1970

SOIL PLANT NUTRIENT RESEARCH REPORT

compiled by

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Printed April, 1971

Saskatchewan Institute
of Pedology Report No. M18

ACKNOWLEDGEMENTS

This report is a summary of field research conducted during 1970 by the staff of the Department of Soil Science, University of Saskatchewan, Saskatoon.

The valuable assistance of Mr. D. MacKenzie, Mr. D. Ehman and Mr. B. Whaley, who were responsible for the major portion of field and laboratory work, is acknowledged. Mr. D. Holben of the Saskatchewan Soil Testing Laboratory, University of Saskatchewan, Saskatoon performed the protein analyses.

Studies on irrigated plots were carried out on lands in the South Saskatchewan River Irrigation Project. The cooperation and assistance of Messrs. A. Hutcheon, G. Hart, V. Davies, and A. Bristol of the Conservation and Development Branch, Saskatchewan Department of Agriculture, and Mr. L. Sonmor of the Canada Department of Agriculture is appreciated.

Valuable criticisms and suggestions by Mr. J.L. Henry are acknowledged and appreciated.

The excellent cooperation of the many farmers, upon whose farms these experiments were conducted, is acknowledged. Without their participation this type of field experimentation would not be possible.

The financial assistance provided by Western Co-operative Fertilizers Limited, Sherritt Gordon Mines Limited and the Saskatchewan Agriculture Research Foundation is gratefully acknowledged. The support provided by the above mentioned agencies, together with funds from the research grants of individual staff members of the Department of Soil Science made this work possible.

Highlights of the 1970 Soil Fertility Research Program

Potassium

1. Barley yields were increased at rates up to 240 lb K_2O/acre for medium soil test values (121-180 lb K_2O/acre). Decreases in yield were experienced on fields testing high and very high in soil K when rates of fertilizer K were above 60 lb K_2O/acre.
2. Dryland alfalfa yields were increased by 30% due to residual sulfur from 1969 fertilization. Rye yields were increased by 8 bu/acre on a test fertilized with 240 lb K_2O/acre in 1968.

Irrigated Crops

1. Yield increases of up to 22 bu/acre were obtained by nitrogen fertilization of irrigated soft wheat, though overall yields were low. An average maximum increase of 10 bu/acre was obtained when fertilized with nitrogen at 75 lb N/acre. Percent protein was reduced by nitrogen fertilization at rates below 100 lb N/acre and increases were not obtained until fertilized at rates of 200 lb N/acre.
2. Small yield increases in irrigated alfalfa were obtained on plots fertilized with 90 lb P_2O_5/acre in 1969.

Nitrogen Sources and Placements

1. Urea was found to be equal to ammonium nitrate in supplying the crop's nitrogen needs when applied as a broadcast application. When placed with the seed, germination was restricted at rates in excess of 30 lb N/acre as urea and 40 lb N/acre as ammonium nitrate. Seed placement of nitrogen

did not result in yield increases when compared to broadcast applications at the same rate. Maximum yields were obtained at rates of 80 lb N/acre. Protein content was increased at N rates in excess of 40 lb/acre. Maximum protein content of 15% for Manitou and 13% for Pitic were obtained at N rates of 160 lb/acre. Moisture use was not substantially increased due to the increased growth and yield resulting from nitrogen fertilization.

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1.1 Potassium requirements of crops on potassium deficient soils.

INTRODUCTION

Previous experiments have established response curves for wheat and barley on soils testing in the low and very low range of available potassium. It was considered advisable to expand the knowledge on responses to additional potassium by including soils testing in the medium and high ranges of available potassium.

Although responses to additional potassium have been obtained by barley and wheat on potassium deficient soils, responses by rape have not been investigated. It was thought necessary, therefore, to include several trials in the 1970 program using rapeseed as the test crop.

EXPERIMENTAL METHODS

On the basis of known potassium status from previous years, three sites were selected in the medium to high range of available soil potassium using barley as the test crop and two sites in the low and very low range where rapeseed was the test crop.

The plots were the length of the field with six 12-foot treatments giving a width of 72 feet. Composite soil samples to a depth of 24 inches were taken across the width of the plot at each of 10 replicates. These samples were analyzed for nitrate nitrogen, available phosphorus and potassium, pH and conductivity.

RESULTS

The results of the yield determinations are presented in Table 1.1.1. On the Skogsrud plot, where the soil tested in the medium range of soil potassium, maximum yields were not attained (i.e. the last increment of added K resulted in further increases in yield) whereas on the two Ewanus plots testing in the high and very high range maximum yields were obtained at the 60 lb K_2O/acre rate (Figure 1.1.1). Statistical analyses showed significant variation due to treatment at the 1% level for the Skogsrud and Ewanus stubble plots and at the 5% level for the Ewanus summerfallow plot.

Table 1.1.1 Yield response of barley and rapeseed to potassium fertilization.

Farmer	Soil Type	Crop	Check[1] Yield (bu/A)	Yield increase (bu/A) 0-0-60 @ (lb/A)				Soil Test data[2]		
				50	100	200	400	N	P	K
Ewanus (Stubble)	Sy:vl	Barley	29.5	1.8	6.0	4.1	3.6	10	28	252
Ewanus (Fallow)	Sy:vl	Barley	45.5	4.3	12.2	7.2	5.3	28	25	311
Skogsrud (Fallow)	Sb:vl	Barley	32.6	2.0	3.1	8.1	11.6	34	12	136
Gentner	Cr:vl	Rapeseed	22.6	-1.5	0.1	0.8	1.8	118	14	72
Kozun	Cr:vl	Rapeseed	12.3	3.5	2.0	0.4	3.9	84	8	63

1. N and P added as 34-0-0 and 11-48-0 respectively at recommended rates on the basis of soil tests. Check yield is the average of 2 checks.

2. N as NO_3-N to 24 inches, P as available phosphorus to 6 inches, K as sodium bicarbonate extractable K to 6 inches.

The method of using the average of two checks as a single treatment in the statistical analyses was compared by randomly selecting one of the two checks at each replicate for purposes of analysis of variance. When analyzed this way, the yield increases at all sites were significant at the 5% level with respect to treatment variation.

The rapeseed plots did not reveal any trends toward responses as shown in Table 1. However, the Gentner plot was subjected to flooding due to heavy rains shortly after emergence and the Kozun plot was severely infested with weeds. To ensure success, a larger number of plots should be seeded to rape in the low and very low soil potassium soils.

CONCLUSIONS

On the basis of the three 1970 tests it would appear that barley grown on soils in the medium soil test range of available soil potassium would benefit from additions of fertilizer potassium. The current soil test recommendations do not recommend additional potassium at soil test values beyond 120 lb soil K/acre.

Considering the predominance of rapeseed as a crop in the potassium deficient soils of Saskatchewan, an intensive experiment on the potassium needs of rapeseed is necessary. Adequate data have not been previously obtained.

<u>Cereal Crops</u>

In 1968 a trial was conducted on a Carrot River soil[2] using wheat as the test crop (Gentner I in the above reference). Potassium was added at rates of 0, 100, 200 and 400 lbs of 0-0-60 per acre. In the autumn of 1969 rye was established and during the summer of 1970 visual response was evident. To determine the extent of this residual response, samples were removed and yields were determined for each treatment. Ten replicates were used down the length of the 1/2 mile test strip.

A yield increase of 8 bu/acre was obtained on the strip fertilized with 400 lbs 0-0-60 (200 lbs K)/acre (Table 1.2.2). Although the yield determinations substantiate the visual response observed during the summer, statistical analysis does not reveal any significant response due to treatment at the 5 percent level.

Table 1.2.2 Residual effect on rye of potassium fertilization.

Check Yield (bu/acre)	Yield Increase (bu/acre) to additional K at		
	50 lbs/acre	100 lbs/acre	200 lbs/acre
40.0	-3.1	2.2	8.5

[2] Henry, J.L., 1969. Soil Plant Nutrient Research Report Saskatchewan Institute of Pedology Report No. M11. Department of Soil Science, University of Saskatchewan, Saskatoon, Sask., Pp. 16-22.

nitrate-nitrogen, available phosphorus and potassium, pH and conductivity.

Fertilizer nitrogen was added by broadcasting ammonium nitrate (34-0-0) with a four-foot Gandy applicator. This was done several days after the crop had been seeded. Rates of 0, 25, 50, 75, 100 and 200 lbs N/acre were applied at each replicate. Phosphorus was added on all treatments with the seed at soil test recommendations. No potassium was required.

Two fifteen-foot rows were harvested from each treatment for yield determinations. Straw yields were determined by weighing the unthreshed sample and deducting the grain weight. No deliberate effort was made to cut the straw at a predetermined height but it is assumed in subsequent discussion that the operator would have cut all samples at approximately the same height. Therefore, the straw weights referred to in this report do not constitute the total above ground plant material and are used for comparison of treatments only. The harvested samples were dried and threshed. Composite samples of the straw from each treatment were retained for total nitrogen analyses. Total nitrogen was determined for the individual grain samples. The analyses of the composite straw samples have not been done at this time and will be reported later.

The Vestre plot was the only plot where the maximum grain yield was experienced beyond the 75 lb rate. This was a much lighter soil (Asquith SL) than the other sites and this may have contributed to the further response. Erratic results at the Carlson sprinkler site could be attributed to the very high nitrate nitrogen status at seeding (Table 2.1.1). Statistical analysis showed this to be the only site at which variation due to treatment was not significant. At the Hauberg site, variation in grain yields due to treatment was highly significant with the remaining two sites (Carlson border and Vestre) being significant.

The straw yields (Table 2.1.2) increased with each increment of additional N up to, and including, the 200 lb N/acre rate with the exception of a slight decrease in straw yields at the 100 lb N/acre rate. The Vestre site was the only site

Table 2.1.2 Average straw yields of irrigated soft wheat fertilized with nitrogen.

	Straw Yields (lb/acre)					
	Nitrogen fertilizer rates (lb N/acre)					
Site	0	25	50	75	100	200
Carlson (border)	1988	2429	3432	4303	3706	4512
Carlson (sprinkler)	2701	2992	3004	3630	3434	4290
Hauberg	1804	2026	2573	3970	2894	4203
Vestre	1425	1995	2359	2553	3240	3424
Average	1980	2361	2842	3614	3319	4107

Table 2.1.3 Average protein content of irrigated soft wheat fertilized with nitrogen.

Site	Protein Content (%)[1] Nitrogen fertilizer rates (lb N/acre)					
	0	25	50	75	100	200
Carlson (border)	9.6	9.0	9.1	9.4	9.3	10.4
Carlson (sprinkler)	10.0	8.9	9.6	9.7	9.9	11.1
Hauberg	10.3	9.8	8.9	9.1	9.3	9.8
Vestre	9.4	8.8	8.7	8.9	9.3	11.5
Average	9.8	9.1	9.1	9.3	9.5	10.7

[1] Protein expressed on 13.5% moisture basis.

CONCLUSIONS

Interpretation of these data is complicated by the fact that a rust infestation appeared to reduce yields drastically. The tendency of rust to infect heavier stands may have reduced yield increases due to additional nitrogen.

When the data for the protein content of the straw is available it will be possible to assess the possible loss of nitrogen due to leaching. Experimentation with split applications may be necessary where heavy irrigations are required early in the growing season.

2.2 Residual response of alfalfa to nitrogen and phosphorus fertilization.

In 1969, nitrogen and phosphorus were applied to established alfalfa stands in the South Saskatchewan River Irrigation Project on Crown land operated by the Saskatchewan Department of Agriculture[1]. Rates of phosphorus were 0, 20, 40, 60, 90 and 120 lb/acre of P_2O_5 and of nitrogen were 0, 20, 30, 40, 60 and 80 lb N/acre. Site 1 of this experiment was

Table 2.2.1 Response of irrigated alfalfa to phosphorus and nitrogen.

	Dry Matter Yields (tons/acre)					
	Site 2		Site 3	Site 2		Site 3
	July	Sept	July	July	Sept	July
lb P_2O_5/acre	N at 0 lb/acre			N at 60 lb/acre		
0	1.40	1.10	1.51	1.30	1.20	1.38
20	1.34	1.20	1.38	1.35	1.31	1.51
40	1.46	1.23	1.44	1.43	1.35	1.36
60	1.25	1.31	1.34	1.51	1.25	1.62
90	1.52	1.30	1.63	1.47	1.27	1.44
120	1.57	1.34	1.70	1.53	1.31	1.49
Average	1.42	1.25	1.50	1.43	1.28	1.47
lb N/acre	P_2O_5 at 0 lb/acre			P_2O_5 90 lb/acre		
0	1.25	1.26	1.24	1.40	1.29	1.42
20	1.31	1.29	1.30	1.49	1.43	1.47
30	1.34	1.47	1.28	1.45	1.31	1.60
40	1.28	1.29	1.35	1.42	1.31	1.39
60	1.21	1.19	1.30	1.49	1.39	1.55
80	1.33	1.58	1.32	1.48	1.35	1.49
Average	1.29	1.35	1.30	1.44	1.35	1.49

[1] Henry, J.L., and E.H. Halstead, 1970. 1969 Soil Plant Nutrient Report. Saskatchewan Institute of Pedology Report No. M15, Pages 36-43.

3. EVALUATION OF SOURCES AND PLACEMENT OF NITROGEN

3.1 Comparative response of crops to ammonium nitrate and urea in field scale trials.

PURPOSE

The purpose of this experiment was to compare the efficiency of urea and ammonium nitrate as nitrogen sources for crops.

EXPERIMENTAL METHODS

The two sites chosen were a winter-wheat field on a Blaine Lake clay loam (Peters farm) and a Carrot River very fine sandy loam (Rediger farm) on which rapeseed was the test crop.

The plot design was a modified split plot with 10 replicates. The modification consisted of no randomization of treatments within replicates. For purposes of statistical analyses it was considered that randomization was achieved by natural field variation due to the distances between replicates. Treatments were 12 feet wide by 1/2 mile long.

Soil test samples were taken across the plot at each of the 10 replicates and analyzed for nitrate nitrogen, available phosphorus and potassium, pH and conductivity.

Fertilizer nitrogen was broadcast with a truck mounted Cominco 70 applicator. Urea was added as 46-0-0 and ammonium nitrate as 34-0-0 at rates of 0, 20, 40, 60 and 80 lb N/acre. On the winter wheat plot no other fertilizer was applied. On the rapeseed plot, phosphorus and potassium were added as 11-48-0 with the seed and 0-0-60 broadcast, respectively,

Table 3.1.1 Yield increases of crops fertilized with two sources of nitrogen

						Yield Increase (bus/acre)							
						20 lbs N/A		40 lbs N/A		60 lbs N/A		80 lbs N/A	
Farmer	Soil	N (0-24")	P (0-6")	K (0-6")	Check Yield	Urea[1]	A.N.[2]	Urea	A.N.	Urea	A.N.	Urea	A.N.
Peters (winter wheat)	B:CL	25	14	584	15.4	11.6	10.0	11.7	11.3	18.7	17.6	20.2	20.4
Rediger (rapeseed)	CR:VL	31	6	86	13.6[3]	-1.4	-0.5	8.6	6.7	11.7	11.7	13.1	5.8

[1] Urea broadcast as 46-0-0

[2] Ammonium nitrate broadcast as 34-0-0

[3] P and K added according to soil test recommendations

Table 3.1.3 Straw yields (lb/acre) of winter wheat fertilized with two sources of nitrogen.

Nitrogen Source	Nitrogen rates (lb N/acre)				
	0	20	40	60	80
Urea	1060	1891	2131	3034	3011
Ammonium nitrate	1077	1757	2292	3059	3004
Grain-straw	.883	.867	.737	.665	.716

CONCLUSIONS

From the foregoing data, it can be concluded that urea is as effective as ammonium nitrate as a nitrogen source for crops when applied as a broadcast treatment at rates to 80 lb N/acre. The following section explains results of an experiment where the two sources were placed with the seed in addition to the broadcast applications.

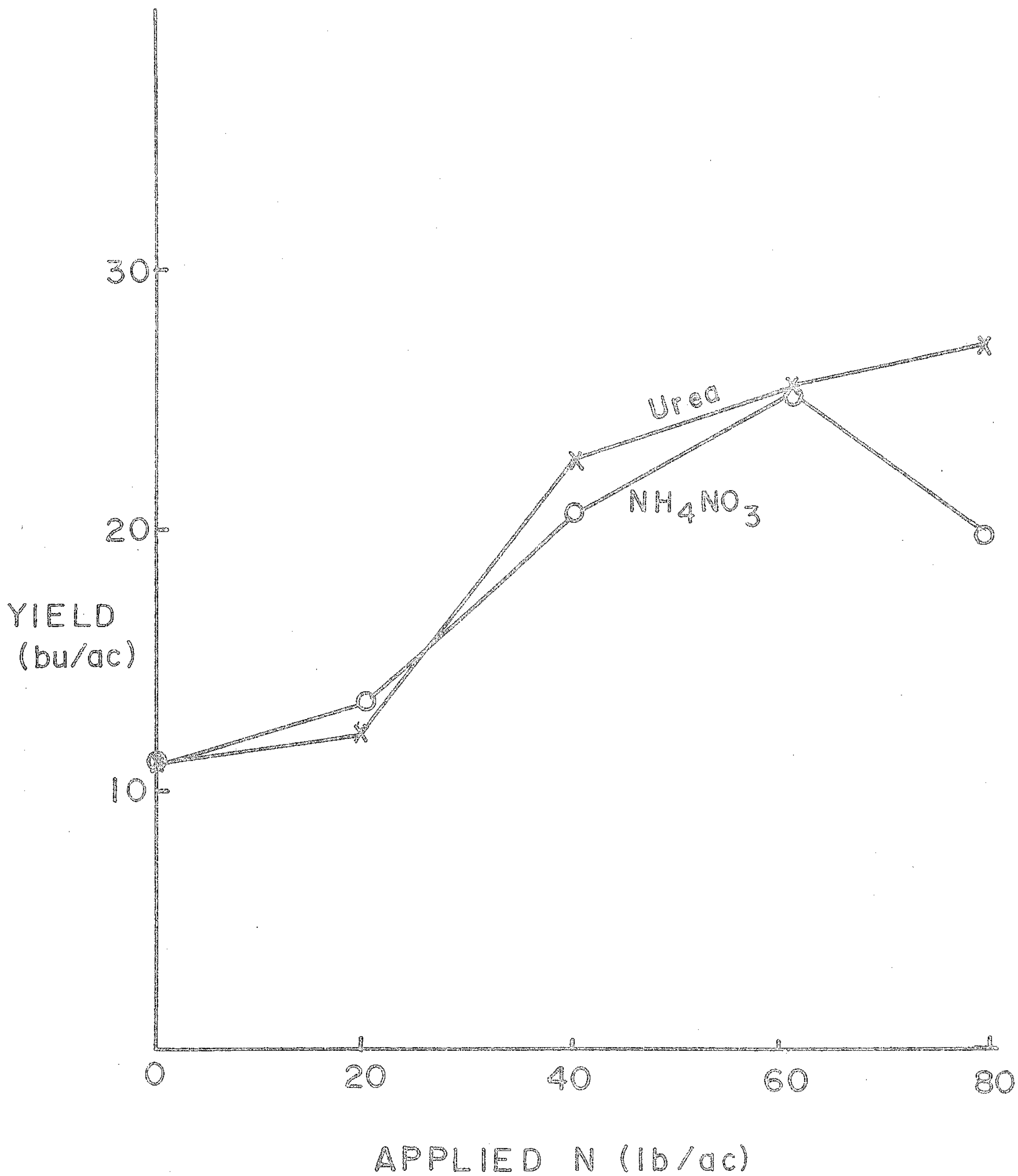

Figure 3.1.2 Comparison of two N sources on rapeseed yields.

Individual experimental units were plots of six rows spaced at 7 inches and were 20 feet long. Each unit was isolated from adjacent units by a 16 inch border which was kept mowed during the season. Header strips of approximately 8 feet separated the blocks. Three units each of the six nitrogen rates, broadcast as ammonium nitrate, were added along the side of the Manitou wheat plot. These were used to monitor soil moisture use and nitrogen status during the growing season, thus preventing any damage being done to the units on which yields were to be determined. Soil moisture was not monitored on the Pitic wheat plots.

Two plots were seeded at each site, one with Manitou wheat and the other with Pitic wheat. Phosphorus was added as 11-48-0, placed with the seed, on all units at a rate of 30 lb P_2O_5/acre. The nitrogen in the added 11-48-0 was taken into account when adding the additional nitrogen fertilizer.

Composite soil samples were taken from the entire plot area at seeding and analyzed for nitrate nitrogen, available phosphorus and potassium, pH and conductivity. Soil samples were taken at 5 dates during the growing season and analyzed for nitrate nitrogen. These samples were removed from the 3 extra units of each rate and composited prior to analysis. Moisture readings were taken at 4 dates during the season beginning on June 1 and 2. This was approximately 10 days after seeding. Moisture was not determined at the time of seeding due to malfunction of the neutron moisture meter. Rainfall was recorded and, along with the soil moisture data, RESULTS

The effect of nitrogen source and fertilizer placement on the germination of wheat is expressed in Table 3.2.1. Germination was not reduced by either urea (46-0-0) or ammonium nitrate (34-0-0) at any rate when applied as a broadcast treatment. When the fertilizer was placed with the seed, germination was effectively reduced beyond the 30 lb N/acre treatment when applied as urea. At 160 lb N/acre as urea, germination was almost completely prevented. When the nitrogen was applied with the seed as ammonium nitrate, rates up to, and including, 40 lb N/acre did not reduce germination. The low germination counts at the Roth site are difficult to explain. The field had been cultivated earlier in the spring and, along with very little precipitation for several weeks after seeding, may have contributed to inadequate surface moisture for satisfactory germination. Subsequent heavy rains resulted in prolific stooling and the low germination rates did not appear to retard yields.

Yields (Tables 3.2.2 and 3.2.3) of Manitou wheat on the Popoff plot increased from 5 bushels per acre at the 20 lb N/acre rate to 19 bushels per acre at the 160 lb rate when applied as a broadcast treatment. On the Roth plot, similar increases from 5.5 to 12 bushels per acre were obtained. Increases by Pitic wheat were higher than Manitou with yield increases of from 8 to 24 bushels and from 5 to 20 bushels experienced on the Popoff and Roth plots respectively when the fertilizer was applied as a broadcast treatment. There was no

Table 3.2.2 Yield increases of wheat to nitrogen fertilization comparing two sources and two placements: E:sicl plot.

		Yield Increase (bus/acre)			
		Manitou Wheat		Pitic Wheat	
Rate[4] (lbs N/acre)	N-Source	Seed Placed	Broadcast	Seed Placed	Broadcast
Check Yield[3]		14.9		19.9	
20	Urea[1]	6.4	4.7	9.8	8.1
	A.N.[2]	7.4	7.1	8.8	9.4
30	Urea	7.5	8.9	12.4	11.3
	A.N.	9.8	9.5	12.7	11.1
40	Urea	6.6	7.5	7.9	11.5
	A.N.	11.6	12.0	13.5	11.5
80	Urea	*	15.6	-4.4	22.6
	A.N.	11.9	14.7	13.3	23.5
160	Urea	*	18.9	*	24.5
	A.N.	8.9	18.7	9.1	23.0

[1]Urea applied as 46-0-0

[2]Ammonium nitrate (A.N.) applied as 34-0-0

[3]Phosphorus added to all treatments as 11-48-0 to supply 30 lb P_2O_5/acre. Check yield is average of 4 checks. Soil test = 25 lb NO_3^--N/acre.

[4]N added to bring total added N (including N from 11-48-0) to stated rate.

* Urea placed with seed prevented germination.

significant difference in response to the different sources of nitrogen when applied as a broadcast treatment.

When the fertilizer was placed with the seed, similar increases were obtained from both sources as when broadcast at rates up to 30 lb N/acre for urea and 40 lb N/acre when applied as ammonium nitrate. Beyond these rates, increases began to diminish.

T-tests (Table 3.2.4) show significant differences between yields due to sources of nitrogen when placed with the seed. These differences were apparently due to the more severe retardation of germination by the seed-placed urea. These differences became significant when more than 30 lb N was added with the seed. Placement became significant at the 1% level of probability when rates of 160 lb N as ammonium nitrate or 80 lb N as urea were used.

Straw yields are given in Table 3.2.5. Results in straw yields are similar to those of grain yields and will not be further discussed in this report.

Statistical analyses of the percent protein content in the grain (Table 3.2.6) have not been completed. Therefore, the significance of inferences drawn from the protein data can not be substantiated. Increases in protein content were experienced at rates above 40 lb N/acre and response continued linearly with further increases in nitrogen. The increase appears to be the same for both nitrogen sources and both fertilizer placements. Comparison of the two wheat varieties shows that the low protein content of feed

Table 3.2.5 Average straw yield (lb/acre) of wheat fertilized with two sources of nitrogen.

Nitrogen Source	Fertilizer Placement	Nitrogen Rate (lb N/acre)					
		0	20	30	40	80	160
15.1 E:sicl: Manitou Wheat							
Urea	Seed	994	1497	1556	1561	**	**
	Broadcast	1090	1359	1573	1500	2155	2315
NH_4NO_3	Seed	1064	1591	1660	1881	2009	1857
	Broadcast	996	1565	1639	1845	2148	2433
15.2 E:sicl: Pitic Wheat							
Urea	Seed	1057	1521	1821	1652	1037	**
	Broadcast	1053	1544	1749	1861	2572	2912
NH_4NO_3	Seed	983	1724	1964	2081	2502	2147
	Broadcast	1082	1587	1764	2212	2584	2775
15.3 B:cl: Manitou Wheat							
Urea	Seed	1774	2312	2563	2579	1139	**
	Broadcast	1691	2279	2391	2430	2812	3145
NH_4NO_3	Seed	1846	2626	2682	2923	3152	2151
	Broadcast	1693	2322	2548	2651	2916	2878
15.4 B:cl: Pitic Wheat							
Urea	Seed	1902	2749	2939	2720	2166	**
	Broadcast	2102	2534	2913	2864	3475	3550
NH_4NO_3	Seed	1939	2712	3124	3130	3417	2825
	Broadcast	1861	2768	2754	2907	3615	3565

** Germination prevented

Table 3.2.6 Average percent protein[1] of wheat fertilized with two sources of nitrogen.

Nitrogen Source	Fertilizer Placement	0	20	30	40	80	160
		1. E:sicl: Manitou Wheat					
Urea	Seed	10.4	9.9	9.9	10.4	**	**
	Broadcast	10.6	10.0	10.2	10.2	12.1	14.8
NH_4NO_3	Seed	10.4	9.8	9.7	9.4	11.8	14.9
	Broadcast	10.5	10.0	10.3	10.6	12.0	15.0
		2. E:sicl: Pitic Wheat					
Urea	Seed	8.2	8.2	8.0	8.3	9.7	**
	Broadcast	8.0	8.0	8.1	8.2	9.8	13.0
NH_4NO_3	Seed	8.1	7.9	8.0	8.1	9.9	13.6
	Broadcast	7.9	7.8	7.8	8.3	9.9	11.8
		3. B:cl: Manitou Wheat					
Urea	Seed	10.9	11.1	10.7	11.5	13.4	**
	Broadcast	11.2	11.7	11.0	11.5	12.6	14.3
NH_4NO_3	Seed	11.4	11.0	11.0	11.7	13.6	15.3
	Broadcast	10.9	11.3	11.5	11.6	13.2	15.3
		4. B:cl: Pitic Wheat					
Urea	Seed	8.6	9.0	9.1	9.3	10.8	**
	Broadcast	8.6	8.7	9.0	9.0	10.5	13.5
NH_4NO_3	Seed	8.9	8.4	9.1	8.9	11.3	13.9
	Broadcast	8.5	8.9	8.8	9.1	10.7	13.4

[1]Expressed on 13.5% moisture basis.

**Germination prevented

Table 3.2.7 Moisture use by Manitou wheat under various fertilizer treatments: E:sicl.

N-rate (lb/A)	Rain (in)	Time Period 1/6-14.7 4.90	14/7-4/8 0.82	4/8-21/8 0.37	Seasonal Use 6.09
0	Soil Water	1.10	2.80	0.50	4.40
	Total Use	6.00	3.62	0.87	10.49
20	Soil Water	1.40	2.90	0.30	4.60
	Total Use	6.30	3.72	0.67	10.69
30	Soil Water	2.30	2.00	1.20	5.50
	Total Use	7.20	2.82	1.57	11.59
40	Soil Water	1.60	3.00	0.80	5.40
	Total Use	6.50	3.82	1.17	11.49
80	Soil Water	2.00	3.20	0.70	5.90
	Total Use	6.90	4.02	1.07	12.80
160	Soil Water	1.80	2.20	1.20	5.20
	Total Use	6.70	3.02	1.57	12.10

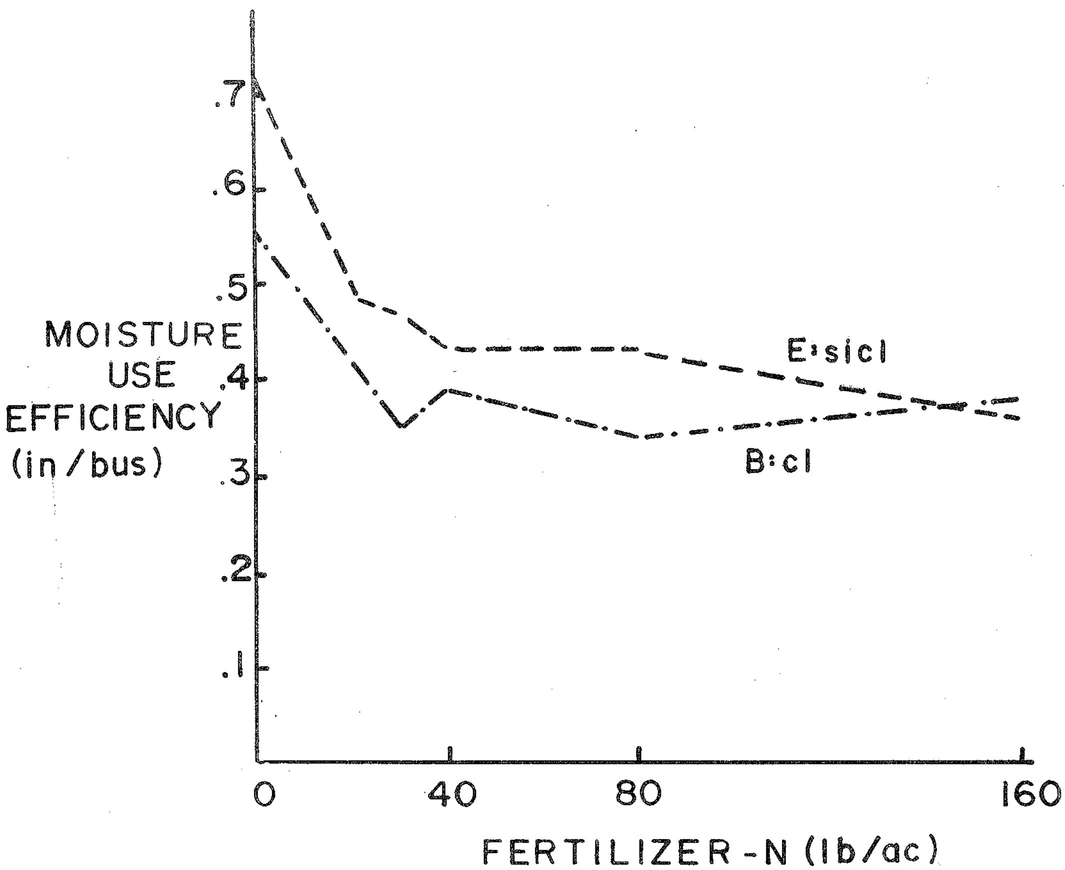

Figure 3.2.2. Moisture use efficiency by Manitou wheat fertilized with various rates of ammonium nitrate.

Table 3.2.10 Nitrate nitrogen status of fertilized wheat plots during the growing season: E:sicl

Date	Layer (in)	Nitrogen Rate (lb N/acre)					
		0	20	30	40	80	160
June 1	0-24	31	23	35	32	42	89
	24-48	30	20	44	32	24	56
	0-48	61	43	79	64	66	145
June 18	0-24	12	17	22	23	65	44
	24-48	30	38	38	32	30	78
	0-48	42	55	60	55	93	122
July 14	0-24	9	5	10	7	16	19
	24-48	26	24	32	22	26	38
	0-48	35	29	42	29	42	57
Aug 4	0-24	7	1	7	2	5	41
	24-48	18	12	22	8	76	28
	0-48	25	13	29	10	81	69
Aug 21	0-24	8	3	5	3	10	9
	24-48	10	0	12	10	6	12
	0-48	18	3	17	13	16	21

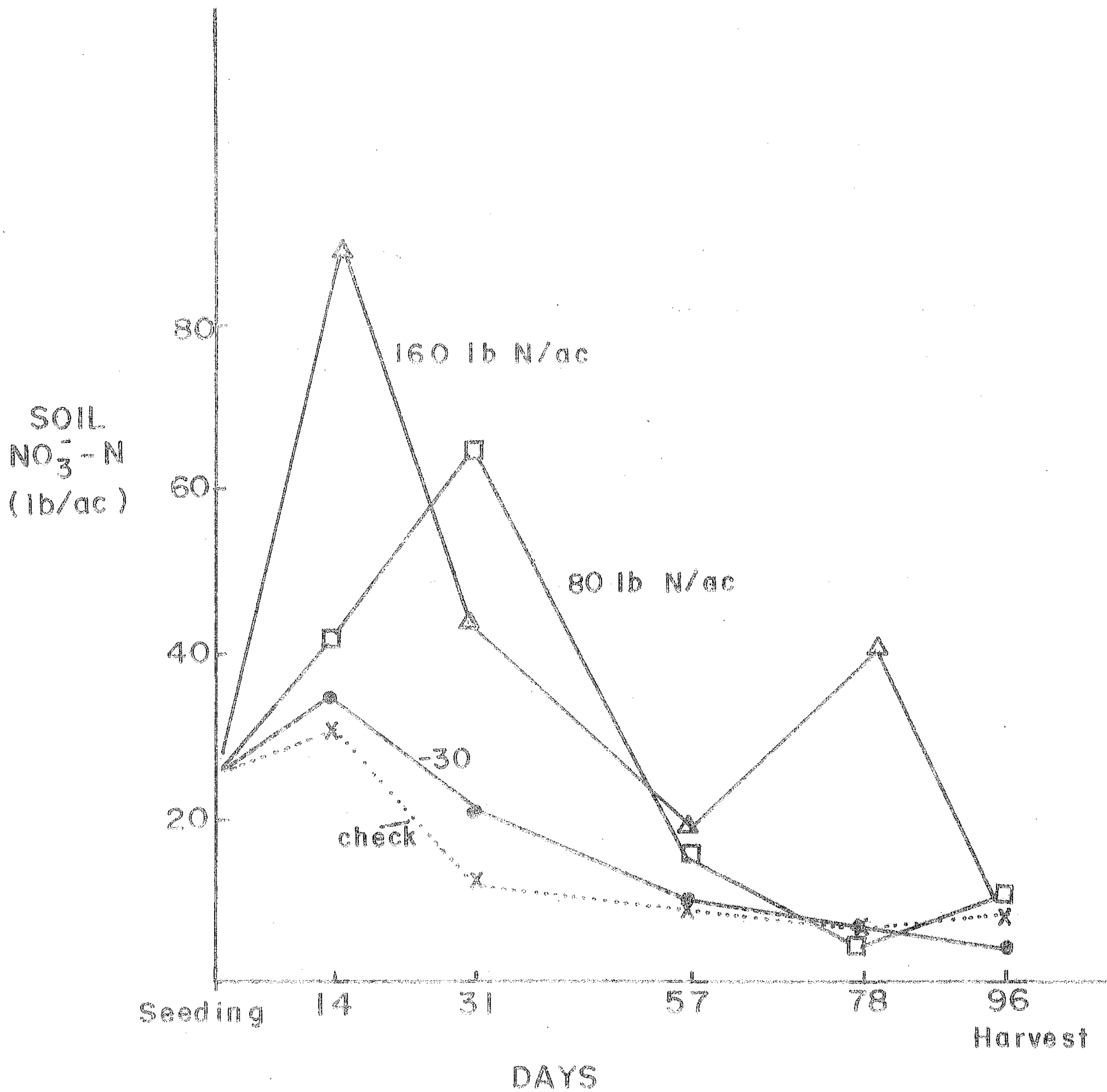

Figure 3.2.4 NO_3^--N status during the growing season under various N fertilizer rates: E:sicl.

6. NO^{-}_{3}-N in the soil is depleted very early in the growing season where low rates of nitrogen fertilizers are used.

Further experimentation with nitrogen placement, particularly as side-banded treatments, is desirable. Lack of a suitable seeder has prevented investigation of this aspect. Tagged fertilizers would increase the scope and value of this type of experimentation.

RESULTS

Although some slight trend toward higher protein content of the grain is indicated on the plot grown on the soil low in nitrate nitrogen, statistical analyses do not reveal any significant effects due to treatment on either plot (Table 3.3.1).

Table 3.3.1 Protein content of grain when sprayed with urea during flowering.

Soil	Spring NO_3^--N (lb/A)	Protein content (%) at N rates of 0 lb/A	10 lb/A	30 lb/A	50 lb/A
[1]Blaine Lake CL	30.4	11.5	10.6	11.9	12.1
[2]Bradwell FL	71.0	13.9	14.5	14.5	13.5

[1]F-ratio due to treatment = 2.86^{NS}

[2]F-ratio due to treatment = 0.877^{NS}

Further investigation is warranted, particularly on soils low in nitrate nitrogen. More replications would be desirable to reduce the variation due to error. Time of spraying may be critical and this should be investigated by spraying at various morphological stages.

Appendix B. Soil test data for all experimental sites.

Farmer/ Soil	Depth (in)	Nitrate Nitrogen (lb/ac)	Available Phosphorus (lb/ac)	Available[1] Potassium (lb/ac)	pH	Cond. (mmho/cm)
			Potassium Trials			
Ewanus	0-6	5	28	253	6.5	0.1
Sy:vl	6-12	2	26	138	6.6	0.1
	12-24	2	40	266	6.7	0.1
Ewanus(smf)	0-6	11	25	311	7.2	0.1
Sy:vl	6-12	5	22	180	7.4	0.1
	12-24	12	38	347	7.4	0.1
Skogsrud	0-6	11	12	136	7.2	0.2
	6-12	7	6	116	7.4	0.2
	12-24	17	9	191	7.8	0.2
Gentner	0-6	70	14	72	7.8	1.1
	6-12	20	3	59	7.9	1.1
	12-24	28	4	141	8.0	1.0
Kozun	0-6	39	8	63	7.5	0.3
	6-12	19	2	45	7.9	0.2
	12-24	26	5	71	8.1	0.2
			Irrigation Trials			
Carlson (border) Br:vl	0-6	17	16	376	7.7	0.3
	6-12	11	4	193	7.9	0.3
	12-24	19	5	391	8.0	0.3
Carlson (sprinkler) E:cl	0-6	36	19	559	7.7	1.9
	6-12	14	6	192	7.9	3.6
	12-24	34	8	398	8.2	6.5
Hauberg	0-6	15	11	371	7.8	0.3
	6-12	12	5	191	8.0	0.3
	12-24	21	9	481	8.3	0.4
Vestre	0-6	11	6	465	8.0	0.2
	6-12	9	3	183	8.0	0.2
	12-24	16	5	288	8.1	0.2

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