The effect of potash on the quality of sugarbeets is given in Table 20. There were no significant differences in sodium content between treatments. However, they were all lower in sodium than the check treatment.

Potassium content increased with increased rates of potash. The 400-lb. rate was significantly higher than the other treatments except the 100-lb. rate.

Table 20. Effect of potash on sodium, potassium, amino-nitrogen and impurity of sugarbeets.

Treatment lbs/A	Na	K	Amino-Nitrogen	Impurity Index
	ppm			
Check	402	1638	493	735
50	387	1708	510	768
100	387	1779	424	702
200	388	1753	480	752
400	351	2064	440	795
	NS		NS	NS
LSD 5%	123	286	123	156

Amino-nitrogen values varied and all treatments except the 50-lb. rate were lower than the check, but there were no significant differences.

There were no significant differences in impurity indices. The 400-lb. rate was the highest.

FODDER BEETS - 1973

Two varieties of fodder beets were sown in replicated plots on May 7 using a six-row planter with 22-inch row spacing. Plots were hand thinned and mechanically cultivated during the season. The plots were harvested on October 10 and the results are given in Table 21.

Table 21. Yield, percent sugar and stand of two varieties of fodder beets, 1973.

Variety	Field Tons/A Root	Field Tons/A Top	Dry Tons/A Root	Dry Tons/A Top	Percent Sugar	Beets Per Acre
Polyfourra	48.4	12.0	6.0	2.0	6.2	36,419
Blanca	33.8	15.5	6.0	2.6	7.5	32,849

These beets were very high in moisture as indicated by the yield on the dry basis. Although Blanca yielded 15 tons less than Polyfourra the weight on the dry was the same. Percent sugar was rather low. The stand was excellent.

The feeding value, which is a composite of the two varieties, is given in Table 22.

Table 22. Nutrient values of fodder beets, 1973.

	Digestible Protein	Raw Protein	Fiber	Fat	Ash	Calcium	Phosphorus
	percent dry basis						
Tops	12.8	19.2	14.4	2.0	19.4	0.7	0.2
Roots	6.0	10.6	8.5	0.7	8.6	0.2	0.1

AVAILABLE SOIL MOISTURE STUDIES

Moisture held in the soil above the gravitational pull and below the permanent wilting point is available for plant growth. This amount varies with the type of soil, but the Fargo and Bearden soils can hold approximately 17 inches of total available water in the top five feet of soil. However, the amount for optimum plant growth is approximately eight to ten inches.

Soil samples were collected from four different cropping systems during the growing season. Available soil moisture determinations were made at this station on 1120 samples of soil during the year. The first samples were taken on April 12 on site 1 and on April 18 on sites 7 and 8. On site 9, which was in alfalfa fallow in 1972, the first soil samples were taken on May 9.

The data in Tables 24, 25, 26, 27 and 28 give the sampling dates, the precipitation for each period, inches of available soil moisture for each depth, and the total for the season. Each table gives the last sampling in the fall of 1972 so that the accumulated overwinter and early spring moisture can be determined. Site 10 was in alfalfa and was plowed on June 28 and fallowed and the results in Table 28 are for the last sampling of the year.

The available moisture supply was low at the end of the 1972 cropping season. The soil moisture increased slightly on all sites over the winter months but was still rather low at the first sampling date in the spring.

The rainfall during the growing season was below average which caused a gradual decline in available soil moisture throughout the summer reaching a point of almost no available water. At site 1 a deficit of 0.66 inches was measured the first part of August. Heavy rains throughout August and September totaling over ten inches helped to relieve the drought condition in the Valley. At the end of the season, October 29, the supply of available moisture had increased but was still below average for this time of the year.

Table 23 summarizes the available water in the soil at the end of the 1971, 1972, and 1973 growing seasons for sites, 1, 8 and 9.

Table 23. Available soil moisture at the end of the growing season, Northwest Experiment Station, 1971, 1972 and 1973.

Site	Soil Type	Texture	Available Water 5 Ft. Depth (Crop)		
			1971	1972	1973
1	Fargo	S. Clay Loam	6.43 (Alfalfa)	1.81 (Alfalfa)	2.98* (Alfalfa)
8	Bearden	Silt Loam	11.10 (Black fallow)	3.98 (Beets)	5.34 (Barley)
9	Bearden	Silt Loam	---	4.82 (Alfalfa fallow)	1.94 (Beets)

* Alfalfa field plowed before last sampling.

Table 24. Site 1. Alfalfa (Alfalfa 1972) Available moisture in inches, 1973.

Sampling Date	Precip. Inches	Depth in inches 0-6	7-12	13-18	19-24	25-36	37-48	49-60	Total
11/1/72	--	0.38	-0.13	0.16	-0.17	-0.46	0.33	1.70	1.81
4/12/73	2.20	0.85	0.78	0.56	0.17	0.28	0.73	0.63	4.00
5/1/73	0.59	0.41	0.38	0.37	0.10	0.01	0.00	1.40	2.67
5/30/73	1.77	0.10	0.08	0.21	0.11	-0.05	0.36	0.88	1.69
7/2/73	2.16	-0.22	-0.18	-0.13	-0.25	-0.43	0.33	1.12	0.24
7/30/73	1.70	0.23	-0.28	-0.21	-0.48	-0.22	-0.46	0.76	-0.66
9/4/73	6.22	0.71	0.70	0.63	-0.14	-0.41	-0.54	-0.39	0.56
10/1/73	3.87	0.50	0.94	0.71	0.55	0.86	-0.14	-0.26	2.94
10/29/73	1.38	0.58	0.69	0.62	0.48	0.87	-0.10	-0.16	2.98
Total precip.	19.89								

Table 25. Site 8. Barley (Sugarbeets 1972) Available moisture in inches, 1973.

Sampling Date	Precip. Inches	Depth in inches 0-6	7-12	13-18	19-24	25-36	37-48	49-60	Total
11/1/72	--	0.44	0.21	0.46	0.52	1.42	1.32	-0.39	3.98
4/18/73	2.52	0.66	0.84	0.95	0.75	1.98	2.18	-0.73	6.63
5/1/73	0.27	0.57	0.77	0.79	0.80	1.72	2.13	0.35	7.13
5/31/73	1.93	0.27	0.54	0.78	0.78	1.87	1.50	0.30	6.04
7/2/73	2.00	-0.10	-0.02	0.07	0.12	0.83	1.19	0.02	2.11
7/30/73	1.70	0.30	-0.35	-0.16	-0.27	0.66	1.05	0.85	2.08
9/4/73	6.22	1.08	0.75	0.54	0.02	-0.07	0.57	1.35	4.24
10/1/73	3.87	0.70	0.71	0.69	0.80	1.32	0.86	0.85	5.93
10/30/73	1.38	0.61	0.72	0.66	0.61	1.46	0.89	0.39	5.34
Total precip.	19.89								

Table 26. Site 7. Sugarbeets (Barley 1972) Available moisture in inches, 1973.

Sampling Date	Precip. Inches	Depth in inches 0-6	7-12	13-18	19-24	25-36	37-48	49-60	Total
4/18/73	--	0.44	0.86	0.85	1.06	2.46	2.36	0.26	8.29
5/1/73	0.27	0.45	0.72	0.51	0.40	0.83	1.06	0.73	4.70
5/30/73	1.93	0.55	0.71	0.86	0.44	0.80	1.27	0.95	5.58
7/2/73	2.00	0.13	0.51	0.55	0.55	1.80	1.43	0.71	5.68
8/3/73	1.70	-0.08	-0.25	-0.02	-0.02	0.10	0.11	0.65	0.49
9/6/73	6.22	0.78	0.68	0.44	0.05	-0.44	0.73	0.20	2.44
10/2/73	3.87	0.75	0.98	0.81	0.72	0.92	-0.39	0.06	3.85
10/29/73	1.38	0.70	0.66	0.73	0.32	0.37	1.20	0.82	4.80
Total precip.	17.37								

Table 27. Site 9. Sugarbeets (Alfalfa fallow 1972) Available moisture in inches, 1973.

Sampling Date	Precip. Inches	Depth in inches 0-6	7-12	13-18	19-24	25-36	37-48	49-60	Total
11/1/72	--	0.34	0.43	0.35	0.26	1.20	1.45	0.79	4.82
5/9/73	3.12	0.25	0.50	0.35	0.19	1.40	2.06	1.29	6.04
5/30/73	1.44	0.40	0.21	0.33	0.53	1.51	1.60	0.76	5.34
7/2/73	2.16	0.18	0.24	0.04	-0.06	0.48	1.71	0.91	3.50
8/3/73	1.70	-0.41	-0.59	-0.40	0.25	0.77	1.25	0.79	1.66
9/6/73	6.22	0.45	0.59	0.38	-0.15	-0.23	0.04	-0.57	0.51
10/2/73	3.87	0.26	0.39	0.50	0.46	1.34	1.79	1.16	5.90
10/29/73	1.38	-0.01	0.29	0.19	0.13	0.50	0.88	-0.04	1.94
Total precip.	19.89								

AVAILABLE SOIL MOISTURE SURVEY
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Table 28. October 31, 1973 Site 10, Field 6 Sugarbeets (Alfalfa fallow 1973)

	0-6	7-12	13-18	19-24	25-36	37-48	49-60	Total
Percent Moisture	24.3	23.7	21.1	20.7	22.4	23.8	23.5	--
Available H_2O	0.39	0.51	0.56	0.46	1.51	1.93	0.97	6.33
Deficit - in.	1.27	0.98	1.15	1.22	1.79	1.82	2.48	10.71

Available soil moisture was low at the end of 1972 and 1973 compared to 1971. In 1973 site 8 shows higher soil moisture than site 1 or 9 due to the shorter growing season of barley. This is also true in 1972 with site 9 where the alfalfa was plowed and fallowed after harvesting the first crop. The soil moisture in this area was generally low at the end of the 1972 and 1973 cropping seasons because of below normal precipitation.

WATER USE PER DAY

From the available soil moisture study it is possible to calculate the water use per day for the three crops mentioned above. This data is given in Table 29.

Table 29. Water use per day for alfalfa, sugarbeets and barley at the Northwest Experiment Station, 1973.

Sample Period	Water Use Per Day in Inches		
	Alfalfa*	Sugarbeets	Barley
4/12 - 5/1	.098		
5/2 - 5/30	.089	.031	.094
5/31 - 7/2	.103	.053	.179
7/3 - 7/30	.087	.210	.056
7/31 - 9/4	.122	.107	.096
9/5 - 10/1	.041*	.080	.066
10/2 - 10/29	.043	.011	.063
Total for season	16.94	19.12	16.92

* Alfalfa field plowed and fallowed September 1, 1973.

Alfalfa with its long root system is a heavy consumer of soil moisture, starting with early spring growth and ending at freeze-up time in the fall. However, the site was plowed on September 1, and fallowed for the rest of the growing season which accounts for the lower values in water use. Grain crops like wheat and barley use considerable soil moisture during the growing season but are harvested earlier than sugarbeets. Sugarbeets are low users during the early growing season but by mid-season require large amounts of soil moisture.

EVAPORATION FROM OPEN PAN

The average monthly and daily evaporation from an open pan together with mean water temperature are given in Table 30. The readings are taken at 5:00 p.m. each day except Saturday and Sunday. The collection of these data started

May 1 and ended October 31 when the water froze solid. June and July were very similar and had the highest daily and monthly evaporation. The large number of clear and partly cloudy days influenced the amount of evaporation.

Table 30. Average daily and monthly evaporation from open pan together with mean water temperature, 1973.

Month	Inches Daily	Inches Monthly	Mean Water Temp.
May	.239	7.42	55.8
June	.317	9.18	65.1
July	.291	9.02	68.5
August	.268	8.31	70.4
September	.164	4.91	55.7
October	.104	3.23	47.9

Table 31 gives the average daily evaporation for 1968-73 and the six-year data.

Table 31. Average daily evaporation from open pan during the growing season, 1968-73.

Month	1968	1969	1970	1971	1972	1973	Average
May	.155	--	--	.252	--	.239	.215
June	.315	--	.204	.213	--	.317	.262
July	.251	.181	.288	.219	.250	.291	.247
August	.210	.297	.270	.242	.253	.268	.257
September	.134	.180	.180	.170	.160	.164	.165
October*	.087	--	--	.219	.137	.104	.137

* Terminated when water froze.

Table 32. Number of clear, partly cloudy, and cloudy days for 1973.

	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Avg.
Clear	10	9	9	9	10	8	12	9	15	12	8	8	10
P. Cloudy	12	6	9	13	13	13	12	17	4	7	11	6	10
Cloudy	9	13	13	8	8	9	7	5	11	12	11	17	10

WEATHER SUMMARY 1973

Slightly warmer temperatures and average precipitation were recorded for 1973 at Crookston. Only four months--July, September, November and December--were

below the long-time mean temperature. August was the hottest month with a 72.6° compared to the long-time mean temperature of 67.5°. January, February and March were also significantly warmer compared to the 60-year average.

The weather summary for 1973, which is given in Table 33, includes precipitation, mean temperature and long-time averages. Table 32 gives the clear and cloudy days.

The last spring frost occurred on May 17 when the temperature dropped to 28°. The first fall frost occurred on September 16 with a reading of 27°.

The frost-free period of 122 days during 1973 was three days shorter than average.

The total precipitation was 0.34 of an inch greater than the 70-year average of 20.20 inches. Of the total precipitation, 19.37 inches fell as rain and the remaining 1.17 inches came from the 12 inches of snow. The precipitation was poorly distributed throughout 1973 with April through July considerably below normal and August and September receiving almost half of the total precipitation recorded.

The snowfall for the calendar year measured over 70% less than 1971 or 1972. The moisture content per inch of snow for 1973 was .098 inches compared to the preceding two years of .054 inches and .065 inches, respectively.

Table 33. Weather summary for 1973 with averages for precipitation and mean temperatures for 1900-1970.

	Precipitation, inches					mean temperature ----degrees-----	
Month	Snow Inch	Precip. Inch	Rain	Total	1900-70	1973	1910-70
Jan.	2.5	0.16	0.02	0.18	0.56	10.6	4.9
Feb.	0.5	0.12	0.00	0.12	0.61	15.7	8.8
March	0.5	0.22	0.93	1.15	0.79	36.9	16.3
April	0.5	0.05	0.54	0.59	1.51	43.6	41.4
May	0.0	0.00	1.93	1.93	2.62	56.0	54.6
June	0.0	0.00	1.94	1.94	3.36	66.6	64.0
July	0.0	0.00	1.76	1.76	2.98	68.3	69.7
Aug.	0.0	0.00	3.40	3.40	2.89	72.6	67.5
Sept.	0.0	0.00	6.69	6.69	2.11	57.1	57.2
Oct.	0.0	0.00	1.38	1.38	1.34	51.0	45.0
Nov.	2.0	0.28	0.66	0.94	0.86	25.8	27.2
Dec.	6.0	0.34	0.12	0.46	0.59	9.6	11.6
Total	12.0	1.17	19.37	20.54	20.20	Avg.--42.8	39.0

AVERAGE WEEKLY SOIL TEMPERATURES

The daily soil temperatures at the four-inch depth were averaged for the week and the results are given in Table 34 for the period April 9 to December 31. Average soil temperature reached a high of 68.2° during the week of August 20 and a low of 20.0° during the week of December 17. Average temperatures of 60° or higher were maintained from the first week in July through the first week of September.

Daily soil temperatures varied and the highest readings were recorded during July and the first part of August.

Table 34. Average weekly soil temperatures, 1973. (4-inch soil depth)

Week	High	Low	Average
April 9	28.4	27.5	28.0
16	33.6	28.9	31.2
24	38.9	34.3	36.6
30	32.3	30.7	31.5
May 7	42.3	35.3	38.8
14	44.8	40.3	42.5
21	49.0	41.1	45.1
28	52.9	48.4	50.7
June 4	60.1	53.1	56.5
11	60.8	52.5	56.7
18	67.3	57.2	62.2
25	62.1	54.7	58.3
July 2	64.4	57.0	60.2
9	71.1	60.3	65.7
16	72.3	61.9	67.1
23	71.4	59.0	65.2
30	66.7	60.3	63.5
Aug. 6	68.4	60.8	64.6
13	68.7	62.1	65.4
20	72.1	64.2	68.2
27	66.7	60.6	63.7
Sept. 3	69.6	64.6	67.1
10	61.3	57.2	59.3
17	55.6	50.7	53.2
24	48.0	42.8	45.4
Oct. 1	52.0	47.5	49.7
8	52.9	48.4	50.7
15	48.9	46.4	47.7
22	44.8	40.5	42.6
29	45.3	42.6	43.9
Nov. 5	36.7	33.8	35.2
12	25.9	20.7	23.3
19	28.9	27.3	28.1
26	26.6	25.9	26.2
Dec. 3	26.4	25.3	25.8
10	22.2	19.9	21.0
17	20.7	19.4	20.0
24	21.7	20.7	21.2
31	22.2	21.7	22.0

GROWING SEASON 1973

Unusually warm temperatures during January, February and March initiated an early spring in the Red River Valley. During the latter part of February the snow pack began to melt and by March 9 just a trace of snow in windbreaks, ditches and fence-lines remained. On March 15 the ground frost had thawed two inches and by April 30 all the ground frost had disappeared.

January was 5.7°, February 6.9°, and March 20.6° warmer than average and helped early seeding. January, February, April and May were also well below average for precipitation which helped early drying of the fields.

Field work started in late March on some of the dryer soils and by the first part of April most farmers had started field work. Wheat and barley plots were seeded April 9 which was nearly one month earlier than 1972. Sugarbeet planting started the first week in May with an average 4-inch soil temperature of 40°.

Crops progressed rapidly during June, July and August even though there were dry periods during this duration.

First crop alfalfa was cut on June 11 and the yields were average. Barley harvest started the 19th of July followed by oats on July 25 and wheat on the 1st of August. Small grain yields were average even though precipitation was below average for the growing season.

Potato and sugarbeet harvest started during the second week in September. There were three five-day periods of rain throughout September and October averaging 2.78 inches per period which temporarily halted the harvesting operations. However, the potato and sugarbeet harvests were completed by November 1 with very little difficulty.

With the predicted shortage of nitrogen fertilizer for the 1974 growing season, there was a marked increase in fall application of fertilizer in the anhydrous ammonia form in the Red River Valley. Relatively dry soil conditions enabled farmers to finish fall work in good shape.

COMPARATIVE VALUE OF SEVERAL SMALL GRAIN CROPS AS FORAGE AND GRAIN CROPS IN NORTHWEST MINNESOTA

CROOKSTON, MINNESOTA - 1973

Charles Simkins, Larry Smith, Robert Schoper

Era wheat, Waldron wheat, Lodi oats and Cree barley were grown under varying levels of fertility and harvested in the soft dough stage for comparison as forage crops. They were also harvested at maturity in order to compare the yields of grain, protein and straw.

All small grains were seeded with grain drill with an application of 100 lbs. per acre of 0-46-0 applied at the time of seeding. Nitrogen applications were made prior to seeding.

Wheat was seeded at the rate of 120 lbs. per acre, oats at 64 lbs. per acre and barley at 72 lbs. per acre.

Nitrogen applications were as follows: Era and Waldron wheat 0, 100, 150 lbs. of nitrogen per acre, oats and barley 0, 30 and 60 lbs. nitrogen per acre.

The soil at the experimental site had the following chemical characteristics:

NO_3-N (2 ft. depth) - 95 lbs/acre

P - 50 lbs/acre

K - 430 lbs/acre

pH - 8.0

Moisture received during the growing season was below normal (8.6 inches). The forage yields obtained by harvesting a portion of each small grain at the soft dough stage is shown in Table 1.

Table 1. Forage yields of small grains and protein content. Crookston, Minnesota - 1973.

Small Grain	N - P_2O_5 - K_2O lbs/acre	Dry Matter tons/acre	Protein %
Era wheat	0 - 46 - 0	3.37 a*	4.7 a*
"	100 - 46 - 0	4.49 b	8.1 b
"	150 - 46 - 0	3.87 a	9.0 b
Waldron wheat	0 - 46 - 0	3.64	3.8 a
"	100 - 46 - 0	4.06	6.4 b
"	150 - 46 - 0	4.39	6.8 b
Lodi oats	0 - 46 - 0	3.54	7.1 a
"	30 - 46 - 0	3.67	8.5 b
"	60 - 46 - 0	3.70	9.3 b
Cree barley	0 - 46 - 0	3.84	5.4 a
"	30 - 46 - 0	3.68	5.2 a
"	60 - 46 - 0	3.41	7.9 b

* Any letter(s) different from another letter in a column indicates a significant difference between means at the 5% level.

Nitrogen fertilizer application produced no significant increases in forage yield in the case of Waldron wheat, Lodi oats and Cree barley. Significant increases were observed in the case of Era wheat. The 100 lb. N rate resulted in more than 1 ton increase in dry matter per acre. The highest yield of forage dry matter was produced by the semi-dwarf wheat variety Era.

It is not surprising that the nitrogen fertilizer did not result in higher increases in forage yield in three of the small grain varieties since the soil was relatively high in available nitrate nitrogen.

The protein content of the forage was significantly increased by nitrogen fertilizer applications. The oat forage was generally higher in protein than the wheat forage or barley forage. The grain and straw yields and the percent protein in the grain is shown in Table 2.

Table 2. Grain and straw yields of small grains - Crookston, Minn. - 1973.

Small Grain	N - P_2O_5 - K_2O lbs/acre	Grain bu/A	GRAIN Protein %	Straw ton/A
Era wheat	0 - 46 - 0	41 a*	8.6 a*	1.34 a*
"	100 - 46 - 0	54 b	12.1 b	1.76 b
"	150 - 46 - 0	51 b	12.3 b	1.82 b
Waldron wheat	0 - 46 - 0	35 a	12.1 a	1.62 a
"	100 - 46 - 0	49 b	13.8 ab	1.96 b
"	150 - 46 - 0	47 b	14.8 b	1.98 b
Lodi oats	0 - 46 - 0	56 a	11.0 a	1.31
"	30 - 46 - 0	63 b	12.7 b	1.31
"	60 - 46 - 0	58 a	13.1 b	1.22
Cree barley	0 - 46 - 0	60	9.2 a	1.58
"	30 - 46 - 0	64	11.7 b	1.90
"	60 - 46 - 0	68	11.6 b	1.69

* Any letter(s) different from another letter in a column indicates a significant difference between means at the 5% level.

Yields of grain were significantly increased by nitrogen fertilizer application except for Cree barley. The lower rate of nitrogen use - i.e., 100 lbs. in the case of wheat and 30 lbs. in the case of oats, resulted in yields which were equal to the higher rates (150 and 60, respectively). The percent protein in the grain was significantly increased by nitrogen fertilizer applications on all small grains. Straw yields of wheat were significantly increased by fertilizer applications. Straw yields of oats and barley were not significantly increased by nitrogen fertilizer applications. Hail damage severely decreased the yield of oats. Based on this one year trial, it would appear that wheat varieties such as Era and Waldron can produce as much forage per acre as oats and barley crops. The total straw yield of the semi-dwarf wheat variety, Era, compared favorably with other small grain varieties, and produced considerably more total pounds of grain per acre than the other small grain crops.

INFLUENCE OF BAND - PLACED FERTILIZER ON SOYBEANS

G.E. Ham and L.J. Smith

Rates of nitrogen, phosphorus and potassium were banded two inches to the side and two inches below the seed of Wilken variety at Crookston. The fertilizer rates and seed yields are shown in Table 1. Seed yield was not increased with any fertilizer treatment.

Table 1. Influence of band-placed fertilizer on soybean seed yields at Crookston (1973).

Fertilizer rate N + P + K, lb/acre	Seed yield bu/acre
0 + 0 + 0	32.9
5 + 0 + 0	31.8
10 + 0 + 0	34.2
0 + 10 + 0	29.6
0 + 20 + 0	33.6
0 + 30 + 0	33.0
0 + 0 + 30	29.9
0 + 10 + 30	30.9
0 + 20 + 30	30.4
0 + 30 + 30	33.6

NITROGEN-SOYBEAN VARIETY STUDY - CROOKSTON 1973

G.E. Ham and L.J. Smith

Urea at the rate of 50, 100 and 200 pounds of nitrogen per acre was applied to Ada, Altona and Wilken variety soybeans at Crookston. The fertilizer was broadcast and disked-in before planting. The seed yield of all varieties was increased at the 100 and 200 pound rates and the yield of Wilken was increased with 50 pounds of nitrogen (Table 1).

Table 1. Effect of nitrogen fertilizer on soybean seed yield at Crookston (1973).

Nitrogen rate	Soybean Variety		
	Ada	Altona	Wilken
lbs/acre	bu/acre		
0	23.0	22.6	24.4
50	23.8	25.2	32.5*
100	29.5*	27.3*	31.5*
200	28.5*	29.2*	36.3*

* Yield significantly greater than check at .05 level.

THE EFFECT OF UREA NITROGEN, WITH AND WITHOUT "N-SERVE" ON THE 1973 YIELD OF RUSSET BURBANK POTATOES GROWN ON IRRIGATED HUBBARD LOAMY FINE SAND IN SHERBURNE COUNTY

John MacGregor, Curtis Klint, Dean Fairchild,
Robert Schoper and Glenn Titrud

Commercial potato growers located on the Mississippi sand plain northwest of the Twin Cities apply relative large amounts of nitrogen fertilizer to increase potato production in their irrigated fields. Most of these soils are quite sandy and porous, low in organic matter and available nitrogen, and also in water holding capacity. While phosphorus, potassium, and possibly other elements are necessary fertilizer materials, adequate water and nitrogen additions are obviously the key components needed in larger amounts for good soil management to maximize tuber yields. Since ammonium nitrate is the most abundant of the solid, but water soluble commercial nitrogen sources, this has been the principal N source used, since its ready market availability and high water solubility make it most convenient to apply through the sprinkler irrigation system at several times during the growing season. However, a 1972 experiment in which Russet Burbank potatoes were grown in an irrigated Hubbard loamy coarse sand using ammonium nitrate to supply a total of 150 lbs N/A at different times by splitting applications, resulted in relatively low tuber yields, with no significant effects of the nitrogen fertilizations. (See Soil Series 89, pp.52-53).

A nitrification retardant "N-Serve" developed by the Dow Chemical Company is designed to depress the activity of urease (present in most soils) and slow the production of nitrates from soil organic matter. The warm, porous sandy soils with limited amounts of organic matter are naturally subjected to rapid nitrification in late May and early June, and this period of relative nitrate abundance is rapidly superseded by insufficient nitrates for normal crop growth which are now supplied by later split fertilization treatments, especially where shallow rooted, high value crops such as potatoes are grown. Urea fertilizer is becoming abundant and competitive in cost with ammonium nitrate, and since it is a soluble organic compound, the use of N-Serve should retard nitrate formation and lengthen out its period of N availability over a much longer season than equivalent amounts of N similarly applied in the ammonium nitrate form.

Early in 1973 an experiment was established with irrigated Russet Burbank potatoes adjacent to the 1972 experimental plots where ammonium nitrate was ineffective in potato yield. Four replications of three rates of urea nitrogen (in addition to the no-urea N plots) supplied 100, 200 and 400 lbs N/A broadcast immediately following tuber planting, in which a total of 0+288+288 was applied along the 36" rows (12" drop). Each 8 row plot was 20' in length and these were then split into 2-4 row subplots one subplot of each of the 32 main plots being randomly treated with "N-Serve"[1/] at the rate of 1.5 lbs per acre. An Eptam spray supplying 3.5 lbs per acre was the herbicide worked into the soil prior to planting, and the systemic Thimet 15 G was also banded at planting. Following planting on April 18, the area was dragged May 12,

[1/] Supplied by courtesy of the Dow Chemical Company, Midland, Michigan.

cultivated on May 30, hilled June 19, and harvested on September 27. Five inches of irrigation water were applied during the season at the rate of 1" per irrigation. Sprays containing Manzate D and either Thiodin or Serin were applied at 9 times, terminating on August 7.

RESULTS

The potato vines on all treated plots showed the beneficial effects of the urea N additions proportional to the increasing rates of application, and growth on each of the split plots showed the nitrification retardant effect of the applied "N-Serve". This chemical treatment also slowed the nitrification rate of the soil organic matter present, since the "N-Serve", but no urea, plot vine growth was also less abundant and lighter in color. This effect persisted over the entire season, except where the heaviest rate of urea-N per acre (400 lbs) was applied. This heavy urea N rate probably exceeded the capabilities of the relatively small treatment rate of the "N-Serve". There was no question of the effectiveness of the "N-Serve" on limiting potato vine growth.

Ten central feet of the two middle rows of each of the 64 sub-plots were dug and weighed late in September, and the average results in hundredweights per acre are shown in the following table.

1973 Yields of Russet Burbank Potatoes Grown in Irrigated Hubbard Loamy Coarse Sand in Sherburne County With Three Rates of Urea Nitrogen Applied, With and Without "N-Serve" (Values are averages of 8 replications).

Rate of Urea N applied at planting [1/] (lbs/A)	1973 Tuber Yield [2/] (cwt/A)		
	With N-Serve	Without N-Serve	Average
0	166	162	164a
100	318	329	323b
200	427	437	432c
400	474	478	476c

[1/] A total of 1152 lbs of 0-25-25/A was banded at planting, supplying 288 lbs of P_2O_5 and of K_2O per acre.

[2/] Total of all tubers weights.

It is immediately apparent that the N-Serve has not significantly affected potato tuber yield, following its marked effect on potato vine growth. The beneficial effect of increasing rates of urea nitrogen significantly increased yields to the 200 lb/A rate, with no marked increase when this rate was doubled.

The ineffectiveness of the ammonium nitrate-N in 1972, and marked effectiveness of urea-N on tuber production in the following year on these irrigated sandy soils suggest that the effectiveness of these two N sources for potato fertilization should be studied further in a well replicated experiment.

A REPORT OF A THREE YEAR STUDY (1971-72-73) OF RATE AND TIME OF NITROGEN FERTILIZATION FOR CORN GROWING ON A HUBBARD LOAMY COARSE SAND IN SHERBURNE COUNTY

John MacGregor, Dean Fairchild, Robert Munter and Robert Schoper

(The reader is referred to p.50, Soil Series 88, and to p.46, Soil Series 89 for preceding reports).

There are several million acres of sandy soils in Minnesota. These soils are low in organic matter and have low water holding capacity, but may be very productive if adequate essential nutrient elements and water are made available. Nitrogen is usually the element most limiting to non-legume plant growth and since most commercial N fertilizers consist of salts quite soluble in water, these may be readily applied during one or more of the sprinkler water applications. Since this element moves readily with water through the soil and is readily leached beyond the reach of most plant roots, especially in porous soils, this experiment was carried on for 3 growing seasons to determine both optimum application rate(s) and time(s) of fertilization at one or more times of irrigation.

Ear corn was harvested in late October, with the stalks chopped and lightly disked in the fall. These were then plowed under in late April or early May, disked, harrowed, and planted in 30" rows, with Minhybrid 4201 (110 day) corn seed to give a population of 30,700 plants per acre. Herbicide sprays of combined Lasso and atrazine provided excellent weed control. Plots were 15' x 50', the 10 treatments arranged in six randomized block replications, with similar treatments repeated in each of the 3 growing seasons. The only nutrient applied during the experiment was nitrogen, broadcast as ammonium nitrate, which was readily dissolved and carried into the soil by rain and/or irrigation waters. The ten annual treatments included four rates of nitrogen application (as ammonium nitrate) to supply 0, 100, 200, and 300 pounds of N per acre as follows:

(1) All applied as a single broadcast a few days after planting,
(2) The same total amounts of N at monthly intervals of planting (in May), June, July, and August,
(3) The same amounts split into 8 bimonthly applications of planting (in May), June, July and August.

Nitrogen effect on corn growth was evident from emergence during each of the three growing seasons, but deficiency symptoms of other essential elements were not evident. Percentage "index" leaf N, ear corn yield, N in grain and total amounts removed (as well as total moisture during the 5 month growing season) are shown in Table 1.

Nitrogen content of the 6th or "index" leaf at tasseling was determined in 1971 only, since these analyses only corroborated the visual symptoms of N deficiencies of corn plants on the different treatments. Yields were significantly increased by all N applications, with the 4 applications at monthly intervals appearing most promising. As application rate increased, time of N fertilization became less important. Whereas the 200 pound N rate generally produced significantly higher grain

yields than the 100 pound rate, the 300 pound rate was not a significant addition to the 200 lb rate at any application time, although increasing N fertilization increased both grain N concentrations and amounts of N removed by the grain per unit area. However, the heaviest N fertilization decreased the economic efficiency of N usage.

CONCLUSIONS

The tremendous effect of fertilizer nitrogen on corn growth during each of the 3 years of this experiment on irrigated sandy soils illustrates the productive capacity of these soils where properly managed. The experimental soil had a good supply of available phosphorus and potassium and hence these elements were not applied. The annual 300 lb/A of nitrogen was obviously excessive, with the intermediate 200 lb rate apparently being most economic at this time. Generally, the greatest fertilizer efficiency occurred when applied at the four monthly intervals.

Table 1(a). Some effects of varying annual rates and times of nitrogen fertilization on corn yield when grown on irrigated Hubbard loamy coarse sand in Sherburne County. (Averages of six replications).

N broadcast annually (NH_4NO_3)	Time(s) of N fertilization	N in lbs/A per application	% N in 6th leaf	Yield of ear corn (bu/A @ 15.5% moisture)			
(lbs/A)			1971	1971	1972	1973	Ave.
None	---	---	0.61	43a[2/]	21a	13a	26a
100	Early May only.	100	1.19	92b	68b	106b	89b
100	Early May, June, July, Aug.	25	1.42	154cd	109d	121bc	128cd
100	1/ 8 bimonthly (M,J,J,A)	12.5	1.53	136c	93c	133bcd	120c
200	Early May only.	200	1.11	158cde	125e	137bcd	140de
200	Early May, June, July, Aug.	50	1.89	185def	143f	150cd	159ef
200	1/ 8 bimonthly (M,J,J,A)	25	2.10	192f	141f	150cd	161ef
300	Early May only.	300	1.15	173def	126e	147cd	149ef
300	Early May, June, July, Aug.	75	2.05	195f	142f	162d	166f
300	1/ 8 bimonthly (M,J,J,A)	37.5	2.43	189ef	138ef	139bcd	155ef
	Total five month moisture (rainfall and irrigation)			30.5"	27.2"	30.3"	29.3"

1/ Applied at 15 day intervals during May, June, July, and August.

2/ Numbers followed by the same letter are not significantly different (Duncan's New Multiple Range Test).

Table 1(b). Some effects of varying annual rates and times of nitrogen fertilization on corn composition and nitrogen removal when grown on irrigated Hubbard loamy coarse sand in Sherburne County. (Averages of six replications).

N broadcast annually (NH_4NO_3) (lbs/A)	Time(s) of N fertilization	N in lbs/A per application	% N in grain 1971	% N in grain 1972	% N in grain 1973	% N in grain Ave.	Total N removal in grain (lbs/A) 1971	Total N removal in grain (lbs/A) 1972	Total N removal in grain (lbs/A) 1973	Total N removal in grain (lbs/A) Ave.
None	---	---	0.92	0.84	1.34	1.03abc[2/]	19	8	7	11a
100	Early May only.	100	0.82	0.88	1.06	0.92a	28	30	57	38b
100	Early May, June, July, Aug.	25	1.06	0.83	1.12	1.00ab	77	43	65	62e
100	1/ 8 bimonthly (M,J,J,A)	12.5	1.02	0.98	1.16	1.05abc	66	43	73	61c
200	Early May only.	200	0.99	1.03	1.18	1.07abc	74	60	77	70cd
200	Early May, June, July, Aug.	50	1.15	1.09	1.30	1.18cd	101	72	92	88def
200	1/ 8 bimonthly (M,J,J,A)	25	1.23	1.00	1.31	1.18cd	112	67	93	91ef
300	Early May only.	300	1.02	1.01	1.26	1.10bc	84	59	88	77cde
300	Early May, June, July, Aug.	75	1.33	1.08	1.37	1.26d	122	71	106	100f
300	1/ 8 bimonthly (M,J,J,A)	37.5	1.36	1.12	1.32	1.27d	121	72	88	94ef

1/ Applied at 15 day intervals during May, June, July, and August.

2/ Numbers followed by the same letter are not significantly different (Duncan's New Multiple Range Test).

IRRIGATED CORN YIELDS, PERCENTAGE GRAIN NITROGEN, AND NITROGEN REMOVAL IN TWO YEARS OF FERTILIZATION OF HUBBARD LOAMY COARSE SAND WITH FOUR NITROGEN FERTILIZERS

John MacGregor, Dean Fairchild and Curtis Klint

Field studies of the efficiency of different sources of fertilizer nitrogen on corn yield and composition have generally shown that most commonly used commercial nitrogen fertilizers have equal efficiencies, where properly applied at similar rates of nitrogen. These conclusions are periodically reexamined by field studies to confirm their validity, since the 300,000 tons of nitrogen fertilizers now applied annually in Minnesota represent a farmer investment of about 70 million dollars or more.

Large acreages of irrigated sandy soils are now planted to corn and this study comparing the effect of four N fertilizers on corn was conducted on an irrigated Hubbard loamy coarse sand near Elk River in both 1972 and 1973.

Minhybrid 4201 (110 day) corn was planted during the first week of May in 30 inch rows in both years, a few days after the corn stalks of the preceding year were plowed under and the surface disked and harrowed. The three solid fertilizers[1/] (ammonium nitrate, urea, and ammonium sulfate) were broadcast within a few days following planting, but wet soil conditions delayed the anhydrous ammonia injections for approximately a week after planting in both years. No banded starter fertilizer was used, and no phosphorus or potassium fertilizer applied after 1969. Corn populations (Minhybrid 4201-110 day maturity) approximated 30,700 plants per acre. The herbicide spray applied immediately following planting consisted of 1.5 to 2.0 lbs of atrazine and 1.0 to 1.5 lbs of Lasso per acre in 37 to 45 gallons of water. In 1972, rainfall plus irrigation water during May through September supplied 27.2" in 1972 and 30.3" in 1973.

Each of the three solid forms of N fertilizers were broadcast both years at the rate of 150 lbs/A on one 15' x 50' plot on each of 5 replicates in a randomized block. The anhydrous ammonia was injected a week later at 30" mid-row intervals.

Initially, growth on the later fertilized anhydrous ammonia plots was slower, but this disappeared in 4 to 6 weeks. No deficiencies of elements other than nitrogen were evident.

Ear corn was harvested in late October, yields were calculated, the N content of grain and N removal per acre was determined and these are shown in Table 1.

[1/] The 3 dry fertilizers used in 1972 were donated by the Howe Fertilizer Company of Brooklyn Center, Minnesota, and the anhydrous ammonia by King Gas Company of Osseo.

Table 1. The relative effect of four nitrogen fertilizers applied at planting to an irrigated Hubbard loamy coarse sand in Sherburne County on 1972 and 1973 corn grain yield, N content, removal, and efficiency when applied at the rate of 150 lbs N/A.

N source	Ear corn (bu/A)			% N in grain			N removal (lbs/A)			Ave. Efficiency (%)
	1972	1973	Ave.	1972	1973	Ave.	1972	1973	Ave.	
none	11a[1/]	11a	11a	0.97	0.97a	0.97	5a	5a	5a	--
Amm.sulfate	119b	142b	131b	1.12	1.15ab	1.14	61bc	81b	71b	44
Anhy. Amm.	123bc	147b	135b	1.02	1.27b	1.15	59b	90b	74b	46
Urea	125bc	123b	124b	1.11	1.07ab	1.09	66bc	64b	65b	40
Amm.nitrate	152c	132b	142b	1.14	1.08ab	1.11	80c	69b	75b	46

[1/] Numbers followed by the same letter are not significantly different at the 5% level (Duncan's New Multiple Range Test).

All four nitrogen fertilizer sources effectively increased corn growth and grain yields, with no significant difference in the nitrogen fertilizer used - with the exception of ammonium nitrate being superior to the sulfate in 1972. Nitrogen concentrations and removal in grain were equivalent from each nitrogen fertilizer in each of the two years. It is apparent that since the 4 nitrogen sources are equivalent, the selection of any of these four fertilizer materials should be based on initial and application costs of nitrogen, services available, product availability when needed, and accessory advisory services.

ASPHALT BARRIER

ELK RIVER 1973

CORN AND ONION YIELDS

George R. Blake

	No barrier	Barrier	Significance	CV %
Onions 1/ lbs/A.				
>3" Jumbo	793	2008	NS	88.8
2-3" No. 1	12156	16139	NS	31.0
>2"	12950	18147	NS	33.8
1-2" No. 2	2610	1604	NS	51.0
>1"	15560	19751	NS	23.6
<1" Culls	25.4	18.0	NS	62.0
Totals	15814	19931	NS	22.2
Corn 2/ Bu/A.				
@15.5% H_2O	26	24	NS	14.2

1/ Irrigated 2 days after planting with 1 inch water. Harvested four 40 foot rows each plot, 30 inch row spacing.

2/ No irrigation. Harvested four 20 foot rows each plot. Row spacing 30 inches.

ASPHALT BARRIER

ELK RIVER SATELLITE, 1973

CORN AND PINTO BEAN YIELDS

George R. Blake

Treatment	Pinto Beans[1/] lbs/A	Corn[2/] Bu/A
No asphalt	1015a	89a
750 gal/A	1370b	106b
950 gal/A	1502b	96ab
1500 gal/A	1497b	108b
Significance	0.01	0.05
C.V. %	11.4	8.0

1/ Harvested 10 rows each 40 feet in length and 30 inch spacing. No irrigation.

2/ Harvested 4 rows each 20 feet in length, 30 inch spacing.

FIELD EXPERIMENTS WITH SOIL MODIFICATION ON AN IRRIGATED SANDY SOIL - ELK RIVER, 1973

R.S. Farnham - D.S. Fairchild

Experiments with organic and inorganic detention layers on an irrigated Hubbard sandy soil at Elk River were started in 1969. The object of these studies was to modify the soil root-zone environment by installing detention layers to make more water and nutrients available to the crop plant. Materials used as dentention layers included various peats, wood products, composted garbage, calcined clay and vermiculite. The layers were installed both as 18 inch bands in rows and 14 ft square plots at a depth of 18 inches below the surface.

FIELD CORN - 1973

The plot area was fertilized with 1000 lbs. of 8-16-16 per acre which was broadcast and disked in on May 8. Corn was planted May 11 in 36" rows at a population of 25,640 plants. Variety used was Minhybrid 4201, 110 day maturity. Herbicide used was Lasso which was applied at planting time.

Nitrogen side dressings were 190 lbs. per acre rate on June 6 and 190 lbs per acre rate on June 22. Corn was harvested Oct. 24.

Irrigation water applied June to Sept. totaled nine inches.

RESULTS:

Yields in 1973 for corn averaged higher than in past two or three years with several of the materials used as detention layers. In some cases the check yields were higher than certain treatments especially on the square plots. Practically all row treatment yields were higher than the checks. The detention layers appear to be contributing to higher corn yields but they do not consistently have this effect.

Studies in 1974 are to evaluate these layers under irrigation rates.

Table 1. Corn yields with soil modification - 1973.

	1973 Yield bu/acre (15.5% H_2O)
Checks (no detention layers)	177 (ave. of 6)
Square Plots	14' x 14'
Sphagnum moss peat	120
Reed-sedge peat	171
Hydromulch (wood product)	166
Calcined clay	172
Vermiculite	191
Row Plots (Bands)	Bushels/acre (ave. of 2 reps) (15.5% moisture)
Hydromulch (wood product)	194
Composted garbage	188
Reed-sedge peat (fresh)	191
Reed-sedge peat (composted)	194
Sphagnum moss peat	185
Vermiculite 1/2"	183
Vermiculite 3/4"	189
Vermiculite 1"	181
Calcined clay	177

POTATO FERTILIZATION ON IRRIGATED LOAMY SANDS - ELK RIVER 1968-1973

C. J. Overdahl and C. P. Klint[1/]

Fertilizer rates of 0, 150 and 500 pounds per acre of K_2O have been applied annually for potatoes since 1968. Also a rate of 50 pounds of magnesium on these various potassium rates have been compared to the same K treatments without magnesium.

Potato yields, soil test levels, and petiole analysis have been used to study the effect of these treatments. Soil test K was initially high (280 pounds exchangeable K). No yield response due to high broadcast potash applications have been observed. Significant responses were obtained from row treatments in 1972 and 1973.

There has been no significant effect of added magnesium at any time. It has been observed that high rates of potash considerably reduce petiole magnesium.

Chieftan was the variety used in 1973. Norland was used for each of the years preceding 1973.

Tuber yields by years were as follows:

Potassium-magnesium Effect	Yield, Cwt/Acre				
$N + P_2O_5 + K_2O + Mg$	1968	1969	1970	1972	1973
200 + 150 + 0 + 0	158	270	267	210	340
200 + 150 + 150 + 0	170	288	268	320	461
200 + 150 + 500 + 0	189	286	287	339	493
200 + 150 + 0 + 50	195	286	237	207	311
200 + 150 + 150 + 50	199	327	294	334	479
200 + 150 + 500 + 50	183	305	263	284	446

1/ Efforts of Dean Fairchild, Bob Schoper, Bob McCaslin, Charles Behrens, Glenn Titrud and others are gratefully acknowledged.

Petiole Analysis

K_2O	Mg	% K			
		1968	1969	1972	1973
0	0	5.82	4.70	0.47	5.24
150	0	6.00	6.25	5.95	7.95
500	0	6.73	6.78	11.16	9.66
0	50	5.95	4.39	0.79	4.69
150	50	6.18	6.48	6.80	7.93
500	50	6.88	7.12	10.68	9.43
		% Mg			
0	0	.31	.27	1.12	0.53
150	0	.26	.15	0.42	0.30
500	0	.17	.11	0.07	0.13
0	50	.36	.40	1.42	0.87
150	50	.30	.20	0.52	0.35
500	50	.19	.13	0.10	0.23

Soil Tests

K_2O	Soil Test K			
	1968	1969	1970	1973
0	280	221	182	135
150	-	292	295	240
500	-	518	408	475

No soil tests were made in 1971 and 1972, petiole samples were not analyzed in 1970. Rye was grown on the plot in 1971.

FERTILIZER TRIALS ON ALFALFA - ELK RIVER 1973

C. J. Overdahl and C. P. Klint[1/]

The alfalfa plots were reseeded in the spring of 1971 and the design modified. The 1972 results are reported in Soil Series 89 (bluebook). In the fall of 1972, the plot treatments were again modified when all potash treatments were reduced by one half. These were reduced from 240 lbs. K_2O per acre in October, 240 lbs. K_2O per acre in June and 240 lbs. of K_2O applied both October and June.

Alfalfa yields (4 cuttings), soil test K and percent K in plant tissue for irrigated vs. unirrigated plots were as follows:

	Rates of K_2O/acre and Time of Application				
	0	0 Oct. 120 June	120 Oct. 0 June	120 Oct. 120 June	
Irrigated (avg. pH 6.9)					
Yield T/A	3.7a	6.3bc	5.9b	6.7c	
Soil test K (Sept.)	60	160	130	535	
Avg. soil P 118					
% K tissue					Avg. % P tissue
1st cut	1.00	2.47	2.91	3.42	.44
2nd cut	.91	2.07	2.12	2.81	.36
3rd cut	.94	2.36	2.04	2.85	.41
4th cut	1.13	2.31	2.12	3.35	.40
Non-irrigated (avg. pH 6.3)					
Yield T/A	2.8a	4.4b	4.1b	4.5b	
Soil test K (Sept.)	70	260	180	600+	
Avg. soil P 158					
% K tissue					
1st cut	1.18	2.96	2.98	4.11	.44
2nd cut	.72	2.15	1.94	2.80	.26
3rd cut	1.24	2.05	2.31	3.40	.45
4th cut	1.14	3.00	2.70	3.40	.38

1/ Acknowledgment is made of the considerable effort put into these plots by Dean Fairchild, Bob McCaslin, Charles Behrens and Glenn Titrud.

FOURTEEN YEARS OF FIELD EXPERIMENTATION WITH NITROGEN SOURCE, PLACEMENT AND TIME OF APPLICATION TO A WEBSTER LOAM NEAR LAMBERTON (1960-1973)

John MacGregor, Wallace Nelson and Robert Munter

(Annual reports of this experiment have been reported in Soil Series 74 through 89 - and some of this information will not be included here).

The fertilizer treatments have now been annually applied to the same plot areas for 14 years. After ear corn removal and stalk cutting, the fall plowdown N treatments are broadcast on their respective plots and the entire area is then plowed to an approximate 12 inch depth. The fall surface N treatments are then broadcast, with no further working of the plowed area. Each plot is 20' x 77.5' and the 4 treatment replications are arranged in a randomized block.

Spring N treatments are broadcast before seedbed preparation late in April or in early May. The corn is drilled in 30" rows to produce approximately 20,000 plants/A, using a banded starter fertilizer of 8-24-12 at the rate of 175 lbs. over the entire experimental area, thus supplying an additional 14 lbs. N/acre to all plots. Herbicides and insecticides are also annually applied. Nitrogen sidedressing treatments are broadcast in June. Nitrogen concentrations present in the sixth or "index" leaf at silking were determined and previously reported in some years, but this was omitted in 1973.

N P_2O_5 K_2O
14-42-21

The 1973 growing season was relatively dry, with only 0.60" of rain in the hot and critical growth month of August, which resulted in the lowest average grain yield since 1966. Ear corn was harvested late in September and the grain analyzed for N content. The 1973 grain yields, percentage dry matter at harvest, N in dry grain, and total N removed in the grain was calculated and these are shown in Table 1.

This shows the effect of annual N fertilization in a relatively dry growing season, with the 94 lb N/A treatments providing some surplus N to that removed by the crop in comparison to either the 14 or 54 lb/A treatment rates. The 174 lb/A rate appears to be excessive, (both economically and environmentally) since there is little increase in either grain yield or in N content of the corn grain. The excess (or unused) N may also increase the nitrate content of the drainage waters. Failure of the corn to remove little more than half of the N applied at the highest rate, with no increase in grain yield emphasizes the law of diminishing returns, which is especially true under drier soil conditions during the summer of 1973.

FOURTEEN YEAR AVERAGE

Average grain yields during the 14 years of the experiment are shown in Table 2. Where only 40 lbs N/A was fall applied, surface application tends to be more effective, and the urea appears to be somewhat more effective than ammonium nitrate - possibly because of its slower

? no signif.

conversion to the highly mobile nitrate form. Plowing down 80 lbs N/A each fall is more effective than the lower rate, approaching the yields produced with the 160 lb fall N treatment. Spring application of either the 40 or 80 pound N rate failed to significantly increase grain yields over similar rates applied late in the preceding fall, but there was a uniform trend toward higher yields with spring fertilization. Sidedressed N produced grain yields similar to the spring fertilized plots. The heaviest sidedressing treatments were equally effective as the same rate plowed down the previous fall.

GENERAL CONCLUSIONS

1. Late fall surface applied N is at least equal to that plowed down, but where N fertilization rates are relatively low, spring or sidedressing N treatments are more effective.

2. Urea appears at least equivalent to ammonium nitrate for producing corn in these medium textured non-calcareous soils.

3. Where corn is annually grown on these soils good yields are maintained with annual N treatments supplying about 100 lbs/A - N provided adequate P and some K are also included. Most of this will be annually removed in grain, with little or no increase in either the soil or drainage waters.

4. By proper use of insecticides and herbicides, annual optimum corn yields and total soil organic matter can be maintained or increased.

Ave. % N Recovery = 53.71%

Table 1. Average harvest grain moisture, grain yield @ 15.5% moisture, N in corn grain (dry basis) and total N removed by grain per acre from annually fertilized Webster loam with NH_4NO_3 or urea. (4 replications).

Ave. lbs removed = 69.84 #N

Treatment[1/] (lbs N/A)	% Dry matter at harvest	Bu/A @ 15.5% moisture I	II	III	IV	Ave.	Ave. % N in grain	lbs N/A removed	Annual fert. N (lbs/A)	Soil N status (lbs/A)	Ave N Removed/bu = 0.64 #N removed/bu	% N Recovery
check	70.1	94.1	63.1	60.0	59.7	69.2a	1.07a	35.0a	14	-21.0	0.50	—
40 N(NH_4NO_3) fall P.D.[2/]	71.6	81.0	97.1	92.9	97.0	92.0b	1.21abc	52.6bc	54	+ 1.4	0.57	44%
40 N(urea) fall P.D.	70.3	97.1	121.9	87.4	99.4	101.5bcd	1.29cd	62.0bcd	54	- 8.0	0.61	67.5
40 N(NH_4NO_3) fall surface	68.9	103.4	99.2	87.1	82.2	93.0b	1.12ab	49.2b	54	+ 4.8	0.52	35.5
40 N(urea) fall surface	72.6	112.3	92.8	89.7	96.3	97.8	1.35cde	62.4bcd	54	- 8.4	0.63	68.5
80 N(NH_4NO_3) fall P.D.	71.8	117.1	133.3	115.0	121.5	121.7e	1.46ef	84.1fgh	94	+ 9.9	0.69	61.3
80 N(urea) fall P.D.	70.6	107.9	145.9	91.9	125.7	117.9cde	1.39def	78.2efg	94	+15.8	0.66	54.0
160 N(NH_4NO_3) fall P.D.	71.2	112.8	135.5	119.4	116.3	121.0de	1.63gh	93.4h	174	+80.6	0.77	36.5
160 N(urea) fall P.D.	72.4	128.0	116.5	111.6	103.4	114.9cde	1.71h	92.8h	174	+81.2	0.80	36.1
40 N(NH_4NO_3) spring	72.2	103.4	119.7	103.9	89.2	104.1bcde	1.33cde	65.0cde	54	-11.0	0.62	75.0
40 N(urea) spring	69.6	101.6	121.0	90.9	76.0	97.4bc	1.22abc	55.7bc	54	- 1.7	0.57	51.7
80 N(NH_4NO_3) spring	68.8	116.5	131.9	106.1	117.5	118.0cde	1.30cd	72.8def	94	+21.2	0.61	47.2
80 N(urea) spring	70.1	109.1	147.3	102.0	111.8	117.6cde	1.39def	76.5def	94	+17.5	0.65	51.8
40 N(NH_4NO_3) sidedress	71.2	95.8	83.8	112.1	104.5	99.1bc	1.25bcd	57.9bc	54	- 3.9	0.58	57.2
40 N(urea) sidedress	70.6	135.2	92.2	92.6	95.4	103.9bcde	1.33cde	65.0cde	54	-11	0.62	75.0
80 NH_4NO_3 - sd	72.4					109.4 bcde	1.52 fg	76.5 efgh	94	+ 15.5	0.71	54.3
80 Urea - sd	71.8					124.0 e	1.46 ef	85.2 fgh	94	+ 8.8	0.68	62.7
160 NH_4NO_3 - sd	69.4					117.1 cde	1.65 gh	90.9 gh	174	+ 83.1	0.77	34.9