Table 1a. The effect of potash, magnesium (Epsom salts), and dolomitic limestone on dry matter yield of grass pasture. Kelly farms, 1978.

	pounds dry grass/acre				
	Cuttings				
	1	2	3	4	Total
Lime 4 T/A*	1690	2772	1226	939	6627
No lime	1803	2362	1336	1026	6527
Significance	ns	*	ns	ns	ns
BLSD (05)	-	353			
Lbs K_2O/A					
0	1850	2528	1230	911	6518
160	1716	2473	1113	886	6187
320	1767	2677	1228	928	6800
640	1624	2512	1545	1284	6964
1000	1803	2537	1313	942	6595
1000+100# Mg/A	1719	2674	1256	948	6596
Significance	ns	ns	ns	*	ns
BLSD (05)	-	-	-	184	-

Table 1b. The effect of potash, magnesium (Epsom salts), and dolomitic limestone on dry matter yield of grass pasture. Kelly farms, 1979.

	pounds dry grass/acre				
	Cuttings				
	1	2	3	4	Total
Lime 4 T/A*	1210	3164	386	930	5690
No lime	1448	3126	326	742	5642
Significance	ns	ns	ns	ns	ns
Lbs K_2O/A**					
0	1000	3380	358	712	5450
160	1238	3394	404	884	5918
320	1409	2779	385	881	5454
640	1427	2340	394	915	5676
1000	1434	3240	283	885	5842
1000+100# Mg/A	1465	3138	311	739	5652
Significance	ns	ns	ns	ns	ns

* Lime added early spring of 1978 + all plots received 120# N/A and 40# P_2O_5/A in 1978 and 1979.

** No potassium added in 1979; 100# Mg was applied both in 1978 and 1979.

Table 2a. Emission spectrograph analysis 1st cutting, Kelly farm, Washington Co. 1978.

Treatment	% P	% K	% Ca	% Mg	ppm Fe	ppm Mn	ppm Zn	ppm Cu	ppm B
No lime	.31	4.10	.30	.16	155	137	34	8	5
Lime 4 T/A	.31	4.48	.27	.14	155	149	35	8	5
Significance	ns	ns	+	*	ns	ns	ns	ns	ns
BLSD (5%)	-	-	.02	.01	-	-	-	-	-
lbs K_2O/A									
0	.35	4.16	.30	.16	153	133	36	8	5
160	.28	3.87	.29	.14	143	129	33	8	6
320	.33	4.47	.29	.14	162	153	35	8	6
640	.30	4.38	.29	.15	158	145	34	8	4
1000	.32	4.56	.28	.16	154	152	35	8	5
1000 + 100# Mg	.28	4.30	.28	.15	159	147	34	8	7
Significance	*	*	ns	ns	ns	+	ns	ns	ns
BLSD (5%)	.04	.44	-	-	-	18	-	-	-

Table 2b. 2nd Cutting

No lime	.32	3.32	.30	.16	71	159	30	8	5
Lime 4 T/A	.34	3.56	.27	.15	70	204	30	8	6
Significance	ns	*	ns	ns	ns	ns	ns	ns	ns
BLSD (5%)	-	.23	-	-	-	-	-	-	-
lbs K_2O/A									
0	.34	3.20	.29	.16	66	169	30	8	6
160	.33	3.42	.30	.15	72	161	31	8	5
320	.31	3.41	.26	.13	66	190	30	8	5
640	.33	3.57	.28	.16	71	189	30	8	5
1000	.35	3.43	.32	.17	78	202	30	8	6
1000 + 100# Mg	.32	3.62	.27	.16	71	176	31	9	5
Significance	ns	ns	ns	+	ns	ns	ns	ns	ns
BLSD (5%)	-	-	-	.02	-	-	-	-	-

Table 2c. Emission Spectrograph analysis 3rd cutting, Kelly farm, Washington Co. 1978.

Treatment	%				ppm				
	P	K	CA	Mg	Fe	Mn	Zn	Cu	B
No lime	.36	3.47	.34	.19	71	163	29	8	6
Lime 4 T/A	.38	3.88	.29	.17	72	183	28	9	6
Significance	+	+	+	*	ns	ns	ns	ns	ns
BLSD (5%)	.02	.24	.04	.01	-	-	-	-	-
Lbs K_2O/A									
0	.39	3.77	.34	.17	73	179	31	8	6
160	.37	3.57	.32	.18	70	140	28	8	6
320	.38	3.53	.29	.15	72	181	27	8	6
640	.36	3.63	.32	.19	74	175	27	8	6
1000	.37	3.73	.31	.19	66	207	28	8	6
1000 + 100# Mg	.37	3.82	.32	.19	75	158	30	9	6
Significance	ns	ns	+	*	ns	**	+	ns	ns
BLSD (5%)	-	-	.03	.02	-	25	3	-	-

Table 2d. 4th cutting.

No lime	.37	3.04	.42	.23	124	185	28	7	4
Lime 4 T/a	.39	3.10	.38	.20	124	214	26	8	5
Significance	*	ns	ns	+	ns	ns	ns	ns	ns
BLSD (5%)	.01	-	-	.02	-	-	-	-	-
Lbs K_2O/A									
0	.38	2.98	.44	.21	129	233	30	8	5
160	.38	2.99	.41	.22	126	146	28	8	5
320	.39	2.95	.40	.18	115	220	27	8	5
640	.37	3.07	.38	.24	123	170	26	7	5
1000	.39	3.25	.37	.22	122	268	27	8	5
1000 + 100# Mg	.37	3.15	.39	.23	131	160	27	8	5
Significance	ns	ns	ns	**	ns	ns	ns	ns	ns
BLSD (5%)	-	-	-	.02	-	43	-	-	-

Table 3a. Emission spectrograph analysis of pasture, Kelly farms, Washington Co., 1979. 1st cutting.

Trt.	% P	% K	% Ca	% Mg	ppm Al	ppm Fe	ppm Mn	ppm Zn	ppm Cu	ppm B
No lime	.31	3.67	.24	.14	21	89	117	33	7	5
Lime	.28	3.64	.25	.17	33	94	72	31	7	5
Significance	ns	ns	+	ns	**	ns	*	ns	ns	+
BLSD	-	-	.01	-	1	-	34	-	-	1
Lbs K_2O/A										
0	.28	3.10	.28	.16	22	88	83	32	8	6
160	.28	3.61	.26	.17	21	90	91	32	6	5
320	.27	3.58	.26	.16	24	87	100	33	7	5
640	.30	3.76	.23	.14	23	90	94	32	7	5
1000	.30	3.77	.21	.13	34	85	94	31	7	5
1000+100# Mg	.31	4.12	.20	.18	37	109	109	33	8	5
Significance	ns	**	**	**	ns	ns	ns	ns	*	*
BLSD	-	.27	.02	.02	-	-	-	-	1	1

Table 3b. Emission spectrograph analysis of pastures, Kelly farms, Washington Co., 1979. 2nd cutting.

Trt.	% P	% K	% Ca	% Mg	ppm Al	ppm Fe	ppm Mn	ppm Zn	ppm Cu	ppm B
No lime	.26	2.94	.22	.14	25	61	128	32	8	4
Lime	.24	2.97	.22	.16	21	60	72	31	7	3
Significance	**	ns	ns	+	ns	ns	**	+	ns	ns
BLSD	.13	-	-	.01	-	-	1	1	-	-
Lbs K_2O/A										
0	.25	2.46	.26	.17	18	58	84	34	8	4
160	.23	2.46	.26	.17	23	59	86	31	7	4
320	.23	2.86	.25	.15	23	64	111	32	7	4
640	.27	3.28	.20	.13	34	65	102	32	7	4
1000	.27	3.30	.19	.11	19	58	95	30	7	4
1000+100# Mg	.26	3.41	.16	.16	19	60	126	31	7	3
Significance	**	**	**	*	ns	ns	*	ns	+	ns
BLSD	.02	.38	.03	.03	-	-	28	-	.7	-

Table 3c. Emmission spectrograph analysis of pasture, Kelly farms, Washington Co., 1979. 3rd cutting.

Trt.	% P	% K	% Ca	% Mg	ppm Al	ppm Fe	ppm Mn	ppm Zn	ppm Cu	ppm B
No lime	.28	2.88	.33	.20	30	81	148	25	6	7
Lime	.29	2.97	.34	.24	26	81	74	25	6	6
Significance	ns	ns	ns	ns	ns	ns	*	ns	ns	ns
BLSD	-	-	-	-	-	-	3	-	-	-
Lb K_2O/A										
0	.29	2.52	.39	.23	30	86	98	90	7	8
160	.27	2.80	.35	.22	24	74	100	99	6	6
320	.27	2.68	.37	.25	35	80	125	87	6	6
640	.29	3.19	.32	.20	24	84	108	101	6	6
1000	.28	3.00	.28	.18	26	79	105	104	6	6
1000+100# Mg	.31	3.34	.27	.24	23	82	132	100	7	6
Significance	ns	+	*	+	+	ns	+	ns	ns	+
BLSD	-	.58	.07	.05	8	-	25	-	-	1

Table 3d. Emission spectrograph analysis of pasture grasses, Kelly farms, Washington Co., 1979. 4th cutting.

Trt.	% P	% K	% Ca	% Mg	ppm Al	ppm Fe	ppm Mn	ppm Zn	ppm Cu	ppm B
No lime	.21	1.75	.47	.21	60	99	292	21	4	7
Lime	.22	1.87	.45	.26	62	94	121	21	4	6
Significance	ns	*	ns	**	ns	ns	**	ns	ns	+
BLSD	-	.06	-	.01	-	-	17	-	-	1
Lbs K_2O/A										
0	.22	1.50	.54	.26	52	90	192	24	4	7
160	.21	1.69	.47	.24	63	99	200	20	5	6
320	.21	1.95	.48	.24	54	87	200	21	5	6
640	.21	1.89	.44	.21	63	101	204	20	5	6
1000	.22	1.87	.42	.20	65	104	193	19	4	7
1000+100# Mg	.22	1.94	.39	.27	67	100	251	22	5	7
Significance	ns	*	*	**	ns	ns	+	ns	ns	ns
BLSD	-	.26	.09	.03	-	-	40	-	-	-

Table 4a. The effect of varying nitrogen treatments on grass yield (dry matter) and percent nitrogen, Kelly farm, 1978.

Treatment N	P_2O_5	K_2O	lbs D.M./A 1	2	3	4	Total	%N 1	2	3	4
0	0	0	969	2066	1040	871	4946	2.75	2.32	2.73	3.20
0	40	40	1098	2129	1093	1018	5340	2.96	2.07	2.68	3.23
30	40	40	1314	2364	1038	1042	5759	3.05	2.29	2.69	3.11
60	40	40	1750	1978	1145	890	5763	3.70	2.71	2.66	3.39
*120(60+60)	40	40	1567	2295	1756	950	6568	3.72	2.48	3.37	3.43
Significance			**	ns	**	ns	**	**	**	**	ns
BLSD (05)			174	-	246	-	.796	.41	.27	.35	-
C.V.			9.1	12.6	13.7	25.5	8.9	8.5	7.2	8.0	6.7

*60# N/A spring + 60# N/A after second cutting

Table 4b. The effect of varying nitrogen treatments on grass yield (dry matter) and percent nitrogen, Kelly farm, 1979.

Treatment N	P_2O_5	K_2O	lbs D.M./A 1	2	3	4	Total	%N 1	2	3	4
0	0	0	572	1734	489	946	3740	2.60	1.63	2.34	2.03
0	40	40	524	1616	532	854	3526	2.59	1.95	2.28	2.10
30	40	40	935	1898	494	818	4145	2.88	1.61	2.14	2.02
60	40	40	1357	2638	475	883	5347	3.57	1.90	2.48	2.13
120(60+60)	40	40	1074	2198	1434	1281	5986	3.74	1.94	3.26	2.07
Significance			**	*	**	+	**	**	+	**	ns
BLSD (.05)			215	630	247	319	739	.37	.29	.37	-
C.V.			16.8	19.1	25.1	23.2	11.2	8.2	11.1	9.9	5.0

Table 5a. Pounds of nitrogen removed per acre and yield of protein. Kelly farms. 1978.

Treatment N	P_2O_5	K_2O	lbs N removed 1	2	3	4	Total	yield lbs protein/ acre
0	0	0	26.7	47.9	28.4	28.0	131.0	819
0	40	40	32.4	43.9	29.1	32.4	137.8	863
30	40	40	40.1	54.0	27.8	32.2	154.1	963
60	40	40	64.6	53.6	30.6	29.9	178.7	1119
120(60+60)	40	40	58.4	57.0	58.4	32.1	205.4	1281
Significance			**	ns	**	ns	**	
BLSD (05)			7.3	-	4.8	-	19.0	
C.V.			11.7	11.7	9.9	21.6	9.0	

Table 5b. Pounds of nitrogen removed per acre and yield of protein. Kelly farms. 1979.

Treatment N	P_2O_5	K_2O	lbs N removed/A 1	2	3	4	Total	yield lbs protein/ acre
0	0	0	14.9	28.6	11.4	19.1	74.0	460
0	40	40	13.5	31.7	12.0	18.0	75.2	459
30	40	40	26.7	30.3	10.6	16.6	84.2	529
60	40	40	48.2	49.9	11.7	18.6	128.4	800
120(60+60)	40	40	40.0	42.6	45.6	26.5	154.7	2652
Significance			**	*	**	*	**	
BLSD (.05)			5.9	12.8	4.0	7.2	10.9	
C.V.			14.6	21.9	15.5	21.4	7.5	

Table 6. Soil tests average of 2 samples per plot at 0 to 3 and 3 to 6 inch depths, according to lime and potash treatments. Kelly farms, Washington Co., 1978 & 1979.

	Potash treatment per acre																	
	0			160			320			640			1000			1000 + Mg		
	pH	P	K	pH	P	K	pH	P	K	pH	P	K	pH	P	K	pH	P	K
0 to 3 inch depth 1978																		
No lime	5.2	24	192	5.2	39	270	5.2	21	314	5.4	42	548	5.4	26	580	5.4	31	600+
Lime	6.2	28	263	6.3	28	207	6.1	28	340	6.2	23	490	6.0	27	555	6.2	23	600+
3 to 6 inch depth 1978																		
No lime	5.4	16	155	5.4	26	195	5.4	13	160	5.4	28	314	5.4	18	426	5.3	16	360
Lime	5.6	22	201	5.6	15	129	5.4	16	236	5.5	15	264	5.5	21	375	5.5	16	479
Avg. P & K 0-6"		23	203		27	200		20	263		27	404		23	484		22	510
0 to 3 inch depth 1979																		
No lime	5.2	11	65	5.1	16	212	5.2	9	135	5.2	19	308	5.2	16	371	5.3	16	294
4 T/A	6.4	17	139	6.5	17	122	6.5	19	205	6.4	24	328	6.4	24	420	6.5	16	328
3 to 6 inch depth 1979																		
No lime	5.6	9	44	5.3	15	152	5.5	8	96	5.3	17	252	5.5	14	271	5.4	13	323
4 T/A	5.6	15	110	5.7	12	75	5.7	15	137	5.6	14	267	5.6	19	308	5.6	13	297
Avg. P & K 0-6"		13	89		15	140		13	143		19	289		18	343		15	311

Avg. pH	1978		1979	
	0-3"	3-6"	0-3"	3-6"
No lime	5.2	5.4	5.2	5.4
4 T/A	6.2	5.6	6.4	5.6

Table 7. Yield comparisons of bromegrass comparing effects of urea vs ammonium nitrate topdressing on high pH soil. 1979.

Nitrogen lbs/A	form	time	*1st cutting	2nd cutting	1979 total
			lbs/A dry matter		
0	-	-	6968	3668	10636
50	urea	1	6742	3723	10465
50	"	2	7120	3698	10818
50	"	3	7648	2620	10268
50	AN	1	5455	2937	8092
50	"	2	6596	3389	9985
50	"	3	6438	3435	9873
100	urea	1	6217	3748	9965
100	"	2	6406	3742	10148
100	"	3	6886	3556	10442
100	AN	1	6158	3487	9644
100	"	2	6422	4018	10440
100	"	3	6794	3564	10358

	urea	AN	none
		lbs/A (DM)	
Total 2 cuts	10394	9580	10270

* Time 1= April, 2=at 1st cut, 3=at 2nd cut

INFLUENCE OF APPLICATION OF LIQUID CATTLE MANURE ON THE NUTRIENT LEVEL OF AGRICULTURAL SOILS IN JACKSON COUNTY, MINNESOTA - 1979

Mike O'Leary, Tim Wagar, and Charles Simkins

Wilder Farms of Jackson County, Minnesota is a cattle feeder operation that annually produces approximately 10,000 animals for processing.

The capacity of the feed lot is 5,000 animals. A majority of the livestock is raised in a slatted floor confinement area. Approximately 4 million gallons of manure is collected yearly.

The manure is normally applied on cropland for disposal. A large tank wagon with an injection system is utilized to apply the liquid manure. Nearly 80 percent of the land area of the farm (850 acres) receives an application of manure either in the spring or fall. The liquid manure is applied at the rate of 15-18 tons per acre. Most of the crop area on the farm is used to produce corn which is harvested as silage and fed to the beef animals. In recent years the only commercial fertilizer used has been 100 lbs/A of K_2O broadcast and 100 lbs/A of 5-12-10 starter.

This cattle feeding operation has been in operation for many years. The specific quantity of manure applied to each field during this time is unknown.

Soils

The soils of the farm are largely Clarion, Nicollet and Webster. Most of the land is nearly level to gently tolling. Clay loam is the main soil texture. These soils have a high nutrient and water holding capacity.

The depressional lands, mainly Webster and Glencoe soils, have been tiled in order to improve the drainage of the lands.

Soil tests prior to manure applications were not made. The level of available phosphorus and potassium prior to the time that cattle feeding operations were initiated is not known.

Methods of Study

The Wilder Farm which consists of 850 acres was divided into 24 soil sampling areas. Each area was approximately 35 acres in size. (See Annex 2).

Soil samples were taken at random in each area. 20 cores were obtained from the area. Cores were taken from a depth of 0-6 inches and from 0 to 24 inches.

The composite samples were analyzed for pH, O.M., P, K and conductivity from a saturated extract. Only NO_3N determinations were made on the samples taken from a depth of 0 to 24 inches. The areas sampled were relatively uniform in respect to soil type.

Results

The results of the soil tests from the various areas are given in Annex 1.

Nitrate-Nitrogen

The nitrate-nitrogen accumulation to a depth of 2 feet ranged from 112 to 900 pounds per acre. Normally a test of 150 lbs. of nitrate-nitrogen in the 0 to 2 feet of soil indicates sufficient nitrogen for optimum yields of corn. The areas tested indicated the following levels.

	Level of NO_3N lbs/acre	Number of areas
Very low	0 - 30	0
Low	30 - 50	0
Medium	51 - 90	0
High	91 - 150	3
Very High	151 - 200	5
Excessive	201 - 500	8
Excessive	500 +	2

Based on the nitrate-nitrogen levels present in most areas, there is good evidence that past manure treatments have resulted in a rather high level of nitrogen for crop production. Since it is the intention of the producer to put additional manure on those fields which had less than 200 pounds of nitrate-nitrogen, it is unlikely that any nitrogen fertilizer would be needed for this years corn crop.

Phosphorus

Phosphorus test levels were determined by the Bray No. 1 method using a soil to extract ratio of 1 to 10. The soil test values for all areas tested are shown in Annex 1. Phosphorus soil test levels ranged from 34 to 175 lbs. of P per acre. A test of more than 30 lbs. per acre of phosphorus is considered to be a relatively high test and little or no crop yield response is obtained by use of additional phosphorus fertilizer. Research results have shown that the use of a small amount of phosphorus and potassium fertilizer at planting time can give economical increases in yields in 5 out of 7 years. This so called "starter effect" can result in yield increases from 5 to 10 bushels per acre.

A summary of the phosphorus level from the various areas are as follows.

		Number of areas
Very low	0 - 5	0
Low	6 - 10	0
Medium	11 - 20	0
High	21 - 30	0
Very high	31 - 50	6
Extremely high	50 +	18

Potassium

The exchangeably potassium was extracted from the soil sample with normal ammonium acetate. A test level of 200 lbs. per acre K is considered high. Tests of over 300 are considered very high. The soil test values and the relative levels in respect to good corn production are as follows.

		Number of tests
Very low	0 - 50	0
Low	51 - 100	0
Medium	101 - 200	3
High	201 - 300	16
Very High	300 +	5

These tests are relatively high when one considers that each year the entire corn crop is removed for corn silage. It is unlikely that additional potassium fertilizer would result in economical increases in crop yield.

Organic Matter

The organic matter level of the 0-6 inch sample taken from each area was determined by a modified Walkley - Black method. These determinations were made to assist the producer in applying herbicides. In general these analyses indicate a rather high level of organic matter. These levels of organic matter probably contribute greatly to the annual soil nitrogen level. There would appear, however, to be little correlation between the percent organic matter and the quantity of nitrate-nitrogen found in the top 2 feet of soil. Soils with organic matter levels of 5 to 6 percent displayed higher nitrate-nitrogen levels than those of 7 percent or above. This illustrates the fallacy of using the organic matter level of a soil as a measure of annual nitrogen availability. It stresses the need for an annual test to determine the nitrate-nitrogen level of each individual field.

Conductivity

Conductivity measurements were made on each area to determine the relative quantity of possible soluble salts which might be injurious to crop growth and soil degeneration. The level of conductivity and the possible depression in crop yields is often expressed as follows.

Conductivity mmhos/cm	Effect on crop
0 - 2	None
2 - 4	Sensitive crops effected
4 - 8	Many crops effected
Over 8	Most crops effected

Only two areas sampled displayed conductivity levels which might have a deleterious effect on crop yields. Those areas which had a high conductivity level also displayed a high level of nitrate-nitrogen. No more manure should be applied on these areas until the conductivity level is below 1.0 mmhos/cm.

Summary and Recommendations

Soil samples taken from 24 areas of the Wilder Farm in Jackson County indicate relatively high levels of nitrate-nitrogen, available phosphorus and exchangeable potassium. Except for the application of starter fertilizer at planting time, the need for additional fertilizer for corn production is probably not warranted.

1. For the 1980 cropping year, each area should be sampled and tested for nitrate-nitrogen. (Preferably in the fall, 1979).

2. It will not be essential to sample the areas for phosphorus and potassium in 1980.

3. Those areas with a conductivity level above 2.0 mmhos/cm should be re-sampled in the fall of 1979.

4. During the 1979 cropping season it is suggested that comparisons of manure and no manure be carried out on several fields by use of strips. Yield determinations should be made from the treated and non-treated areas at harvest time.

5. Soil and plant analysis for zinc might be carried out in the near future. The soils of this area may be deficient in zinc, especially when phosphorus levels are high.

6. It is unlikely in this case since cattle manure contains considerable zinc. The analysis of the manure is shown in Annex 3. It is evident that the amount of heavy metals in the manure would not pose any problems in a land application program.

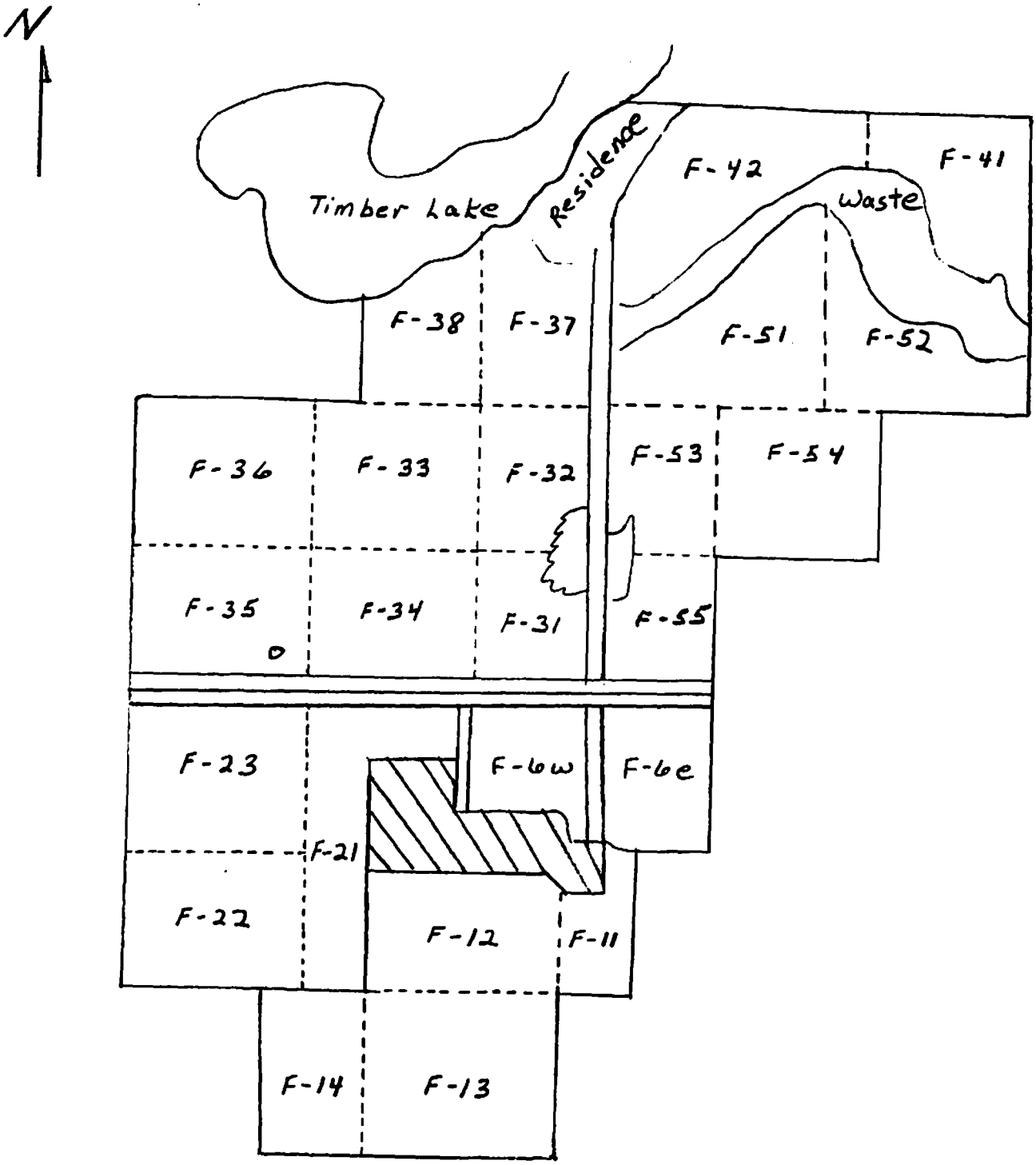
7. Soil and plant analyses could be helpful in avoiding any future problems.

ANNEX 1

Results Soil Analysis - Wilder Farms
Wilder, Minnesota

Field F_1	NO_3N Lbs/A	P Lbs/A	K Lbs/A	OM %	COND. mmhos
Area 1	Alfalfa	119	343	5.2	.8
Area 2	900	96	600+	9.9	3.0
Area 3	480	42	341	9.9	2.3
Area 4	215	36	265	7.8	.8
Field F_2					
Area 1	Oats	118	460	6.0	.8
Area 2	282	68	252	7.0	.9
Area 3	218	44	253	9.2	.7
Field F_3					
Area 1	360	59	206	4.9	.9
Area 2	350	50	195	5.2	1.0
Area 3	---	56	220	6.2	.9
Area 4	---	46	210	6.7	.7
Area 5	172	45	212	6.3	.6
Area 6	130	51	224	6.6	.7
Area 7	152	70	240	7.3	.8
Area 8	112	52	190	7.6	1.0
Field F_4					
Area 1	140	53	195	5.0	.6
Area 2	244	66	278	5.6	.6
Field F_5					
Area 1	182	85	248	5.3	.6
Area 2	175	54	247	5.2	.8
Area 3	---	34	213	8.0	.7
Area 4	---	68	264	5.2	1.0
Area 5	530	175	600+	5.7	1.3
Field F_6					
Area E	200	70	264	4.4	.8
Area W	500	60	224	5.9	.8

WILDER FARMS- WEIMER & DELAFIELD TWP.



ANNEX 3

Manure Analysis - Wilder Farms

	Percent - Wet Weight
Kjeldahl - Nitrogen	0.6
NH_3-N	0.5
PO_4-P	0.1
K	0.3

	Mg/Kg - Wet Weight
Cu	1.5
Ni	< 2.09
Pb	< 2.6
Zn	14.1
Cd	< 0.5
Cr	< 2.6

TOTAL SOLIDS	14.0%
CALCIUM CARBONATE EQUIVALENT	1.25%

YIELDS AND QUALITY OF SUNFLOWER AND WHEAT CROPS AS INFLUENCED BY FERTILIZER RECOMMENDATIONS FROM SEVERAL SOIL TESTING SERVICES*

Charles Simkins and Michael O'Leary

Farmers in Minnesota have an opportunity to utilize soil test services from a rather large number of independent as well as land-grant college laboratories. The value of these services to the agriculturist should ultimately be measured in the resulting returns of increased crop yield and or quality of the crop for the amount of investment in fertilizer.

Soil test services should supply to the farmer a fertilizer program which will result in the highest economical yield with the least cost of fertilizer.

It is nearly impossible to predict with absolute certainty the ability of a soil to supply a given nutrient for crop use. However, the use of a soil testing service which has carefully researched the soil test values against the response of the crop in the field usually provides an economical and effective fertilizer recommendation.

Most soil testing services can do a precise, reproducible test on a soil sample and obtain an index of the nutrient level in the soil. If, however, the nutrient index is not correlated and calibrated with field response the test is of doubtful value.

Minnesota soil specialists have recognized for some time that there is considerable difference in the fertilizer recommendations furnished farmers by various laboratories providing these services. Farmers in several instances have voiced a concern and have indicated that they have lost faith in soil testing because of the wide variation in recommendations they have obtained from different laboratories.

In order to develop educational information which would assist the University of Minnesota soil specialists in re-establishing farmers confidence in soil testing, experiments were established on two crops (wheat and sunflowers).

These trials were carried out on farmers fields in W. Polk and Marshall County, Minnesota. A large composite sample of soil was taken at each location in the spring of 1979. The samples were dried thoroughly, mixed and sub-divided for testing at 5 different laboratories.

Sub-divided samples were sent by the farmer to these laboratories with an indication of the desired crop and yield goal. After receiving the recommendations for the 5 different laboratories, fertilizer treatments were formulated from dry fertilizer materials. The fertilizer materials were applied broadcast and incorporated by disking prior to planting. The weed control, tillage and planting were done by the farmer cooperators.

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*This project was financed through support in part by Minnesota Wheat Council.

The samples were sent to 3 commercial laboratories and 2 land-grant college laboratories.

Results and Discussion of Sunflower Trials

The sunflower trial was established on a Bearden silty clay loam near Crookston, Minnesota. The field was well drained and soil test indexes indicate a rather high state of residual fertility. It had been in sugarbeets the previous year. Soil test values obtained from the University of Minnesota Soil Testing Laboratory were the following: pH 7.8, P - 103 lbs/acre, K - 481 lbs/acre, NO_3-N 2 feet 62 lbs/acre.

The recommended fertilizer useage by each laboratory for a yield goal of 2400 lbs/acre are shown in Table 1. Each fertilizer treatment and check plot was replicated 4 times in a randomized complete block design. Each individual plot consisted of six - thirty six inch rows forty feet in length.

Table 1. Comparison of Fertilizer Recommendations for Sunflowers (Yield Goal 2400 lbs/acre) from Various Soil Testing Laboratories - 1979

Laboratory	Recommendations lbs/acre							
	N	P_2O_5	K_2O	S	Zn	Fe	Mg	Mn
A	121	--	30	-	4	3	5	2
B	95	45	40	8	-	-	-	-
C	105	--	35	6	3	-	-	-
D	60	--	--	-	-	-	-	-
E	60	--	--	-	-	-	-	-

A summary of fertilizer costs based on average price of materials in April, 1979 is shown in Table 2.

In the case of iron the price of iron sulfate was used. An application of 3 pounds per acre of chelate iron would have greatly increased the cost of this nutrient.

Table 2. Fertilizer Costs ($/acre) from Fertilizer Recommendations for Sunflowers. Crookston - 1979

Laboratory	Total Fertilizer Costs/Acre
A	28.40
B	25.20
C	18.20
D	7.20
E	7.20

The final plant population of sunflowers was approximately 15,100 plants/acre. During the growing season there was a rather ample supply of precipitation. There were essentially no weeds in the field and little or no problems were associated with insect damage.

A number of pathological diseases were observed during the growing season and at harvest time. The most prevalent were Sclerotinia, Rhizopus and Fusarium. It is estimated that yields were reduced approximately 15 percent by the presence of these organisms.

Seed yields and oil yields were determined from samples harvested from the middle two rows of each plot.

Harvested sunflower heads were cut, bagged and dried to eight percent moisture. Threshing and cleaning of seed was accomplished with a Volgel thresher and dockage cleaning equipment.

The yields and percent oil were obtained from seed samples of areas treated as recommended by the various soil testing laboratories are compared with non-treated areas in Table 3.

Table 3. Seed and Oil Yields of Sunflowers from Fertilizer Recommendations from Various Soil Testing Laboratories. Crookston, Minnesota - 1979

Laboratory	Seed Yields Lbs/Acre	Oil Percent	Oil Yield Lbs/Acre
A	2224	38.6	858
B	2221	39.0	866
C	2292	39.0	894
D	2138	38.0	812
E	2108	37.7	795
No Treatment	2081	40.0	834
Significance	NS	NS	NS

No significant increase or decrease in seed yields, percent oil, or oil yields were observed as a result of the fertilizer treatments recommended.

The yields although somewhat reduced by disease were considered good yields for the crop year 1979. Farmers yields in the same area ranged from 1000 to 1500 lbs seed/acre.

The data indicated a slight reduction in oil percentage as a result of fertilizer applications. This reduction was not significant at the 5% level.

Results and Discussion of Wheat Trials

Wheat trials were established on a Fargo silty clay loam soil near Warren, Minnesota. The previous crop was wheat. The recommended fertilizer usage by each laboratory for a yield goal of 60 bushels of wheat per acre was applied and disked in prior to the planting of wheat. Each fertilizer treatment and check plot was replicated 4 times in a randomized complete block design. Each individual plot consisted of an area fourteen x thirty feet. The recommended fertilizer use by the various laboratories is shown in Table 4.

Table 4. Fertilizer Recommendations for Wheat (Yield Goal 60 bu/acre) from Various Soil Testing Laboratories - 1979.

Laboratory	Recommendations lbs/acre						
	N	P_2O_5	K_2O	S	Zn	Fe	Mg
A	85	--	30	--	-	3	5
B	50	30	--	24	-	-	-
C	60	--	50	5	2	-	-
D	60	--	--	--	-	-	-
E	65	--	--	--	-	-	-

The wheat crop was seeded on May 18, 1979, using 90 lbs. of Era wheat seed per acre.

The soil test value obtained from tests at the University of Minnesota Soil Testing Laboratory were as follows: pH 7.7, P - 139 lbs/acre, K - 600+ lbs/acre, NO_3-N 2 feet 81 lbs/acre.

A summary of fertilizer costs based on the average price of fertilizer materials in April, 1979 is shown in Table 5.

Table 5. Comparison of Fertilizer Costs ($/acre) Based on Fertilizer Recommendations from Various Laboratories - Wheat Trials, Warren, Minnesota - 1979

Laboratory	Total Fertilizer Costs/Acre
A	21.10
B	12.90
C	13.70
D	7.20
E	7.80

Weed control for the crop was accomplished by 2 spray applications of herbicide. During the growing season excessive rain was obtained on several occasions. Additionally, during the latter part of the growing season the crop was subjected to several weeks of continuous cloudy weather. Despite these handicaps the yield and quality of the grain was above normal whem compared to other fields in the area.

The yields, protein and test weight of the wheat obtained from the various treatments are shown in Table 6.

Table 6. Yields, Protein Percent and Test Weight of Era Wheat from Various Fertilizer Recommendations. Warren, Minnesota - 1979

Laboratory	Bu/A	Protein %	Test Weight Lbs/Bu
A	53.3	14.3	59.9
B	52.0	14.3	60.7
C	51.6	14.6	60.8
D	54.2	14.4	60.4
E	51.9	14.6	60.0
No Treatment	55.2	14.1	60.1
Significance	NS	NS	NS

No significant differences in yield, protein content or test weight of wheat were observed as a result of the various fertilizer treatments.

These trials illustrate the need for farmers to consider and select carefully the laboratory which they use to develop their fertilizer program.

1979 Soybean Foliar Fertilizer Studies**

G.E. Ham, G.W. Randall and S.D. Evans

During the 1979 growing season, Folian was applied at the rate of 100 pounds of material per acre (12-4-4-1/2 S analysis) and Eco-Gro was applied at the rate of one quart per acre (8-4-4). Hodgson '78 soybeans were planted in 14 inch rows at Rosemount and Waseca and in 30 inch rows at Morris. Foliar fertilizer treatments were not applied at Lamberton due to very frequent rainfalls during flowering and pod-filling. Soil tests indicated that no soil fertilizer was needed.

The only seed yield increase occured at Rosemount when Folian was applied. Folian did not increase seed yields at the other locations while Eco-Gro did not increase seed yields at any location.

Table 1. Influence of commercial foliar fertilizer on soybean seed yields.

	Location		
Treatment	Morris	Rosemount	Waseca
	bu/acre		
Control	37	43	36
Eco-Gro	36	44	36
Folian	38	48*	36

*Seed yield significantly greater than unfertilized control at the same location.

**This project was financed through support by Minnesota Soybean and Promotion Board.

NITROGEN FERTILIZATION OF SUGARBEETS IN WEST-CENTRAL MINNESOTA - 1979

G. L. Malzer, J. N. Lensing, and O. M. Gunderson

Nitrogen management continues to be a prime economic consideration that sugarbeet growers not only in West-Central Minnesota, but also in other sugarbeet production areas should be concerned with if they are to attain maximum sugar production per acre. Nitrogen management involves many aspects of nitrogen fertilization, including not only rates of application but also nitrogen forms, methods of application and time of application. The need for nitrogen in sugarbeet production is well documented, but it has also been demonstrated that excess nitrogen fertilizer may decrease the sugar percentage and purity thereby lowering the recoverable sugar per acre. An accurate prediction of nitrogen needs is therefore essential in the overall nitrogen management system. The measurement of residual nitrates in the soil to a depth of two feet has aided a great deal in estimating the nitrogen needs for sugarbeets, but depending on the year (weather), soil type, soil organic matter, soil drainage and previous cropping history, the nitrogen fertilizer requirement may vary from one location to another. The sugarbeet variety planted and the plant population utilized could also influence the yield, quality and the nitrogen needs of the crop.

Research was initiated in 1976 to study the problem of predicting fertilizer nitrogen requirements for sugarbeets in West-Central Minnesota. One of the major concerns of the research in 1976 was to determine the adequacy of the two foot nitrate-nitrogen test in making fertilizer recommendations. Since many soils outside of the Red River Valley have better drainage characteristics, large accumulations of nitrate-nitrogen below a depth of two feet have been encountered. If sugarbeets are capable of utilizing large quantities of nitrate-nitrogen below a depth of two feet this will influence the fertilizer nitrogen needs and the soil test should be altered to make a more accurate prediction. The objectives of the studies in 1979 were to look at various aspects of nitrogen management and to: 1) evaluate the importance of deep subsoil nitrates, and to determine the optimum soil sampling depth; 2) to correlate and calibrate soil nitrate-nitrogen levels to fertilizer nitrogen rates; 3) to investigate the importance of nitrogen rate, and timing of nitrogen application on soil nitrates and various yield components; 4) to evaluate the importance of nitrogen forms and rates; and 5) to determine the responses of different varieties of sugarbeets to rates of nitrogen application.

Materials and Methods: Eleven locations were selected in West-Central Minnesota for nitrogen management studies in 1979. Seven locations were established for fertilizer nitrogen correlation-calibration information, two locations to evaluate time, rate and form of nitrogen application, and two locations to investigate the response of different sugarbeet varieties to increasing rate of nitrogen.

The correlation-calibration experiments consisted of two locations with nitrogen rates of 0, 40, 80, and 120 pounds of nitrogen per acre applied in the fall as urea. These trials were established with four replications and

arranged in a randomized complete block. Five additional locations consisting of four paired comparisons of nitrogen fertilizer versus a no nitrogen control were also conducted. These 200-400 foot strips were established by farmers utilizing the nitrogen fertilizer rate and form which was used on the remainder of the field. Two different experiments were established to investigate the importance of time, rate, and form of nitrogen application. One location was on the Earl Davison farm which consisted of two dates of fall applied nitrogen (Aug. 15 and Nov. 5) and one spring application (May 17). Nitrogen was applied as urea at rates of 40, 80 and 120 pounds per acre. An ammonium nitrate comparison was included on the Nov. 1 application date. A second trial was established on the West-Central Experiment Station at Morris, Minnesota. The trial consisted of two dates of nitrogen application (Nov. 1 and May 15), with three rates of nitrogen (0, 40, 80 lbs. N/A), and four nitrogen sources (anhydrous ammonia, urea, ammonium nitrate, and urea-ammonium nitrate (28%) solution). All treatments were replicated four times. Trials to investigate the importance of nitrogen rates and sugarbeet varieties were established at the West-Central Experiment Station at Morris, Minnesota and the LeRoy Stamer farm in Renville County. These trials were conducted in cooperation with Dr. Larry Smith at the Crookston station and results from the Morris station along with the overall summary of the project has been prepared by Dr. Smith. Both trials were conducted in the same manner with six varieties, three nitrogen levels and four replications in a split block arrangement. Nitrogen levels were established at soil nitrate (two feet) plus fertilizer nitrogen of 150, 250, and 350 lbs N/A. The six varieties utilized were: Beta 1443, G.W. R-1, ACH-30, Beta 1345, Bush Monofort, and H 309.

Soil cores were taken to a depth of five feet prior to fertilization in all experiments. The soil cores were separated into increments of 0-½', ½-1', 1-2', 2-3', 3-4', and 4-5' and analyzed for nitrate-nitrogen. In addition soil analysis were made on a composite sample of the 0-½' depth for pH, organic matter, available phosphorus, exchangeable potassium and zinc. Young-mature petioles were sampled from all experiments three times in four week intervals beginning on July 31 to monitor nitrate-nitrogen levels in the sugarbeet tissue.

Plots were harvested during the first two weeks of October utilizing either a four row farmhand lifter or a modified one row plot harvester supplied by Dr. Smith at the Crookston Experiment Station. Subsamples were collected and processed through the tare lab either at the Minn-Dak Farmers Cooperative and American Crystal lab at Moorhead or the American Crystal lab at East Grand Forks.

Results and Discussion: Of the eleven experimental locations established in 1979 only five locations produced favorable responses to the addition of fertilizer nitrogen. The residual nitrates in the top two feet of the experimental locations were high (>150#/N) at only three locations, and this coincided very well with the lack of a nitrogen response from these areas. From the eight locations which were low to medium in nitrate-nitrogen (less than 150) in the top two feet, five locations responded to nitrogen fertilization, two locations did not appear to respond because of high subsoil nitrates (below two feet) and one was severely influenced by poor drainage.

The experiments which compared different nitrogen forms suggested that their was no difference between materials. Although there was no overall response

to nitrogen at the Earl Davison location, timing of application did directly influence yield, gross sugar and recoverable sugar. Early fall application of nitrogen was in general inferior to a later fall application. This would suggest that the position of nitrate-nitrogen in the soil profile may be an important parameter to consider when evaluating nitrogen responses and its relationship to sugar production.

Responses of different sugarbeet varieties to increasing nitrogen fertilization can be very important when evaluating sugar production. Please refer to the report by Dr. Larry Smith in the 1979 Sugarbeet Research and Extension Reports for the long term summary of this topic.

General Comments: The present two foot soil sample for nitrate-nitrogen is a very valuable tool in predicting the nitrogen needs for sugarbeets. When the nitrate test is high (greater than 150# N/A) response to fertilizer nitrogen are minimal. When the nitrate test (2') is less than 150 lbs. N/A responses and calibration are less clear cut. In several situations an estimate of the nitrate-nitrogen below a depth of two feet was useful in predicting the type of response which would be expected. The positioning of the nitrates in the soil profile may also be important and a 0-3' or 0-4' may not be as good as a 0-2' and 2-4' sample.

Minnesota soils have a tremendous ability to release nitrogen from organic matter when the moisture and growing season are adequate. The sugarbeet grower should, therefore, not be misled into believing he needs to apply large amounts of nitrogen to obtain high tonnage. These excessive rates of nitrogen fertilization can decrease sugar and purity and not necessarily increase tonnage.

Acknowledgements: Sincere appreciation is extended to the Sugarbeet Research and Education Board and to the University of Minnesota Experiment Station for financing and supporting this research project. Recognition should be given to our farmer-cooperators for their interest and assistance and to Wayne Schwitter for his special assistance during harvest. Special appreciation is also extended to Jerome Lensing and the Department of Soil Science field crew for their attention to the field phases of the project and to Dr. Larry Smith and Mr. Gordon Rudolph for their assistance with the experiments.

Table 1. Soil nitrate-nitrogen at the experimental locations for the 1979 studies.

Soil Depth	H. Peterson, P. Frieborg ----- Calibration ------		E. Davison N Rate x Time Aug. 15, Nov. 5, May 17			W.C. Station N Form	L. Stamer N Variety
Feet	---------- lbs NO_3-N/A ----------						
0-½	34	45	17	23	24	24	17
½-1	43	17	9	18	17	20	7
1-2	66	20	9	17	18	23	15
2-3	40	13	9	9	10	44	8
3-4	97	18	9	9	10	43	
4-5	34	16	9	8	7	33	

Table 2. Effect of various rates of nitrogen on sugarbeet root yield, percentage sugar, gross sugar, purity, and recoverable sugar. Harold Peterson farm, Chippewa County - 1979.

Nitrogen Rate	Yield	Sugar	Gross Sugar	Purity	Recoverable Sugar
lbs/A	T/A	%	lbs/A	%	lbs/A
0	19.8	16.8	6636	87.7	5814
40	21.2	16.4	6960	87.1	6080
80	20.4	15.6	6360	83.5	5324
120	19.4	15.9	6184	85.4	5285
Significance	NS	NS	NS	**	NS
BLSD (.05)	--			0.2	

Table 3. Effect of various rates of nitrogen on sugarbeet root yield, percentage sugar, gross sugar, purity, and recoverable sugar. Pete Frieborg farm, Renville Co. - 1979.

Nitrogen Rate	Yield	Sugar	Gross Sugar	Purity	Recoverable Sugar
lbs/A	T/A	%	lbs/A	%	lbs/A
0	24.7	15.7	7760	86.4	6708
40	26.2	15.4	8072	87.5	7060
80	24.9	15.7	7809	87.3	6816
120	25.1	15.2	7640	86.5	6607
Significance	NS	NS	NS	NS	NS
BLSD (.05)	--	--	--	--	--

Table 4. Effect of nitrogen rate, timing of nitrogen application and nitrogen form on sugarbeet root yield, percentage sugar, gross sugar, purity, and recoverable sugar. Earl Davison farm, Grant County - 1979.

Treatments					Gross		Recoverable
N Rate	Date	Form	Yield	Sugar	Sugar	Purity	Sugar
lbs/A			T/A	%	lbs/A	%	lbs/A
40	8/15	Urea	14.0	18.4	5152	87.0	4481
40	11/1	Urea	16.6	19.0	6299	88.9	5598
40	11/1	A.N.	15.6	18.6	5811	88.2	5126
40	5/17	Urea	14.3	17.7	5083	85.5	4363
80	8/15	Urea	14.9	18.5	5499	85.3	4691
80	11/1	Urea	15.8	18.6	5876	86.9	5102
80	11/1	A.N.	15.5	18.5	5769	87.4	5043
80	5/17	Urea	15.5	17.9	5568	86.5	4823
120	8/15	Urea	14.9	18.4	5483	84.7	4650
120	11/1	Urea	15.6	19.0	5908	85.6	5056
120	11/1	A.N.	17.3	19.0	6564	86.4	5678
120	5/17	Urea	16.0	17.6	5606	83.0	4660
Nitrogen Rates - lbs/A							
40			15.1	18.4	5586	87.4	4892
80			15.4	18.4	5678	86.5	4915
120			15.9	18.5	5890	84.9	5011
Significance			NS	NS	NS	**	NS
BLSD (.05)			--	--	--	0.8	--
Time of N Application							
	8/15	Urea	14.6	18.4	5378	85.7	4607
	11/1	Urea	16.0	18.8	6028	87.1	5252
	5/16	Urea	15.2	17.7	5419	85.0	4616
Significance			+	*	*	+	**
BLSD (.05)			1.0	0.8	482	1.5	439
Nitrogen Form (Nov. 1)							
		Urea	16.0	18.8	6028	87.1	5252
		A.N.	16.1	18.7	6048	87.3	5282
Significance			NS	NS	NS	NS	NS
BLSD (.05)			--	--	--	--	--
N Rate x Time x Form							
Significance			NS	NS	NS	NS	NS
BLSD (.05)			--	--	--	--	--

Table 6. Effect of nitrogen rate and sugarbeet variety on root yield, sugar content, gross sugar, purity and recoverable sugar. LeRoy Stamer farm, Renville County - 1979.

N Rate	Variety	Yield	Sugar	Gross Sugar	Purity	Recoverable Sugar
lbs/A		T/A	%	lbs/A	%	lbs/A
150	Beta 1443	18.2	16.0	5840	89.8	5244
150	G.W. R-1	17.2	16.6	5714	90.9	5200
150	ACH-30	15.9	16.8	5351	91.5	4899
150	Beta 1345	15.1	17.0	5149	91.5	4711
150	Bush Mono	11.9	17.3	4108	91.7	3767
150	H 309	14.6	16.4	4790	90.5	4333
250	Beta 1443	16.5	16.6	5490	89.3	4908
250	G.W. R-1	17.2	16.4	5645	91.3	5151
250	ACH-30	18.6	17.1	6344	90.6	5746
250	Beta 1345	16.3	16.6	5446	90.4	4930
250	Bush Mono	15.8	17.0	5351	90.2	4827
250	H 309	18.4	16.3	5986	90.0	5390
350	Beta 1443	18.8	16.0	6008	89.7	5384
350	G.W. R-1	20.0	15.9	6332	88.5	5608
350	ACH-30	18.4	16.8	6174	89.9	5553
350	Beta 1345	16.4	16.2	5356	90.1	4818
350	Bush Mono	17.4	16.2	5659	89.5	5067
350	H 309	17.6	15.6	5560	88.8	4942
N Rate lbs/A						
150		15.5	16.7	5159	91.0	4692
250		17.1	16.7	5710	90.3	5159
350		18.1	16.1	5848	89.4	5229
Significance		*	NS	NS	**	NS
BLSD (.05)		2.0	--	--	0.1	--
Variety						
	Beta 1443	17.8	16.2	5779	89.6	5179
	G.W. R-1	18.1	16.3	5897	90.2	5320
	ACH-30	17.6	16.9	5956	90.7	5399
	Beta 1345	16.0	16.6	5317	90.7	4820
	Bush Mono	15.0	16.8	5039	90.5	4554
	H 309	16.9	16.1	5445	89.8	4888
Significance		**	**	**	NS	**
BLSD (.05)		1.3	0.6	527	--	482
N x Variety						
Significance		*	NS	NS	NS	NS
BLSD (.05)		2.8	--	--	--	--

Table 7. Effect of nitrogen fertilization on sugarbeet root yield, sugar percentage, gross sugar, purity and recoverable sugar - 1979.

Cooperator	Nitrate-Nitrogen 0-2'	0-3'	0-4'	0-5'	N Treatment	Yield	Sugar	Gross Sugar	Purity	Recoverable Sugar
	lbs				#/A	T/A	%	lbs/A	%	lbs/A
B. Skalbeck	47	63	77	90	0	16.0	14.7	4708	86.4	4070
Renville Co.					100	17.9	15.6	5605	88.3	4947
N. Bosch	159	230	331	366	0	18.8	15.7	5884	86.9	5120
Chippewa Co.					90	19.0	14.7	5598	84.8	4768
C. Morrow	102	144	178	205	0	13.9	19.1	5326	85.6	4564
Grant Co.					70	16.9	18.9	6418	85.2	5471
J. Berger (North)	174	261	359	397	0	14.6	18.0	5290	81.6	4340
Grant Co.					80	15.0	17.3	5192	80.2	4163
J. Berger (South)	130	176	196	208	0	9.1	18.4	3363	82.6	2771
Grant Co.					80	12.9	19.4	5006	85.7	4296

Table 5. Effect of nitrogen rate, timing of nitrogen application and nitrogen form on sugarbeet root yield, percentage sugar, gross sugar, purity and recoverable sugar. West-Central Experiment Station, Stevens County - 1979.

Treatments Time of Appl.	N Rate	N Form	Yield	Sugar	Gross Sugar	Purity	Recoverable Sugar
	lbs/A		T/A	%	lbs/A	%	lbs/A
----	0	------	19.8	17.0	6725	84.3	5766
11/1	40	A. Amm	21.0	17.4	7288	85.2	6211
11/1	40	Urea	20.2	17.0	6839	85.7	5859
11/1	40	A.N.	20.8	17.5	7290	87.7	6392
11/1	40	UAN	21.2	18.0	7628	87.3	6667
11/1	80	A. Amm	20.5	17.2	7019	85.5	6000
11/1	80	Urea	20.5	17.8	7301	85.8	6269
11/1	80	A.N.	20.8	17.0	7044	84.9	5985
11/1	80	UAN	20.5	17.4	7115	86.2	6131
5/15	40	A. Amm	20.0	17.3	6890	85.8	5918
5/15	40	Urea	21.2	17.6	7435	86.6	6439
5/15	40	A.N.	20.1	17.4	6978	85.9	5992
5/15	40	UAN	21.3	16.9	7182	82.2	5909
5/15	80	A. Amm	21.2	17.2	7340	84.3	6192
5/15	80	Urea	20.4	17.3	7027	86.2	6058
5/15	80	A.N.	20.8	16.2	6763	84.9	5742
5/15	80	UAN	20.8	16.6	6911	83.0	5750
Significance			NS	*	NS	NS	NS
BLSD (.05)			--	1.0	--	--	--
Time of Application							
Nov. 1			20.7	17.4	7191	86.0	6189
May 15			20.7	17.1	7066	84.9	6000
Significance			NS	*	NS	*	NS
BLSD (.05)			--	0.3	--	1.0	--
N Rates lbs/A							
40			20.7	17.4	7191	85.8	6173
80			20.7	17.1	7065	85.1	6016
Significance			NS	*	NS	NS	NS
BLSD (.05)			--	0.3	--	--	--
N Form							
		A. Amm	20.7	17.3	7134	85.2	6080
		Urea	20.6	17.4	7150	86.0	6156
		A.N.	20.6	17.0	7019	85.8	6028
		UAN	21.0	17.2	7209	84.7	6114
Significance			NS	NS	NS	NS	NS
BLSD (.05)			--	--	--	--	--
Time x Rate x Form							
Significance			NS	NS	NS	NS	NS
BLSD (.05)			--	--	--	--	--

Fertilizer Trials on sunflowers - 1979

S.D. Evans, G.W. Randall, C.J. Overdahl

Field trials on sunflowers were started in 1978 and continued in 1979.

Plots were located at Waseca, Morris, and Becker, Minnesota. Additional trials were conducted by Dr. Varvel in the Crookston area and his data are in the Crookston reports; and by Dr. Simkins, also reported elsewhere in the annual report. Tables 1 through 4 show results from nitroten treatments.

Table 1. Yields of sunflowers at 3 locations according to nitrogen treatments - 1979.

Treatment N lbs/A	Morris	Waseca	Becker
		lbs seed/acre	
0	1524	1930	1013
30	1992	1849	-
60	2092	1776	1746
90	2331	1619	1824
120	2426	1572	1866
150	2317	1581	1940
180	-	-	1940
Significance	**	*	**
BLSD (.05)	180	282	249
C.V.	6.8	9.8	10.2
Soil tests 1979 (early)			
Nitrate 0-2	31	56	10
P	H	M-H*	75
K	H	M-H*	60*

* 0+120+200 applied at Waseca, 0+0+120 applied at Becker.

Table 2. Effect of N treatments on leaf N, percent oil and oil yield. 1979.

N Lbs/A	Morris % N 5th leaf	Morris % oil	Morris oil lbs/A	Waseca % N 5th leaf	Waseca % oil	Waseca oil lbs/A	Becker % N 5th leaf	Becker % soil	Becker oil lbs/A
0	2.43	44.3	676	3.39	44.2	854	3.48	44.8	454
30	2.82	43.8	873	3.41	43.5	806	-	-	-
60	3.16	44.0	943	3.40	41.4	736	3.80	44.6	777
90	3.13	43.1	1009	3.48	42.2	685	3.76	45.2	801
120	3.39	43.6	1058	3.87	41.0	645	4.28	43.4	812
150	3.66	42.3	982	3.77	40.8	645	3.99	42.8	830
180	-	-	-	-	-	-	4.32	42.4	823
Significance	**	*	**	ns	**	*	**	+	**
BLSD (.05)	.35	1.0	88	-	1.1	129	.14	1.9	113
C.V.	9.1	1.7	7.8	9.7	1.8	11.2	2.6	3.1	10.6

Table 3. Soil nitrates in profile at Waseca & Morris, 1979.

Depth feet	Morris	Waseca 1st sampling May	Waseca 2nd sampling July
0-1	19	40	38
1-2	12	18	16
2-3	8	17	16
3-4	8	40	32
4-5	11	61	58

Table 4. Head size, percent lodged, population. Waseca, 1979/

	Head size cm	Head size inches	% lodged	Population plants/acre
0	15.0	6.0	2.5	23,810
30	14.7	5.8	12.0	24,540
60	15.0	6.0	17.0	24,530
90	13.6	5.4	28.2	25,840
120	13.8	5.5	27.5	24,100
150	14.1	5.6	30.0	25,700

Nitrogen summary -

Highly significant response to nitrogen was obtained at Morris and Becker. The 60 pounds per acre treatment at Becker appeared optimum and 90 pounds per acre appeared best at Morris. There was no significant response from nitroten at Waseca. High nitrates below 3 feet at Waseca appeared to be the reason for no response. Nitrates were low at Becker and Morris all the way to 5 feet. Oil content dropped as nitrogen rates were increased.

Results from potassium treatments at Becker are shown in Tables 5 and 6.

Table 5. Sunflower yield, soil test K, percent K in leaves, and percent oil related to 6 levels of potassium.

K_2O lbs/A	Yield lbs seed/A	Soil test K	% K, 5th leaf Aug. 20	% oil	Oil yield lbs/A
0	1277	63	2.60	41.2	527
60	1965	69	2.77	44.2	870
120	2017	76	2.90	44.3	914
180	2082	86	3.01	44.8	932
240	2172	87	3.27	44.7	971
300	2033	91	3.28	45.1	916
Significance	**		**	**	**
BLSD (.05)	220		.30	1.6	86

Potassium summary

The 60 pounds of K_2O treatment appeared nearly optimum, although the 240 pound treatment was significantly higher than 60 pounds. Oil content increased with treatment. The failure of the soil test to increase above a "low" level even with 300 pounds of K_2O is difficult to explain.

Table 6. The effect of potassium treatments on 9 elements in the 5th leaf - Becker, 1979.

K-Trt	---------%----------				---------ppm----------				
lbs K_2O/A	P	K	Ca	Mg	Fe	Mn	Zn	Ca	B
0	.44	2.60	2.17	1.30	68	132	47	19	30
60	.45	2.77	2.13	1.17	68	126	49	19	28
120	.45	2.90	1.96	1.02	69	124	44	19	30
180	.43	3.01	2.00	1.04	68	132	44	20	30
240	.43	3.27	1.82	.94	67	131	45	19	32
300	.44	3.28	1.88	.94	70	122	45	19	28
Significance	ns	**	*	**	ns	ns	+	ns	ns
BLSD (.05)	-	.30	.23	.10	-	-	4	-	
C.V.	3.8	6.8	7.1	6.6	3.7	16.2	5.8	7.4	14.4

NITROGEN, PHOSPHORUS AND POTASSIUM FERTILIZER RATE STUDIES ON SUNFLOWER - 1979

G.E. Varvel and R.K. Severson

The objective of this study was to gather data on the fertilizer needs of sunflower over a range of soil types and fertility levels. This data will be used for improving fertilizer recommendations on sunflower. Leaf samples were also taken during the growing season to investigate the effect of applied fertilizer on nutrient levels in the leaf and to determine if critical levels could be established for these nutrients.

Experimental Procedures:

Five potassium, 4 phosphorus and 1 nitrogen experiments were conducted in northwestern Minnesota over a range of soil types and textures. The fertilizer treatments and soil test information for each location are shown in Tables 1-10. Yield and oil content were determined for each location and leaf samples (5th leaf) at approximately 10% bloom were taken at 4 of the locations.

All treatments were spring applied. A randomized complete block design was used at all locations.

Results:

Yield, oil content and oil yield are shown in Tables 1-10 for all locations. Information on nutrient content of the 5th leaf is presented in Tables 1-4.

Significant yield responses were obtained in 3 of the experiments, 2 from phosphorus and 1 from potassium, at the Fosston and McIntosh locations (Tables 1-4). Visual responses and an increasing yield trend indicate that responses to both P and K may have been obtained at the Crookston location (Tables 5-6), but were nonsignificant due to uneven stands. The experiments at Blackduck were highly variable due to many complicating factors and no conclusions were apparent (Tables 7-10).

Oil content was not affected by the fertilizer treatments at any location.

Table 1. Effects of different rates of potassium fertilizer on sunflower at Fosston.

Treatment K_2O Rate	Yield	Oil	Oil Yield	Population at Harvest	Leaf Analyses N	P	K	Ca	Mg	Fe	Na	Mn	Zn	Cu	B
lb/A	lb/A	%	lb/A	Plants/A	%					ppm					
0	2087	42.6	888	21,586	4.6	0.54	2.52	1.81	1.08	74	13	65	54	16	98
50	2082	42.7	888	20,522	4.3	0.51	2.56	1.78	1.14	80	10	61	49	14	98
100	2147	42.7	917	22,458	4.6	0.52	2.68	2.02	1.07	77	7	69	51	13	103
150	2115	42.9	908	21,780	4.4	0.52	2.83	1.88	0.98	76	11	60	51	13	103
200	1997	42.7	852	21,393	4.5	0.53	2.90	1.98	1.00	78	8	67	51	14	103
250	2097	42.1	882	19,360	4.4	0.51	3.04	1.98	1.01	72	9	63	48	16	106
Significance	NS	NS	NS	NS	NS	NS	**	NS	NS	NS	NS	NS	NS	NS	NS
B.L.S.D.(.05)							0.22								
C.V. (%)	7.7	1.7	8.6	10.1	4.2	4.8	5.3	10.8	8.1	11.5	42.4	14.5	7.7	12.3	6.5

Table 2. Effects of different rates of phosphorus fertilizer on sunflower at Fosston.

Treatment P_2O_5 Rate	Yield	Oil	Oil Yield	Population at Harvest	Leaf Analyses N	P	K	Ca	Mg	Fe	Na	Mn	Zn	Cu	B
lb/A	lb/A	%	lb/A	Plants/A	%					ppm					
0	1937	42.5	823	19,457	4.6	0.45	3.34	2.12	0.89	73	8	69	62	19	92
40	1991	42.7	851	19,941	4.8	0.53	3.29	1.98	0.91	76	10	57	55	14	102
80	1951	41.6	811	16,069	4.6	0.54	3.23	2.03	0.99	70	8	60	54	14	102
120	2006	42.0	842	18,682	4.5	0.56	3.22	2.03	0.99	72	8	61	56	13	107
160	2157	42.4	915	19,263	4.3	0.49	3.28	2.09	1.09	63	7	61	46	14	103
200	2345	42.1	987	20,812	4.6	0.61	3.09	2.09	0.96	70	9	62	51	12	97
Significance	**	NS	**	NS	NS	**	NS	NS	NS	NS	NS	NS	*	*	NS
B.L.S.D.(.05)	232		108			0.08							11.4	4.9	
C.V. (%)	7.0	2.1	7.6	13.7	5.7	9.7	9.3	11.0	14.3	12.3	22.5	12.1	12.1	19.6	8.9

Soil Test P = 20 lb/A K = 227 lb/A Broadcast 100 K_2O over P Study.

Farmer applied 85 N as anhydrous ammonia. Broadcast 40 P_2O_5 over K Study.

Table 3. Effects of different rates of potassium fertilizer on sunflower at McIntosh.

Treatment					Leaf Analyses										
K_2O Rate	Yield	Oil	Oil Yield	Population at Harvest	N	P	K	Ca	Mg	Fe	Na	Mn	Zn	Cu	B
lb/A	lb/A	%	lb/A	Plants/A	%					ppm					
0	1628	43.7	712	22,167	4.3	0.35	2.65	1.96	1.09	59	8	64	50	22	84
50	1631	43.5	709	22,070	4.2	0.33	2.96	2.01	1.03	59	8	63	51	24	87
100	1768	43.8	775	22,651	4.0	0.33	3.15	2.24	1.05	60	10	65	48	23	95
150	1840	44.2	813	22,651	4.4	0.40	3.28	2.11	0.96	61	7	57	45	19	93
200	1900	44.1	838	22,651	4.2	0.35	3.47	2.19	0.89	62	8	62	45	24	96
250	1921	44.1	847	23,135	4.1	0.33	3.53	2.14	0.93	63	11	64	43	22	95
Significance	**	NS	**	NS	NS	NS	**	NS	NS	NS	NS	NS	*	NS	NS
B.L.S.D.(.05)	170						0.54						5.8		
C.V. (%)	6.1	1.1	6.1	8.3	4.0	13.5	10.4	11.7	13.0	8.9	27.3	15.4	7.3	14.1	9.1

Table 4. Effects of different rates of phosphorus fertilizer on sunflower at McIntosh.

Treatment					Leaf Analyses										
P_2O_5 Rate	Yield	Oil	Oil Yield	Population at Harvest	N	P	K	Ca	Mg	Fe	Na	Mn	Zn	Cu	B
lb/A	lb/A	%	lb/A	Plants/A	%					ppm					
0	1684	43.8	736	23,038	4.2	0.31	2.61	1.96	1.19	60	7	56	46	20	81
40	1613	43.5	701	23,038	4.1	0.34	2.66	2.13	1.21	59	6	62	42	21	88
80	1876	42.5	799	22,070	4.4	0.39	2.55	2.18	1.29	59	6	68	38	19	91
120	1997	43.0	859	22,458	4.4	0.43	2.48	2.25	1.39	67	7	77	36	17	99
160	1963	42.6	836	21,006	4.4	0.42	2.45	2.16	1.39	63	6	63	35	17	89
200	2032	43.2	878	22,941	4.4	0.46	2.40	2.44	1.48	61	8	76	37	16	93
Significance	**	NS	*	NS	NS	**	NS	NS	*	NS	NS	NS	**	**	NS
B.L.S.D.(.05)	262		126		0.09								5.3	2.8	
C.V. (%)	8.8	2.1	9.4	7.7	7.1	14.9	7.4	11.5	9.0	10.6	29.2	23.0	8.7	9.4	10.3

Soil Test P = 11 lb/A K = 196 lb/A Broadcast 50 lb/A K_2O over P Study.

Farmer applied 90 N as anhydrous ammonia. Broadcast 40 lb/A P_2O_5 over K Study.

Table 5. Effects of different rates of phosphorus fertilizer on sunflower - Crookston.

P_2O_5 Rate	Yield	Oil	Oil Yield
lb/A	lb/A	%	lb/A
0	1463	42.9	621
40	1601	43.5	696
80	1814	43.2	782
120	1770	40.4	713
160	1575	41.3	653
200	1627	42.2	686
Significance	NS	NS	NS
C.V. (%)	14.2	3.7	13.4

Soil Test P = 13 lb/A K = 103 lb/A Broadcast 60 lb/A N over both studies, 120 lb/A K_2O on P Study and 40 lb/A P_2O_5 on K Study.

Table 6. Effects of different rates of potassium fertilizer on sunflower - Crookston.

K_2O Rate	Yield	Oil	Oil Yield
lb/A	lb/A	%	lb/A
0	1492	40.3	600
50	1585	42.8	676
100	1461	42.3	617
150	1798	41.9	756
200	1740	42.3	736
250	1792	41.4	742
Significance	NS	NS	NS
C.V. (%)	18.7	3.1	19.0

Soil Test P = 13 lb/A K = 103 lb/A Broadcast 60 lb/A N over both studies, 120 lb/A K_2O on P Study and 40 lb/A P_2O_5 on K Study.

Table 7. Effects of different rates of nitrogen fertilizer on sunflower - Blackduck.

NO_3-N Rate	Yield	Oil	Oil Yield
lb/A	lb/A	%	lb/A
0	1246	47.5	590
30	908	46.7	428
60	1220	47.2	579
90	1370	46.4	640
120	1185	47.1	559
150	1200	45.8	548
Significance	NS	NS	NS
C.V. (%)	29.4	2.9	30.1

Soil Test P = 150 lb/A K = 154 lb/A.
Farmer had applied 100 lb/A on field.

Table 8. Effects of different rates of phosphorus fertilizer on sunflower - Blackduck.

P_2O_5 Rate	Yield	Oil	Oil Yield
lb/A	lb/A	%	lb/A
0	1463	43.5	638
40	1418	42.6	604
80	1506	42.7	641
120	1359	41.3	564
160	1703	42.6	728
200	1474	44.0	651
Significance	NS	NS	NS
C.V. (%)	10.7	4.7	12.5

Soil Test P = 11 lb/A K = 157 lb/A.
Farmer had applied 100 lb/A N on field.

Table 9. Effects of different rates of potassium fertilizer on sunflower - Blackduck.

K_2O Rate	Yield	Oil	Oil Yield
lb/A	lb/A	%	lb/A
0	1838	44.6	824
50	1711	42.3	725
150	1533	43.4	665
250	1428	43.5	619
Significance	NS	NS	NS
C.V. (%)	17.9	2.8	19.2

Soil Test P = 17 lb/A K = 95 lb/A.
Farmer had applied 100 lb/A N on field.

Table 10. Effects of different rates of potassium fertilizer on sunflower - Blackduck.

K_2O Rate	Yield	Oil	Oil Yield
lb/A	lb/A	%	lb/A
0	876	47.7	418
50	1074	46.4	498
100	938	47.3	445
150	857	46.9	405
250	858	46.9	405
Significance	NS	NS	NS
C.V. (%)	23.2	3.9	25.3

Soil Test P = 150 lb/A K = 154 lb/A.
Farmer had applied 100 lb/A N on field.

NITROGEN AND POTASSIUM STUDIES ON SUNFLOWERS IN PENNINGTON COUNTY, MINNESOTA - 1979

Charles Simkins and Michael O'Leary

The limited sunflower fertility studies in Minnesota have been conducted largely on the medium to fine textured soils of western and northern Minnesota.

In general the response to fertilizer has been relatively small and limited to nitrogen. Currently sunflower production in Minnesota has spread so that many of the coarse textured soils are being utilized for production.

These studies were conducted on a sandy loam soil overlying poorly drained sand, probably a Toppleton series. This soil represents a large acreage in Red Lake, Pennington and other counties on the beach areas of the Red River Basin.

Soil test data from the field indicated a rather low nitrate-nitrogen content (0-24 in.) of 58 to 71 lbs. The phosphorus test level at the 0-6 in. depth was 66 lbs. per acre and the K test indicated a range of 76-141 lbs. per acre.

Methods and Materials

Fertilizer materials were broadcast prior to planting and disked in. Sunflowers of the variety Sun Bred NK254 were seeded with a 6 row planter. Each plot was 15 feet by 40 feet.

Four replications of each treatment in a randomized complete block design were established in the trials. The nitrogen trials included rates of 0,30,60,90, 120, and 150 lbs. of N per acre on land which a broadcast application of 120 lbs. of K_2O has been applied.

In the potassium experiment 120 lbs. of nitrogen and 40 lbs. of P_2O_5 were applied to the experimental area with the exception of control treatments. The potassium treatments consisted of 90 lbs. of K_2O applied as KCl, K_2SO_4 and KCl plus sulfur. Remaining treatments were a non fertilized check, a nitrogen and phosphorus treatment and a nitrogen, phosphorus and sulfur treatment.

The potassium sulfate and sulfur treatments were included since the farmer had indicated that his crops often suffered from sulfur deficiency. The soil test subsequently indicated a rather high sulfur content (15 ppm).

Leaf samples were collected and analyzed for nitrogen content on the nitrogen rate study and for nitrogen, phosphorus and potassium content on the potassium study. The fifth leaf down from the blossom was utilized. The plants were sampled in the early bloom stage (Aug. 11, 1979). Weed and insect control for the trials was carried out by the cooperator. This control included a pre-plant herbicide application, one cultivation and one application of insecticide for control of sunflower leaf beetles.

Results and Discussion

The seed yields, oil percentage and pounds of oil per acre obtained as a result of the various potassium and sulfur fertilizer treatments are shown in Table 1.

Table 1. Influence of Various Fertilizer Treatments on the Seed and Oil Yields of Sunflowers - Fleshe Farm - Pennington County, Minnesota - 1979

Treatment Lbs/Acre N	P_2O_5	K_2O	Seed Yield Lbs/Acre	% Oil	Lbs Oil/Acre
0	0	0	657	39.7	263
120	40	0	888	37.2	335
120	40	90 (KCl)	1323	41.5	549
120	40	90 (K_2SO_4)	1366	41.6	566
120	40	90 (KCl+S)	1365	41.6	568
120	40	0 + S	682	37.6	256
		Significance	**	**	**
		BLSD (.05)	210	2.0	81

*Sulfur at 32 lbs/acre

Seed yields as well as oil yields were increased by nitrogen-phosphorus fertilizer treatments as well as nitrogen-phorphorus-potassium treatments. It is rather obvious that the addition of 90 lbs. of K_2O in combination with nitrogen and phosphorus resulted in striking increases in yield. The addition of sulfur either as calcium sulfate or in potassium sulfate did not result in significant increases in seed or oil yields. The inclusion of potassium in the fertilizer treatments significantly increased the percentage of oil in the sunflower crops.

Leaf analysis of the plant tissue from the various fertilizer treatments at the time of early bloom are shown in Table 2.

Table 2. Influence of Various Fertilizer Treatments on the N, P and K Content of Sunflower Leaves. Fleshe Farm - Pennington County, Minnesota - 1979

Treatment Lbs/Acre			% in Fifth Leaf		
N	P_2O_5	K_2O	N	P	K
0	0	0	3.4	.34	1.7
120	40	0	4.2	.39	1.3
120	40	90 (KCl)	4.1	.40	1.4
120	40	90 (K_2SO_4)	4.1	.41	1.9
120	40	90 (KCl+S)	4.1	.51	1.5
120	40	0+S	4.2	.42	1.4
		Significance	**	+	**
		BLSD (.05)	.4	.06	.2

*Sulfur at 32 lbs/acre

As indicated in Table 2 the application of nitrogen and phosphorus with or without the addition of potassium fertilizer increased the nitrogen and phosphorus content of the sunflower leaves. There was a significant reduction in the percent potassium in the leaves when nitrogen and phosphorus were applied alone. The percent potassium in the leaves, range (1.3 - 1.9 percent) is quite low in comparison to the level generally encountered when sunflowers are grown on soil high in potassium (normally 3.0 to 4.0 percent). The nitrogen and phorphorus levels in the fifth leaf are similar to those obtained on more fertile soils.

A nitrogen rate study conducted in the same field did not result in statistically significant increases in seed or oil yields. The seed and oil yields as well as nitrogen content of the fifth leaf as influenced by the various nitrogen treatments is shown in Table 3.

Table 3. The Influence of Various Nitrogen Fertilizer Rates on Seed and Oil Yield and Leaf Nitrogen Content of Sunflowers

Nitrogen Lbs/Acre	Seed Yield Lbs/Acre	Oil %	Lbs Oil/Acre	% N In Fifth Leaf
0	1304	43.7	567	3.5
30	1490	42.7	636	4.2
60	1421	42.0	601	3.9
90	1448	42.6	616	4.1
120	1495	43.0	643	4.2
150	1568	42.4	664	4.7
Significance	NS	NS	NS	+
BLSD (.05)	--	--	--	.7

As indicated by the data in Table 3, nitrogen fertilizer treatments did not result in significant increases in seed or oil yields. There was however, a general trend towards increasing yields as a result of nitrogen treatments. The lack of significance may have been influenced by the rather mediocre plant population (15,000 per acre).

The nitrogen content of the sunflower leaves was significantly increased by the application of nitrogen fertilizer. This would further suggest a need for higher plant population to utilize the higher nitrogen level.

NITROGEN FERTILIZATION OF IRRIGATED SWEET CORN

J.N. Lensing, G.L. Malzer, O.M. Gunderson, and S.L. Johnson.

In 1979 a trial was conducted at Westport, MN to evaluate the influence of nitrogen on the production of irrigated sweet corn. Two Green Giant varieties of sweet corn; Code 7 as early planting and Code 47 planted approximately two weeks later were evaluated with ten treatments replicated four times. Treatments included a control, 4 nitrogen rates (60, 120, 180, 240 #N/A), 2 methods of application (single preplant), split application (1/4-preplant, 1/4-8 leaf stage, 1/3-12 leaf stage, 1/6-16 leaf stage) and one treatment of 180 #N/A coated with 1/2 #a.i./A Terrazole (nitrification inhibitor). Experimental area was irrigated as needed with a one tower center pivot system. Weeds were controlled with an application of atrazine.

Dry matter and nitrogen uptake were determined by harvesting 2 rows 20 ft. long from each plot. Ears were separated from stalks, field weights obtained and samples removed for moisture determination and nitrogen analysis. Wet ear T/A were recorded because farmer payments are based on wet ear weights delivered to factory. Quality factors were analyzed on samples taken to Green Giant plant at Glencoe, Minnesota.

Results

Early planted (Code 7) sweet corn (Table 1) ear dry matter production responded to 60 #N/A with 240 #N/A significantly better than check. Stover and total dry matter production were increased significantly up to 180 #N/A in a single application compared to 60 #N/A applied as split application, however, 240 #N/A applied as a split application and 180 #N/A with terrazole were significantly better than 60 #N/A. Ear and stover %N were signficantly increased with 60 #N/A. Ear, stover and total N-removal showed similar trends as the dry matter yields. Wet ear T/A were significantly increased from 5.6 T/A without N to 10.4 T/A with 240 #N/A. Split applications of N did not significantly increase yields of wet ear T/A.

Late planted (Code 47) sweet corn (Table 2) ear dry matter yields, nitrogen removal, and wet ear T/A responded significantly to 60 #N/A. Quality factors were not significantly affect by application or rate of nitrogen for either planting dates.

Table 1. Influence of nitrogen on dry matter, % N, N-removal, and wet ear T/A of Code 7 sweet corn. Westport, MN. 1979

Treatments # N/A	# of Appl.	Ears	Stover	Total	Ears	Stover	Ear	Stover	Total	Wet Ear T/A
		----------# D.M./A----------			-------%N--------		--N-Removal-#/A----------			
0	-	2088	3004	5092	1.37	1.06	28.5	31.7	60.3	5.6
60	1	3342	3314	6656	1.55	1.84	51.5	60.7	112.2	8.3
120	1	3096	3106	6202	1.51	1.61	46.8	49.6	96.4	8.3
180	1	3510	4166	7676	1.61	1.97	56.5	82.3	138.8	9.3
240	1	4062	4262	8324	1.59	2.08	64.7	88.7	153.4	10.4
60	4	3536	3444	6980	1.53	1.64	54.4	57.0	111.4	8.8
120	4	3424	3662	7086	1.57	1.96	53.5	71.4	124.9	9.0
180	4	3744	3784	7526	1.60	2.00	59.7	74.8	134.5	9.5
240	4	3928	4056	7984	1.63	2.06	64.0	83.3	147.3	10.4
180 + Dwell		3710	4298	8008	1.65	2.08	61.3	89.1	150.4	9.9
Signif.		**	**	**	NS	*	**	**	**	**
BLSD(.05)		787	498	873	-	.52	14.5	16.0	20.9	1.7
C.V.		12.8	8.0	7.4	5.8	15.3	15.5	14.3	10.6	11.0

Table 2. Influence of nitrogen on dry matter, % N, N-removal and wet ear T/A of Code 47 sweet corn. Westport, MN. 1979.

Treatments		Ears	Stover	Total	Ears	Stover	Ear	Stover	Total	Wet Ear
# N/A	# of Appl.	----------#D.M./A----------			--------%N----------		---N-Removal----#/A----------			T/A
0	-	2622	5916	8538	1.26	1.35	32.9	79.9	112.8	6.1
60	1	3656	7150	10808	1.30	1.40	47.3	99.3	146.6	8.5
120	1	3232	7424	10656	1.41	1.59	45.5	118.2	163.6	7.4
180	1	3424	7518	10942	1.36	1.59	46.4	121.4	167.5	7.9
240	1	3162	6496	9658	1.41	1.66	44.7	107.6	152.1	7.4
60	4	3502	7298	10798	1.41	1.43	49.3	104.0	153.2	8.3
120	4	3466	6614	10080	1.32	1.48	45.7	98.4	144.1	7.8
180	4	3126	7288	10416	1.45	1.60	44.9	117.3	162.2	7.3
240	4	3204	7038	10244	1.40	1.61	45.0	113.0	158.0	7.6
180 + Dwell		3304	6582	9886	1.40	1.54	46.3	101.3	147.7	7.5
Signif.		+	NS	NS	NS	NS	+	NS	NS	*
BLSD		613	-	-	-	-	9.4	-	-	1.4
C.V.		12.2	14.1	11.7	8.0	10.3	13.7	17.7	14.1	10.9

N Rate, Source, and Incorporation Study - Wheat

W. Nelson, S. Evans, G. Varvel, J. Lensing, and H. Meredith

Objective of Study: Determine wheat yield differences when broadcast forms of nitrogen are incorporated into the surface soil or left on the soil surface unincorporated. A secondary objective of the study is to utilize the nitrate soil test to correlate soil nitrate levels and wheat grain yields.

Locations: Crookston, Morris and Lamberton experimentation stations. Site selection based on nitrate tests where probability of response to N is high.

N Sources: Urea, ammonium nitrate and 28 percent urea-ammonium nitrate solution are compared.

N Rate: At Lamberton and Morris 40 and 80 pounds N per acre were applied. At Crookston 50 and 100 pounds N per acre were applied. Zero N plots serve to delineate an N response.

In general rainfall was adequate to slightly excessive in 1979. High yields in 1977 and 1978 have tended to lower residual N levels which have increased probability of a crop response to applied N.

There were little or no yield differences between the sources or incorporation, Table 1. Most, if not all of the response to applied N was achieved from the lower N addition.

Table 1. Yield of Era Wheat at Morris, Lamberton and Morris Experiment Stations as a Response to N Rates, Incorporated vs. Non-incorporation, 1979.

Lbs N/A	Am. Nitrate		Urea		28% N Soln.	
	I	N	I	N	I	N
Morris - check: 13.4 - Yield - Bu/A						
40	23.6	25.3	27.7	21.6	25.0	24.1
80	24.4	25.4	26.5	28.4	26.6	25.0
Lamberton - check: 15.3						
40	20.4	18.7	19.3	19.6	19.8	17.8
80	21.9	21.8	19.8	20.6	22.3	21.6
Crookston - check: 31.5						
50	47.5	49.7	44.9	47.2	47.5	46.5
100	49.6	47.3	46.1	48.2	47.5	48.2

I - Incorporated N - Nonincorporated

Table 2. Nitrate Soil Tests, pH and Available Water, at Lamberton.

Depth, In.	NO_3-N Lbs/A	pH	Available Water In/ft.
0-12	29	6.0	1.69
12-24	13	6.3	1.38
24-36	21	6.9	1.55
36-48	44	7.9	1.88
48-60	39	7.9	1.85
	146		8.35

Sampled May 1979
Ave. of 4 reps.

Table 3. Nitrate Soil Tests at Morris.

Depth, In.	NO_3-N (Lbs/A)
0-12	31
12-24	17
24-36	11
36-48	25
48-60	14
0-24	48
0-36	59
0-48	84
0-60	98

THE YIELD AND PROTEIN CONTENT OF ERA WHEAT AS INFLUENCED BY STARTER FERTILIZER AT SEVERAL FARM LOCATIONS IN RED RIVER BASIN OF MINNESOTA - 1979*

Charles Simkins, Michael O'Leary, and Terrance Courneya

The application of fertilizer at seeding time with an attachment on the grain drill is a common practice in the Red River Basin of Minnesota and North Dakota. Early investigators have shown that the application of phosphorus fertilizer in this manner, particularly on soils low in available phosphorus, was an efficient means of meeting the phosphorus needs of the crop. As a general guide for low testing soils it was recommended that 40 lbs. of P_2O_5 per acre be applied with the seed at planting time. Doubling these rates was required for the same response when the fertilizer was broadcast and worked into the soil.

With time, the phosphorus reserves of most soils producing wheat have reached rather high levels in the Red River Basin. Agriculturists question the need for applying phosphorus fertilizer with the grain drill at planting time. It is generally agreed that if fertilizer could be omitted at planting time without loss of yield or quality, there would be several opportunities for economic savings.

Methods and Materials

Trials were established at 8 locations in the Red River Basin of Minnesota. Wheat producers prepared seed beds, applied nitrogen fertilizer and seeded wheat with grain drills in their customary manner. The starter fertilizer applied at seeding time with the grain drill varied from location to location. The quantity used by each producer is shown in Table 1.

During seeding the fertilizer attachment on the grain drill was shut down, so that strips the width of the grain drill were seeded without starter fertilizer.

Table 1. Starter Fertilizer Applied by Various Cooperators (Starter vs. No Starter Trials) - 1979

Cooperator	Starter Fertilizer Used	
Ross	10 gal/acre	10-34-0
Christensen	100#/acre	10-26-26
Sanders	160#/acre	10-26-26
Fleshe	100#/acre	18-46-0
Skaar	100#/acre	10-26-26

Previous to seeding soil samples were taken for chemical analysis. These chemical properties are shown in Table 2.

*This project was financed through support in part by Minnesota Wheat Council.

Table 2. Some Chemical Properties of Soils in Trials Comparing Starter Fertilizer with No Starter Fertilizer - 1979

Location	pH	NO_3-N (2 ft)	P lbs/a	K lbs/a
Skaar	8.3	---	27	251
Fleshe	8.1	---	38	160
Christensen	8.0	---	10	152
Sanders	8.1	---	25	98
Ross 1	8.2	79	54	385
Ross 2	8.1	113	21	435
Ross 3	8.1	208	51	380
Ross 4	8.1	208	51	380

At harvest time plant samples were harvested from those strips which received starter fertilizer and those strips which received no starter fertilizer. Four samples were collected from each treatment at each location. The samples consisted of 4 drill rows 30 feet in length. Yield and protein determination were made on threshed samples.

Results and Discussion

During the growing season there was little indication that the application of starter fertilizer produced a difference in plant growth which could be detected by observation. Yields in general were below normal for all the farmers or cooperators concerned. This perhaps was largely due to excessive rainfall and cloudy weather.

Comparison of yields between strips receiving starter fertilizer and no starter fertilizer are shown in Table 3.

Table 3. The Influence of Starter Fertilizer on Yield of Era Wheat - Red River Basin of Minnesota - 1979

Location	Yield Bu/A	
	Starter	No Starter
Christensen	53.9	50.9
Sanders	37.6	37.8
Fleshe	27.5	28.3
Skaar	45.2	44.5
Ross 1	50.1	47.4
Ross 2	48.4	38.1
Ross 3	56.4	53.3
Ross 4	52.7	55.0

The application of starter fertilizer failed to result in significant increases in yield at any of the locations. Further indication of the response of the wheat plants to application of starter fertilizer under the conditions of these trials is illustrated in the amount of phosphorus and or potassium in the wheat plants at heading stage in Table 4.

Table 4. Phosphorus and Potassium Content on Wheat Plants (Heading Stage) on Starter and No Starter Trials

	%P		%K	
Location	Starter	No Starter	Starter	No Starter
Fleshe	.31	.31	1.9	2.5
Christensen	.20	.20	2.1	1.9

The wheat plants from 4 replications at each location were not significantly different in percent phosphorus or potassium. The wheat plants at different locations were significantly different in levels of phosphorus in the plant. These differences can be readily explained due to the levels of available phorphorus in the soil.

The effect of starter fertilizer versus no starter on the protein content of the grain is shown in Table 5.

Table 5. Percentage Protein in Wheat Grain as Influenced by Starter Fertilizer Treatments - Red River Basin of Minnesota - 1979

	% Protein	
Location	Starter	No Starter
Christensen	14.1	13.6
Sanders	14.4	14.0
Fleshe	14.3	14.5
Skaar	11.2	11.8
Ross 1	14.3	14.3
Ross 2	12.5	12.4
Ross 3	14.1	13.8
Ross 4	14.2	14.4

Non-Significant

Summary

Starter fertilizer applied with the grain drill at 8 locations in the Red River Basin did not significantly increase the yield or protein content of wheat grain under soil and weather conditions in 1979.

The soil test levels for phosphorus and potassium were relatively high except for the Christensen location.

Additionally, the late planting date at most of the locations may have influenced the response to starter fertilizer. Starter fertilizer normally gives best responses when soil test levels are low and when cold weather conditions exist after seeding.

YIELDS OF WINTER WHEAT ON FINE-TEXTURED SOIL IN NORTHERN MINNESOTA - 1979*

C. Simkins, M. O'Leary, M. Johnson, and H. Shurson

Winter wheat is grown on a very limited acreage in northern Minnesota. Due to the possibility of winter kill yields have been inconsistent and in general have been lower than spring wheat yields. With several new winter wheat varieties there is a renewed interest in the possibility of winter wheat production in Minnesota. If winter wheat could be grown successfully it would be of value to farmers in helping distribute their labor. Additionally, the crop seeded in the fall could provide winter cover to assist in reducing soil erosion by wind in the winter months.

In cooperation with the County Extension Director and Mr. Bachholz, a farmer near McIntosh, Minnesota, wheat trials were established in the fall of 1978.

Methods and Materials

The trial was established on a fine textured soil of the McIntosh-Winger complex probably a Waukon silty clay loam. The fertility level of the soil was relatively high - P test 38 lbs/acre, K test 250 lbs/acre, and 220 lbs. of NO_3-N in the top 2 feet. Wheat was seeded at the rate of 90 lbs. per acre in strips 8 feet wide. Each variety was seeded in 3 replications. The strips were 50 feet long.

Fertilizer was applied with the grain drill at planting time at the rate of 100 pounds per acre of 16-24-24. Seeding was made on Sept. 13, 1978. In May, 1979, 50 pounds/acre of nitrogen as urea was topdressed on the growing wheat.

Wheat was harvested on August 14, 1979. Samples were harvested with a binder, and threshed in a Vogel thresher.

Results and Discussion

The yield and protein content of the various winter wheat varieties used in the trials are shown in Table 1. These yields and protein percentages are the average of 3 replications.

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*This project was financed through support in part by Minnesota Wheat Council.

Table 1. Yields and Percent Protein of Various Winter Wheat Varieties, McIntosh, Minnesota, 1979

Variety	Bu/A	% Protein
Centurk	56.2	15.7
Eklund	37.8	16.1
Froid	37.7	17.1
Gent	43.2	17.7
Minter	32.0	16.4
Roughrider	38.9	16.0
Winoka	44.0	16.7
Significance	**	NS
BLSD (.05)	9.6	--

As a result of good stand survival and adequate moisture, relatively good yields were obtained. Yields of various varieties showed a significant difference.

The percent protein in the various varieties was non significant. This one year trial indicates that under favorable winter weather conditions satisfactory wheat yields can be obtained. Further studies are needed to determine the feasibility of winter wheat production under less favorable conditions.

WILD RICE FERTILIZATION RESEARCH - 1979

A PROGRESS REPORT
December 27, 1979

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Research was continued during 1979 on fertilization, nutrient requirement and water quality. Soil, water and air temperatures, and quality of paddy water were monitored during the growing season to obtain information on the environment in which wild rice grows. A nitrogen rate study was conducted on a mineral soil at Grand Rapids with the Netum variety in first production year. Three fertilization experiments were conducted with a second year stand of K2 variety on peat in Aitkin County to study N, P, K rates, and the effectiveness of foliar fertilization. Tissue samples were collected for plant analysis to learn more about nutrient uptake by the plant.

A. WEATHER AND PLANT DEVELOPMENT

The average air temperature (Table 1) was slightly below normal during April, May and August, and nearly normal during June and July. Generally, weather conditions during the 1979 growing season were more "normal" than those of 1976 and 1977 seasons which were exceptionally early and warm.

Soil, water and air temperatures were measured at three locations by 3-point automatic sensing and recording thermographs (see Fig. 1, 2, 3). Instrument malfunctions caused interruptions in temperature measurements.

The air and water temperatures fluctuated much more than the soil temperatures. The mineral soil at Grand Rapids also showed greater temperature fluctuations than the two organic soils. The temperature of both organic soils was in the low 40's during the plant emergence in early May. The temperature of organic soils measured about 50°F by mid-May, gradually increased to 65°F by mid-July and then gradually decreased towards harvest time.

Plants emerged on May 8 in Aitkin County and on May 11 at Grand Rapids (Fig. 4, 5). The jointing stage was reached by Netum at Grand Rapids on July 6, 55 days after emergence, and by K2 in Aitkin County on July 9. Netum was harvested on August 27, 108 days after emergence. The K2 wild rice was harvested on August 28, 112 days after emergence.

Table 1. Average air temperature as measured at three U.S. weather stations.[1/]

Station Year	Month April	May	June	July	August	5 Month Average	GDD T_b=40
	----------average air temperature, °F----------						
Fosston, Polk Co.							
Normal[2/]	41.0	54.6	63.6	69.4	67.5	59.2	2955
1974	41.0	50.5	63.4	71.6	62.8	57.9	2744
1975	34.8	55.7	61.9	70.5	64.6	57.5	2852
1976	46.6	54.9	66.8	68.8	70.9	61.6	3315
1977	49.1	66.4	64.6	70.3	60.6	62.2	3446
1978	41.7	59.2	63.4	67.8	67.7	60.0	3060
1979	36.0	48.7	63.6	69.6	63.6	56.3	2627
Grand Rapids, N.C. School							
Normal	39.9	52.7	62.0	67.4	65.1	57.4	2681
1974	41.6	49.4	62.7	70.7	62.8	57.4	2670
1975	34.7	57.0	62.2	71.5	65.2	58.1	2951
1976	47.1	54.4	66.1	68.2	67.4	60.6	3166
1977	48.2	63.8	64.0	69.2	60.2	61.1	3284
1978	41.3	57.9	62.8	66.5	66.0	58.9	2892
1979	37.1	49.5	61.5	68.1	62.6	55.8	2511
Aitkin							
1974	42.9	49.8	63.1	71.1	63.3	58.0	2770
1975	39.0M[3/]	59.4M	64.4M	72.1	66.2M	60.2	3141
1976	47.5	54.8	66.8	69.3M	68.1	61.3	3267
1977	48.3M	64.4M	65.4M	70.3M	61.0	61.9	3446
1978	40.7M	57.5M	64.1M	67.0M	66.9	59.2	2938
1979	37.7	50.6M	62.0	68.1M	63.4	56.4	2585.1

1/ Source: Climatological Data, Minnesota, Vol. 80, 81, 82, 83, 84, 85 (1974-79), U.S. Dept. of Commerce.

2/ Normals for the period 1931-60.

3/ M = less than 10 days record missing.

Fig. 1

MEAN AIR, WATER AND SOIL TEMPERATURES

GRAND RAPIDS – 1979

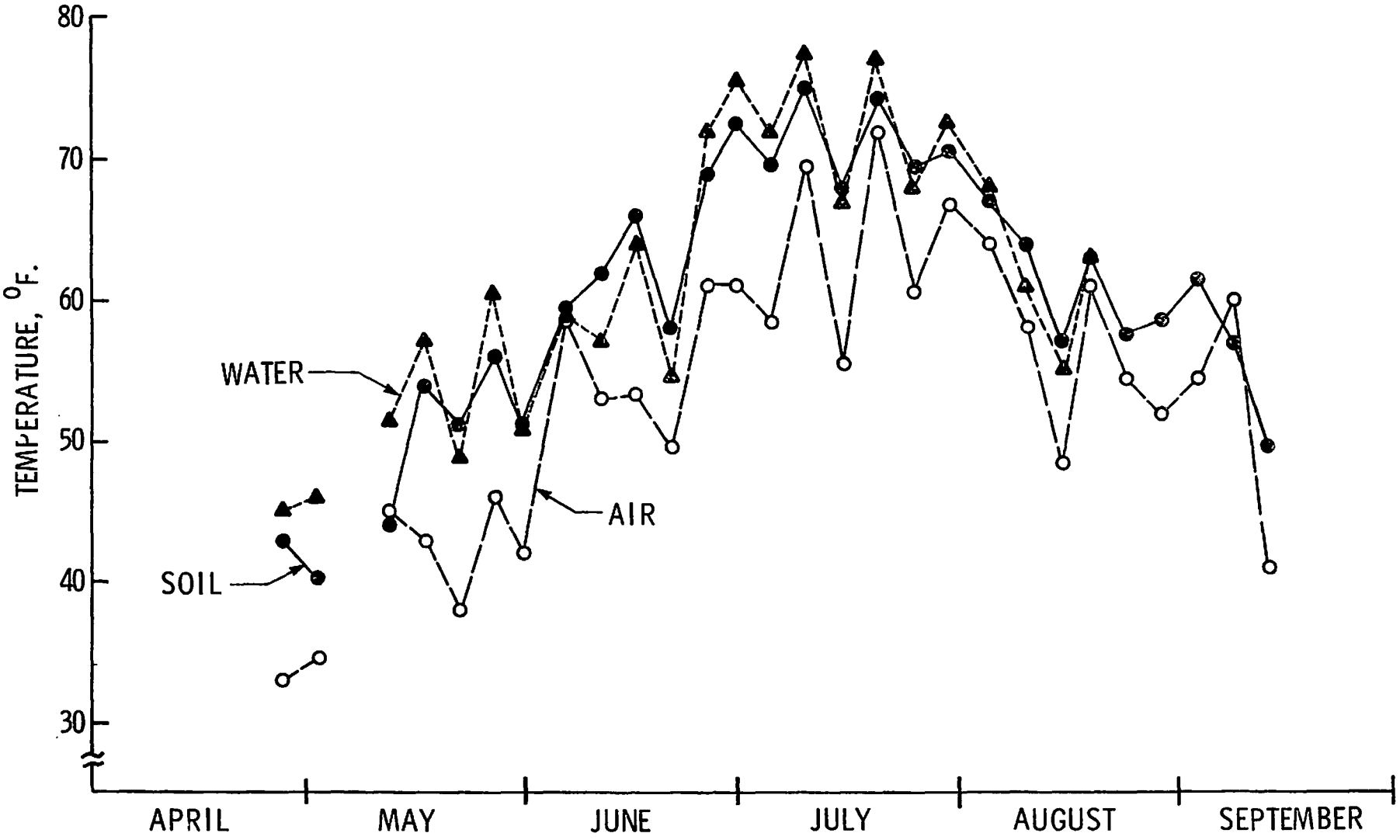

Fig. 2

MEAN AIR, WATER AND SOIL TEMPERATURES

KOSBAU BROS., AITKIN – 1979

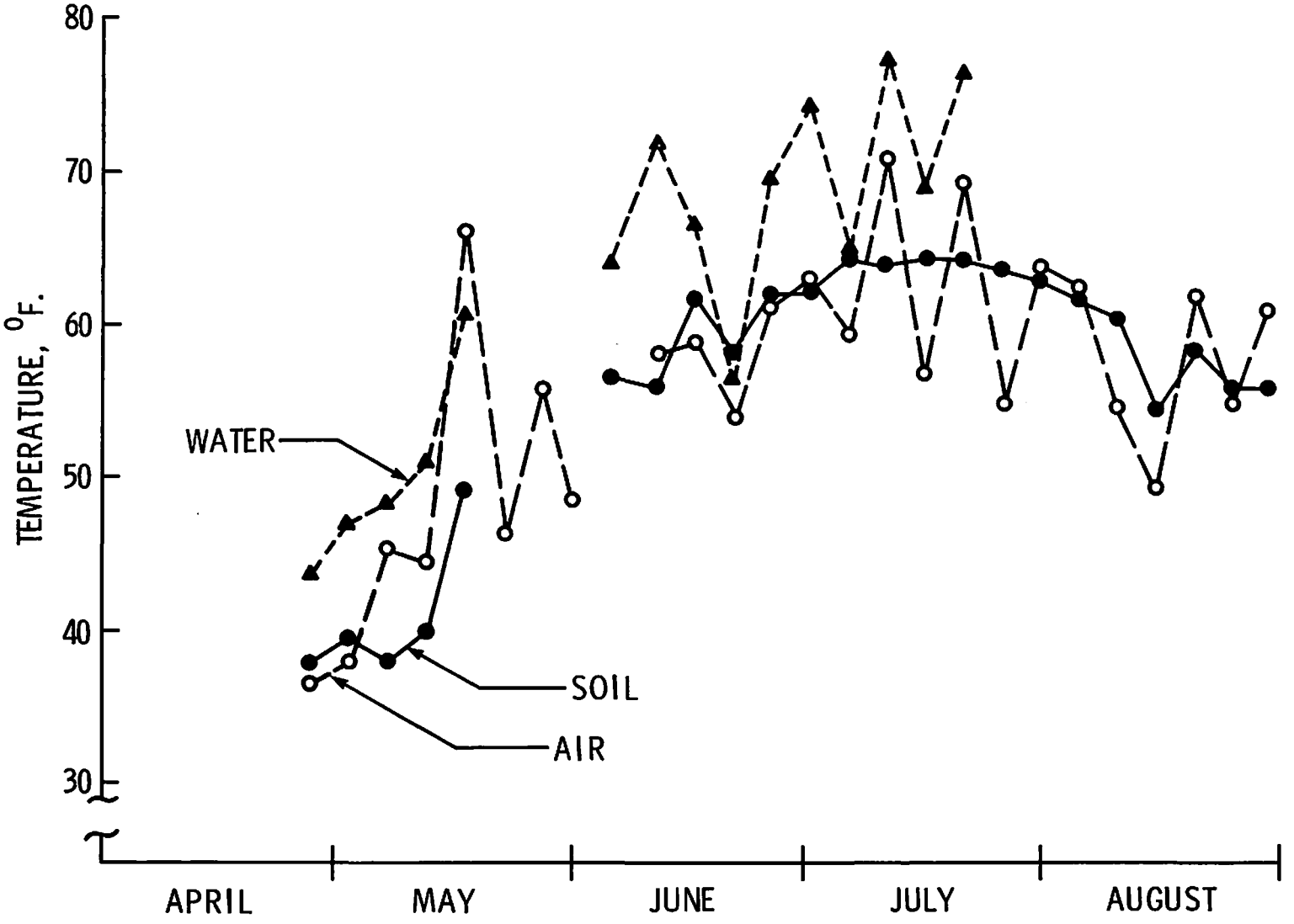

Fig. 3

MEAN AIR, WATER AND SOIL TEMPERATURES

GULLY – 1979

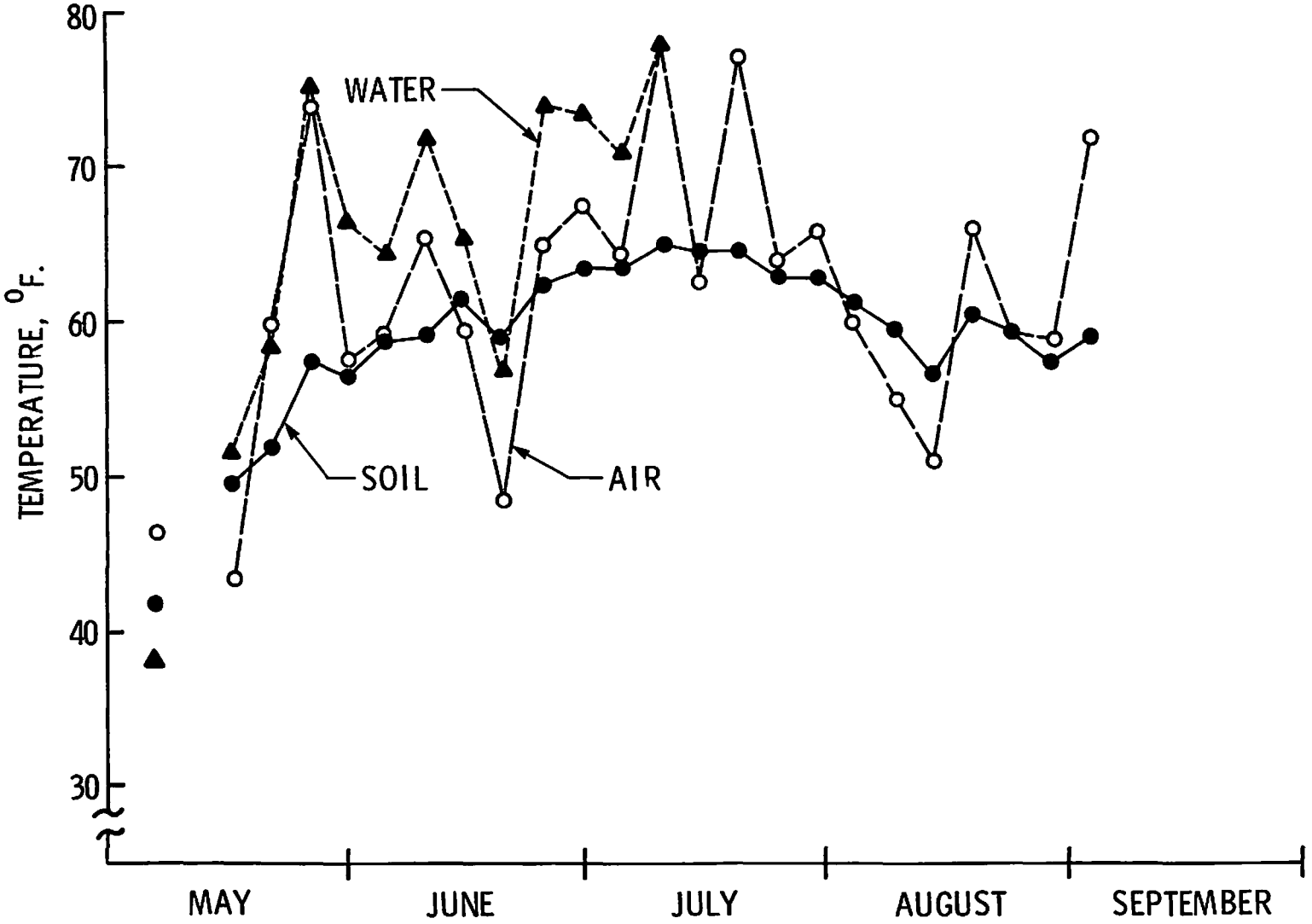

Fig. 4

WILD RICE DEVELOPMENT
NETUM VARIETY, GRAND RAPIDS, 1979

	STAGES OF DEVELOPMENT	DAYS	DATE
VEGETATIVE GROWTH PHASE	EMERGENCE	0	MAY
	FLOATING LEAF	21	JUNE
	AERIAL LEAF	26	
	TILLERING	40	
REPRODUCTIVE GROWTH PHASE	JOINTING	55	JULY
	BOOT	60	
	MID-FLOWERING	71	
	MATURITY	108	AUGUST

Fig. 5

WILD RICE DEVELOPMENT
K2 VARIETY, KOSBAU BROS., AITKIN CO., 1979

	STAGES OF DEVELOPMENT	DAYS	DATE
VEGETATIVE GROWTH PHASE	EMERGENCE	0	MAY
	FLOATING LEAF	27	JUNE
	AERIAL LEAF	44	
	TILLERING	52	
REPRODUCTIVE GROWTH PHASE	JOINTING	62	JULY
	BOOT	72	
	MID-FLOWERING	84	
	EARLY GRAIN FORMATION	97	AUGUST
	MATURITY	112	

B. CHEMICAL CHARACTERISTICS OF PADDY WATER

The quality of paddy water is of interest to the grower as well as to state and federal agencies. The grower may be concerned, for example, with the concentration of sulfate in the water. Plant response to fertilization may be related to nutrient levels found in the water. Public control agencies may want to know levels of nitrogen and phosphorus present in the water when it is released during draining of paddies.

Water samples were collected from several sites at three different paddy locations during the 1979 growing season. At Washkish, water samples were collected from two sites on May 22 for general reference. At Grand Rapids, samples were collected from an experimental paddy used for a nitrogen rate study on mineral soil. Source of water is the Prairie River. Water was also sampled at two sites in Kosbau Bros. paddies in Aitkin County. Paddies at this site derived water from the Little Willow River via a diversion ditch. One sampling site was located at the beginning of the diversion ditch, just above a bridge; the other site was within a paddy in which three fertilization trials were conducted. The third sampling location was in the Imle and Gunvalson paddies near Gully. These paddies derived water from the Clearwater River.

Water samples were collected and stored in 250 ml polyethylene bottles. After the determination of pH and conductivity, a preservative was added (2 ml mercuric chloride solution, made by dissolving 40 mg $HgCl_2$/L, to 250 ml of sample). Chemical analyses were made by the Research Analytical Laboratory, University of Minnesota. Information on location, sampling dates, and chemical composition data of water are given in Table 2.

The pH of water is the measurement of hydrogen-ion activity. Water samples from the rivers showed some differences. Greatest differences in pH, however, were found in the water from different paddies. There was a certain relationship found between the pH and hardness of the water from different sampling sites. The hardness of water is calculated by multiplying calcium and magnesium concentrations by specific factors, adding up and is expressed as $CaCO_3$, mg/liter. Water from the Clearwater River was very hard (314 mg/L) and strongly alkaline with pH of 8.0 or above. The water from the Prairie River and the Little Willow River is moderately hard, with values of 96 and 89 mg/L, respectively, and had a pH value of 7.3, indicating slight alkalinity. At Gully and Grand Rapids, the levels of hardness and pH of paddy water were nearly the same as those found in the river water. In Aitkin County on peat, however, the paddy water showed 18 to 23% lower calcium and 30 to 43% lower magnesium content than the river water, and 4-fold decrease in hardness. Consequently, the water within the Kosbau paddy was acid (pH 5.0-6.6) and was relatively soft, having a hardness value of 22 mg/liter.

At Grand Rapids, concentrations of total N and P in paddy and river water were nearly the same, and remained relatively constant throughout the growing season. Total concentration in the water ranged from 0.2 to 0.9 ppm N, and 0.04 to 0.2 ppm P. The K concentration of paddy water was only slightly higher than that found in river water, except for the June 21 sampling date when the paddy water had three times more K than river water (17.5 vs. 5.9 ppm K).

At Gully, nutrient concentrations in the river and paddy water were inconsistent and showed considerable variation.

Paddy water at the Aitkin County location had considerably higher concentration of total N, P and K than found in the river water. Total N concentration of paddy water ranged from 1.9 to 4.3 ppm compared to 0.4-0.8 ppm found in samples collected from the diversion ditch. Total P concentration in paddy water ranged from 1.45 to 1.93 as compared to 0.04-0.11 ppm in the water from the diversion ditch. Potassium levels of paddy water ranged from 7 to 11 ppm while the water from the diversion ditch had concentration of less than 1 ppm to 5 ppm K.

The sulfate concentration of water is reported in terms of parts per million of sulfate-sulfur. To convert results to the sulfate form, they would have to be multiplied by 3. For example, 20.5 ppm sulfate-S x 3 = 61.5 ppm sulfate (SO_4) in the water.

The water at Grand Rapids and in Aitkin County did not contain appreciable amounts of sulfate (4-9 ppm SO_4). The sulfate concentration in the water at Gully, however, was relatively high (62-79 ppm SO_4).

Table 2. Chemical composition of water collected from wild rice paddies during 1979 growing season.

Sample No.	Sampling Date	Location	pH	Conductivity milli-mhos/cm	Alkalinity as $CaCO_3$ mg/L	Hardness $CaCO_3$ mg/L	Total Kjeldahl N ppm	Ammonium N ppm	Nitrate & nitrite N ppm	Total P ppm	Soluble P ppm	Sulfate S ppm	Ca ppm	Mg ppm	K ppm
Location: Grand Rapids															
5.	5/22	EP	7.5	.12	44.5	63.8	0.3	0	0	0.04	0.03	1.4	17.8	4.4	3.3
6.	5/22	PR	7.3	.16	70.5	96.1	0.2	0	0	0.09	0.05	2.1	27.5	6.3	2.9
10.	6/21	EP	7.6	.12			0.4			0.04			34.5	8.4	17.5
11.	6/21	PR	7.3	.18			0.9			0.05			31.4	7.8	5.9
16.	7/6	EP	7.2	.14			0.6			0.05			18.7	4.3	<0.75
17.	7/6	PR	7.0	.17			0.6			0.04			23.0	5.3	<0.75
20.	7/11	EP		.14			0.7			0.05			17.5	4.3	<0.75
21.	7/11	PR	7.3	.15			0.6			0.06			19.8	4.5	<0.75
22.	7/19	EP	7.7	.13			0.8			0.08			19.7	4.7	<0.75
23.	7/19	PR	7.0	.13			0.6			0.20			19.9	4.4	<0.75
26.	7/31	EP	7.7	.12			0.6			0.08			16.1	6.6	1.27
27.	7/31	PR	7.5	.16			0.5			0.05			19.9	6.1	<0.75

Abbreviations and description of sampling sites at Grand Rapids: EP = Experimental Paddy #1E; PR = Prairie River

Location: Kosbau Bros., Aitkin Co.															
7.	5/15	EP	5.2	.05	3.5	18.9	1.9	0.5	0	1.45	1.33	2.4	3.9	1.6	8.1
8.	5/25	EP	5.0	.07	7.0	22.3	2.4	0.1	0	1.81	1.69	2.9	4.5	1.9	8.1
9.	5/25	DD	7.3	.17	69.0	88.9	0.4	0	0	0.09	0.08	1.7	24.4	6.3	2.1
12.	6/21	EP	6.6	.05			3.3			1.87			6.3	2.6	11.2
13.	6/21	DD	7.3	.18			0.4			0.04			27.8	6.0	5.0
18.	7/6	EP	5.7	.05			4.3			1.93			5.5	2.6	6.5
19.	7/6	DD	7.3	.19			0.8			0.11			26.9	7.1	<0.75
28.	7/31	D	5.1	.10			6.2			3.07			8.5	2.7	3.5

Abbreviations and description of sampling sites at Kosbau Bros.: EP = Experimental Paddy; DD = Diversion ditch at bridge near the Little Willow River; D = Ditch on the south side of experimental paddy.

Table 2. Chemical composition of water collected from wild rice paddies during 1979 growing season (continued).

Sample No.	Sampling Date	Location	pH	Conductivity milli-mhos/cm	Alkalinity as $CaCO_3$ mg/L	Hardness $CaCO_3$ mg/L	Total Kjeldahl N ppm	Ammonium N ppm	Nitrate & nitrite N ppm	Total P ppm	Soluble P ppm	Sulfate S ppm	Ca ppm	Mg ppm	K ppm
Location: Imle and Gunvalson, Gully															
1.	5/21	PP	8.1	.48	135.5	262.8	1.1	0	0	0.33	0.24	26.4	71.5	20.3	15.6
2.	5/21	CR	8.0	.51	194.5	314.3	0.5	0	0	0.05	0.05	20.5	85.9	24.0	4.1
14.	6/27	PP	8.3	.62			0.8			0.14			88.4	24.6	7.6
15.	6/27	CR	8.0	.53			2.0			1.15			99.5	26.5	18.3
24.	7/31	D	7.0	.43			0.9			0.11			57.6	17.4	1.4
25.	7/31	CR	7.4	.45			1.7			0.41			56.5	19.9	2.1

Abbreviations and description of sampling sites at Gully: PP = Production Paddy; CR = Clearwater River; D = Ditch on west side of paddy.

Location: Washkish															
3.	5/22	D	7.1	.21	40.5	88.1	1.6	0	0	0.68	0.58	4.1	22.1	7.7	20.7
4.	5/22	TR	6.9	.14	55.5	85.8	0.7	0	0	0.07	0.06	2.6	22.4	7.0	1.6

Abbreviations and description of sampling sites at Washkish: D = Ditch on east side of paddy complex; TR = Tamarac River.

C. NITROGEN RATE STUDY ON MINERAL SOIL

A field experiment was conducted with the Netum variety on a mineral soil at the North Central Experiment Station, Grand Rapids. The experimental paddy, No. 1 East, was in fallow during 1978 and was fumigated with methyl bromide in the fall. Soil tests indicated a very high level of extractable phosphorus, nearly a high level of exchangeable potassium (Table 3). The nitrate-N reading of 42 lb/A in the top 6 inches of soil (main rooting depth of wild rice) indicated that considerable amount of nitrate had been produced under fallow. Four rates of nitrogen were used in this experiment: 0, 20, 40 and 80 pounds per acre. Urea (46-0-0) was applied by hand and incorporated into the soil by rototilling. A randomized block design was used in this experiment. Each nitrogen treatment was replicated five times. Individual plots occupied a 14 x 16 ft. area and were separated from adjoining plots by 5 ft. wide alleys. Seed of Netum variety was broadcast-applied by hand on October 18 and rototilled into the soil. Plant density, at jointing, was about three plants per square foot. Water level was maintained at about 6 to 10 inches. Ten plants were collected at random from each plot at jointing, and five plants at late flowering for weight measurements and plant analysis. The jointing state was reached on July 6 (Fig. 4). Water was drained from the paddy on August 25. A 32 sq. ft. area from each plot was hand-harvested on August 27 for yield determination.

Netum wild rice produced 945 to 1049 pounds of grain per acre (Table 4). The yield, however, was not affected by N fertilization.

The second leaf at jointing contained 4.16 - 4.55% N, considered to be a relatively high concentration (Table 5). Total nitrogen uptake by wild rice at jointing or late flowering was not affected by the nitrogen treatments (Table 6).

Table 3. Soil test values of experimental paddy, No. 1 East, Grand Rapids.

Sampling Depth inches	pH	Extractable P pp2m	Exchangeable K pp2m	NO_3-N lb/A
0 - 6	5.5	84	196	42
6 - 12	5.6	83	197	42

Samples collected on 10/18/78.

Table 4. Effect of nitrogen application on the yield of Netum wild rice, Grand Rapids, 1st year stand, 1979.

N Rate lbs/acre	Grain Yield lbs/acre
0	1037[1)]
20	945
40	1049
80	999
Significance	ns
C.V., %	13

1) 7% moisture, average of 5 replications

Table 5. Effect of nitrogen application on N concentration in 2nd leaf of Netum wild rice at jointing, Grand Rapids, 1979.

N Rate lbs/acre	N % in Dry Matter
0	4.29
20	4.16
40	4.32
80	4.55
Significance	ns
C.V., %	25

Table 6. Effect of nitrogen application on total uptake of N by the wild rice plant at jointing and late flowering. Netum variety, Grand Rapids, 1979.

N Rate lbs/acre	Stage of Development	
	Jointing	Late Flowering
	---N in milligrams per plant---	
0	234	535
20	210	604
40	196	599
80	226	625
Significance	ns	ns
C.V., %	37	23

D. FERTILIZATION STUDIES ON PEAT

Three fertilizer experiments, carried out in a Kosbau Bros. paddy in Aitkin County during 1978, were continued in 1979. A second year stand of the K2 variety was used. Fertilizer was applied by hand to 12 x 12 foot plot areas on October 23, 1978 and incorporated into the soil by rototilling. Wild rice started to emerge on May 8 and by July 9 (62 days after emergence) had reached the jointing stage (Fig. 5). Rice was thinned once by airboat on June 4 when most plants were in the floating leaf stage. Average plant density was three plants per square foot. The stand, however, was spotty and thin in some areas. The paddy was drained on July 26. A 4 x 4 foot area was hand-harvested from each plot for yield measurement on August 28. No color or height differences were observed during growing season and the crop response to fertilization was modest and rather inconsistent. Soil tests, of samples collected on October 23, 1978 prior to fertilizer application, indicated medium to high extractable P levels, medium to high exchangeable K level, and low nitrate-N content (Table 7). The grain yield ranged from 250 to 550 lb/acre.

Table 7. Soil test values of experimental areas, Kosbau Bros., Aitkin Co.

Area		pH	Extractable P pp2m	Exchangeable K pp2m	NO_3-N lb/A
NK trial,	K0	4.3	18	124	0.5
	K60	4.3	20	154	
	K200	4.3	25	217	
NP trial,	P0	4.3	22	205	0.8
	P80	4.2	25	197	
Foliar Fertilization (check plots)		4.4	20	178	1.5

Samples collected on 10/23/78. Results are for 0-6 inch depth.

NK Rate Trial

Potassium treatments, made in the fall of 1977, had resulted in a gradual increase of K test levels. Exchangeable K test levels of 124, 154 and 217 pp2m corresponded with the potassium treatments of 0, 60, 200 lbs. K_2O per acre, respectively (Table 7). Nitrogen treatments consisted of the following rates: 0, 30, 90 pounds per acre. Potassium was applied at rates of 0, 60 and 200 pounds of K_2O per acre. All plots received phosphorus at 40 pounds P_2O_5 per acre. Fertilizer treatments, arranged in a randomized block design, were replicated six times. Urea, muriate of potash and concentrated superphosphate were applied by hand during the fall of 1978 and incorporated into the soil by rototilling.

The yield of wild rice ranged from 258 to 405 pounds per acre (Table 8). Neither nitrogen nor potassium treatments had any effect on the yield.

Table 8. Effect of nitrogen and potassium application on grain yield of wild rice, Kosbau Bros., 1979.

K Rate K_2O lb/acre	N Rate, lb/acre 0	30	90	Average (K Rate)
	----------Grain Yield, lb/acre----------			
0	265	280	405	317
60	333	269	291	298
200	258	367	309	311
Average (N Rate)	285	305	335	
Significance	ns			
C.V., %	35			

7% moisture, average of 6 replications.

NP Rate Trial

Average extractable phosphorus in the experimental area measured 22 and 25 pp2m, indicating high relative level (Table 7). Nitrogen was applied at rates of 0, 30, 60 lb/acre, and phosphorus treatments included 0, 40, 80 pounds of P_2O_5 per acre. All plots received potassium at 60 lbs/acre of K_2O. Fertilizer treatments were replicated six times. Urea, concentrated superphosphate and muriate of potash were applied by hand in the fall and incorporated into the soil by rototilling.

Grain yields ranged from 251 to 366 pounds per acre (Table 9). Although some yield differences were detected at the 10% level, crop response was inconsistent and not related to nitrogen and phosphorus treatments.

Table 9. Effect of nitrogen and phosphorus application on grain yield of wild rice, Kosbau Bros., 1979.

P Rate P_2O_5 lb/acre	N Rate, lb/acre 0	30	60	Average (P Rate)
	----------Grain Yield, lb/acre----------			
0	277	340	313	310
40	251	291	300	281
80	366	298	262	309
Average (N Rate)	298	310	292	
Significance	+			
BLSD (0.10)	79			
C.V., %	21			

7% moisture, average of 6 replications.

Foliar Fertilization Trial

Interest in foliar application of fertilizer was aroused in 1975-76 by publicity generated by spectacular soybean yield increases obtained in Iowa. Numerous field trials were initiated with soybeans and other crops and a full-scale sales program was launched by at least one major fertilizer company. Research in Minnesota and other states, mainly with soybeans, has not shown any substantial benefits from foliar fertilization.

Some wild rice growers also showed interest in foliar fertilization. Field trials were initiated in 1976, and continued in 1977, in Aitkin County to provide information on the effectiveness of foliar fertilization of wild rice.

In the fall of 1977, a new experiment was established on a new seeding of K2 variety in an area adjoining NK and NP trials. The experiment was continued in 1979. Soil tests indicated medium phosphorus and potassium availability, and the nitrate-N content of top 6 inches was relatively low (Table 7).

Soil application of fertilizer (30+40+60) was made during the fall of 1978 and incorporated into the soil. Fertilizer solution was sprayed on 12 x 12 foot plot areas with a backpack sprayer at a rate of 26.4 gallons per acre or 250 pounds per acre. Spraying pressure was maintained at 30 psi by using a carbon dioxide cylinder. The formulation, materials used and costs were reported, in detail, in the 1976 Wild Rice Research Report. At 1976 prices, the total cost of three foliar applications would be $48.15 per acre, consisting of $19.35 for fertilizer materials and $28.80 for aerial application. Currently the cost of such applications should be well over $50.00 per acre. Soil application of 30+40+60 pounds per acre of plant nutrients, at present prices, would cost about $22.00 per acre, including application costs.

In 1979, foliar fertilizer applications were made on the following dates:

1st spraying, 7/11 - jointing to early boot stage,
2nd spraying, 7/31 - mid-flowering,
3rd spraying, 8/14 - early grain formation.

No "leaf burn" damage to wild rice was observed in this trial.

The grain yield in this experiment ranged from 380 to 565 pounds per acre (Table 10). The yield of wild rice was increased significantly (at 10% level) by about 150 lb/acre over the control either by soil applied fertilizer or three foliar applications. There was no advantage, however, of combining these two types of fertilizer application. It must be pointed out that similar yield increases from fertilization were obtained at (a) $22.00 for soil application, and (b) over $50 per acre for three foliar applications. Consequently, foliar fertilization of wild rice is not recommended, at the present time, neither as a substitute of nor as a supplement to soil application. Topdressing of solid nitrogen fertilizers, urea and ammonium nitrate, at jointing (basically a soil application) is not included in this recommendation.

Table 10. Effect of foliar and soil application of fertilizer on grain yield of wild rice, Kosbau Bros., 1979.

Number	Foliar Application				Soil Application		Average
	Total Plant Nutrients Applied, lbs/acre						
	N	P_2O_5	K_2O	S	None	30+40+60	(Foliar)
					----Grain Yield, lbs/acre-----		
None		None			380a	523b	452
1x	15 +	6 +	9 +	1.3		427ab	427
2x	30 +	12 +	18 +	2.6		514ab	514
3x	45 +	18 +	27 +	3.9	565b	441ab	503
Average (soil)					473	476	
Significance					+		
BLSD (0.10)					142		
C.V., %					25		

7% moisture, average of 6 replications.

Values followed by different letters are significantly different (10% level).

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