.

Summary

Water quality of runoff from pastureland was lower while livestock were grazing than when they were not grazing, but NO_3-N concentrations did not exceed recommended water-quality standards, except when runoff occurred shortly after fertilization. Concentrations of all measured chemical components in runoff from an ungrazed control area were higher than those from a grazed pasture and were attributed in part to the increased wildlife activity within the control area.

The FC counts in rainfall runoff from grazed pasture were increased by livestock and generally exceed recommended water-quality standards; however, FC counts in runoff from ungrazed areas also exceed these standards. Analyses of specific bacteriological indicators in runoff water suggest a relatively large background contribution from wildlife. Thus, the recommended bacteriological water-quality standards, developed for point source pollution, seem inappropriate for characterizing nonpoint source pollution from pasture runoff.