HIGH PHOSPHORUS AND POTASSIUM RATES FOR CONTINUOUS CORN

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EXPERIMENTAL PROCEDURES

Ten P and K treatments (Table 1) were applied at three branch experiment stations (Southern Experiment Station, Waseca; Southwest Experiment Station, Lamberton; and West Central Experiment Station, Morris) in Minnesota. A randomized, complete-block design with four replications was used. The 50-pound rates were estimated to be "maintenance" rates, and the 0, 100 and 150-pound rates provide the response curves for each element. Treatment 5 and 8 will receive P and K, respectively, every third year for the duration of the experiment. Treatments 9 and 10, applied in the fall of 1973, will not receive P and K again until either P or K starts to become limiting (determined via soil test, tissue test or yield). All other treatments will be applied annually.

Table 1. Phosphorus and potassium treatments applied in the high P and K rate study in Minnesota.

Trt. No.	Application Year (Fall) 1973	1974	1975	1976	1977
	lbs. P_2O_5 + K_2O				
1	0 + 0	0 + 0	0 + 0	0 + 0	0 + 0
2	0 + 100	0 + 100	0 + 100	0 + 100	0 + 100
3	50 + 100	50 + 100	50 + 100	50 + 100	50 + 100
4	100 + 100	100 + 100	100 + 100	100 + 100	100 + 100
5	150 + 100	0 + 100	0 + 100	150 + 100	0 + 100
6	100 + 0	100 + 0	100 + 0	100 + 0	100 + 0
7	100 + 50	100 + 50	100 + 50	100 + 50	100 + 50
8	100 + 150	100 + 0	100 + 0	100 + 150	100 + 0
9	150 + 100	0 + 0			
10	100 + 150	0 + 0			

Treatment numbers 2, 3, 4, 5, 6, 7, 8 were broadcast on cornstalks and plowed down at all locations in the fall of 1974. Phosphorus was applied as CSP (0-46-0) and K as muriate of potash (0-0-60). Starter fertilizer was not used.

Specific experimental procedures used at each of the stations are presented in Table 2. Management practices providing for optimum yields were employed at each location. Nitrogen rates were slightly higher than optimum.

Table 2. Experimental procedures for the high P and K rate study on continuous corn at the three branch stations in 1975.

Variable	Lamberton	Morris	Waseca
Planting date	5/12	5/6	5/17
Row spacing	30"	30"	30"
Population	23,000	23,500	26,000
Hybrid	Pioneer 3780	Pioneer 3965	Pioneer 3780
Nitrogen rate	100# N	110# N	200# N
Herbicide	5# Ramrod/A (bdct)+1.5# Atrazine +1½ gal oil (Post)	2# Lasso + 2# Bladex/A (Bdct)	3# Lasso + 2.5# Atrazine/A (Bdct)
Insecticide	1# Furadan/A	1# Furadan/A	1# Counter/A
Harvest date	10/17	9/24	10/16

RESULTS AND DISCUSSION

Soil samples were taken at the end of the 1975 growing season. After two years of application soil test P was affected significantly by the P treatments at all locations (Table 3). It is interesting to note that in 1974 after one application, soil test P was affected only at Morris (1974 report). Soil pH and K were not influenced by the treatments at any of the locations.

Table 3. Soil test values as influenced by two year's application of the P and K treatments.[1]

Treatment		pH			P				K		
No.	Description[2]	La	Mo	Wa	La	M_{10}	M_{50}	Wa	La	Mo	Wa
	lb P_2O_5+K_2O/A				---------- lb/A ----------						
1	0 + 0	5.5	7.8	6.0	38	16	50	32	170	290	190
2	0 + 100	5.6	7.9	6.0	36	17	58	29	225	360	220
3	50 + 100	5.9	7.8	5.8	51	28	72	39	225	330	235
4	100 + 100	5.5	7.9	6.0	58	34	92	45	230	335	210
5	0 + 100	5.8	7.8	6.0	43	27	83	37	215	320	205
6	100 + 0	5.4	7.8	6.1	63	33	90	39	185	300	200
7	100 + 50	5.6	7.8	6.0	49	33	89	55	215	330	220
8	100 + 0	5.5	7.7	6.0	42	44	106	49	190	325	205
9	0 + 0	5.7	7.8	6.0	56	42	100	40	225	325	205
10	0 + 0	5.7	7.9	6.0	47	27	86	29	215	320	220
Significance:[3]		ns	+	ns	*	**	**	**	+	ns	ns
BLSD (.05) :					20	14	26	12			
CV (%) :		6	1	3	23	15	10	20	14	5	10

1/ Samples were taken in October before the 1975 treatments were applied.
2/ Rates applied in fall of 1974 for 1975 crop.
3/ **, *, and + are significant at the 99, 95 and 90% levels, respectively; ns = not significant at the 90% level.

Approximately 5-6 weeks after planting, ten plants randomly selected from each plot were harvested, dried and weighed to determine early plant growth. In addition, plant height was measured at Morris. Early plant growth (weight and height) was increased significantly by the P treatments at Morris (Table 4). Early weight at Waseca was not affected due to the high variability, which was caused by uneven seedling emergence due to the dry seedbed conditions.

Table 4. Early plant growth characteristics as influenced by high P and K rates at the three experimental sites in 1975.

Treatment		Weight			Height		
No.	Description	La	Mo	Wa	La	Mo	Wa
	lb P_2O_5+K_2O/A		g/dry plant		-----	inches	-----
1	0 + 0		4.7	6.6		18.7	
2	0 + 100		5.3	7.2		18.5	
3	50 + 100		6.2	7.6		20.5	
4	100 + 100		6.2	7.7		20.6	
5	0 + 100		6.4	8.8		20.6	
6	100 + 0		6.1	8.2		20.2	
7	100 + 50		5.4	8.4		20.3	
8	100 + 0		6.1	9.4		21.4	
9	0 + 0		5.6	7.6		19.3	
10	0 + 0		5.9	7.1		19.9	
	Significance:		*	ns		+	
	BLSD (.05) :		1.0				
	CV (%) :		5	22		3	

The P treatments resulted in increased leaf P concentrations at Waseca but not at Lamberton or Morris (Table 5). However, leaf Zn was reduced significantly at Lamberton by some of the P treatments. Leaf K concentrations were increased significantly at Morris with a concomitant decrease in Mg. Other nutrient concentrations were generally not affected by the P and K treatments.

Concentrations of all nutrients in the leaf tissue were considered to be adequate at all locations with the exception of Zn at Morris. Even though 10 lb Zn/A as Zn SO_4 was applied at Morris in 1973 and Zn levels in the tissue averaged 28 ppm in 1974, the 1975 Zn levels bordered on deficiency.

Table 5. Effect of high P and K rates on the nutrient concentrations in the corn leaf at the three experimental sites in 1975. 1/

Treatment No.	Description lb P_2O_5+K_2O/A	P	K	Ca	Mg	Fe	Mn	Zn	Cu	B
		%				ppm				
					Lamberton					
1	0 + 0	.23	2.35	.87	.55	325	57	26	6	27
2	0 + 100	.20	2.49	.76	.46	320	45	22	5	24
3	50 + 100	.23	2.46	.84	.51	310	52	18	6	25
4	100 + 100	.23	2.57	.84	.53	330	48	19	5	24
5	0 + 100	.23	2.54	.90	.62	320	56	20	7	22
6	100 + 0	.23	2.30	.89	.60	325	49	20	5	22
7	100 + 50	.24	2.44	.83	.52	300	52	24	6	24
8	100 + 0	.22	2.48	.83	.57	300	46	18	5	22
9	0 + 0	.23	2.40	.88	.56	330	60	21	6	22
10	0 + 0	.24	2.42	.84	.56	315	51	23	6	25
	Significance:	ns	ns	ns	ns	ns	ns	**	ns	ns
	BLSD (.05) :							4		
	CV (%) :	9	10	9	14	7	15	13	29	12
					Morris					
1	0 + 0	.25	1.63	.60	.41	445	57	17	8	12
2	0 + 100	.26	2.01	.54	.37	445	47	16	8	10
3	50 + 100	.26	1.86	.52	.32	420	46	16	7	10
4	100 + 100	.28	1.84	.57	.36	440	54	15	9	12
5	0 + 100	.29	2.00	.56	.36	480	56	16	8	11
6	100 + 0	.28	1.70	.58	.40	465	53	15	8	10
7	100 + 50	.27	1.96	.54	.34	435	56	16	8	10
8	100 + 0	.27	1.92	.55	.35	430	48	14	8	9
9	0 + 0	.28	1.98	.55	.40	430	51	16	8	11
10	0 + 0	.28	1.92	.56	.37	435	52	15	8	12
	Significance:	ns	*	ns	*	ns	**	ns	ns	**
	BLSD (.05) :		.27		.05		1			2
	CV (%) :	4	4	5	4	5	4	4	7	5
					Waseca					
1	0 + 0	.24	2.05	1.06	.53	200	67	36	6	19
2	0 + 100	.24	2.13	1.02	.47	185	57	33	9	21
3	50 + 100	.24	2.20	1.02	.48	200	62	32	7	21
4	100 + 100	.27	2.37	1.10	.49	205	63	28	5	21
5	0 + 100	.23	2.14	1.04	.50	195	56	29	6	19
6	100 + 0	.27	1.99	1.17	.56	190	66	25	7	20
7	100 + 50	.26	2.18	1.11	.51	190	68	29	6	19
8	100 + 0	.26	2.10	1.13	.54	190	69	31	6	20
9	0 + 0	.25	2.15	1.07	.48	190	66	29	6	21
10	0 + 0	.24	2.18	1.00	.46	185	50	31	6	20
	Significance:	*	+	ns	ns	ns	ns	ns	ns	ns
	BLSD (.05) :	.03								
	CV (%) :	6	6	8	25	8	19	18	29	12

1/ Leaf opposite and below the ear at silking.

Final population and lodging counts were taken at Morris and Waseca (Table 6). No significant differences existed at either location.

Table 6. Final population and lodging as influenced by high P and K rates in 1975.

Treatment No.	Treatment Description	Final population La	Final population Mo	Final population Wa	Lodging La	Lodging Mo[1]	Lodging Mo[2]	Lodging Wa[1]
	lb P_2O_5+K_2O/A	plants/A x 10^3			%			
1	0 + 0	3/	20.2	25.0	3/	1.4	1.8	5.1
2	0 + 100		20.6	24.1		2.0	2.5	8.1
3	50 + 100		20.2	25.4		2.2	3.9	6.1
4	100 + 100		19.3	25.4		0.7	1.1	4.5
5	0 + 100		20.2	24.5		0	2.5	7.6
6	100 + 0		20.5	25.8		2.5	1.8	7.6
7	100 + 50		20.0	25.0		1.1	2.5	11.8
8	100 + 0		20.0	25.3		1.8	1.5	7.0
9	0 + 0		20.1	25.1		2.1	2.0	11.9
10	0 + 0		20.9	24.3		0	2.2	9.1
	Significance:		ns	ns		ns	ns	ns
	CV (%) :		2	7		81	55	72

1/ Stalk lodging at harvest.
2/ Broken stalks at harvest.
3/ Data not taken.

Silage and grain yields and grain moisture (an indication of maturity at harvest) are given in Table 7. Significant differences (95%) in silage yields were not found at any of the locations. Grain yields from Morris were significantly different; although, trends or relationships to the P and K rates were not evident. No yield differences were found at Lamberton or Waseca. Yields from both Lamberton and Waseca were markedly less than those from Morris, primarily because of the lack of mid-summer rainfall. Grain moisture was not affected significantly (95%) at any of the locations.

Table 7. Corn yields and moisture at harvest as influenced by high P and K rates in Minnesota in 1975.

Treatment		Silage yield			Grain yield			Grain moisture		
No.	Description	La	Mo	Wa	La	Mo	Wa	La	Mo	Wa
	lb P_2O_5+K_2O/A		T DM/A		----	bu/A	-----	------	%	-------
1	0 + 0	4.4	6.5	4.7	64.5	118.2	103.2	22.2	25.2	21.9
2	0 + 100	3.5	6.6	5.5	55.7	125.9	105.1	22.2	23.5	21.9
3	50 + 100	3.9	6.1	5.5	50.3	125.8	118.7	21.9	23.1	21.5
4	100 + 100	4.1	6.7	4.6	69.7	127.1	87.3	21.6	24.3	21.3
5	0 + 100	3.7	6.9	5.0	48.2	127.4	110.4	21.7	24.6	21.4
6	100 + 0	4.8	6.4	5.0	69.0	125.6	104.4	20.3	23.7	20.4
7	100 + 50	4.1	6.8	4.9	58.9	126.3	108.3	22.8	25.4	21.1
8	100 + 0	3.8	6.1	5.2	59.4	124.5	109.9	22.2	23.2	21.0
9	0 + 0	4.0	6.5	4.6	46.6	128.0	102.1	21.6	23.4	20.3
10	0 + 0	4.2	6.9	4.5	65.8	141.8	92.6	20.3	23.2	20.5
Significance:		+	ns	ns	ns	*	ns	ns	ns	+
BLSD (.05) :						12.1				
CV (%) :		13	3	14	30	3	14	8	3	4

NAVY BEAN TRIALS - 1975

J.N. Lensing and G.E. Ham

Two field experiments were established at the Lamberton and Rosemount Experiment Stations to study the effects of nitrogen rates and the effects of Rhizobium phaseoli strains on yield of two varieties of of navy beans. The two varieties used were Seafarer and Sanilac navy beans. The nitrogen source for the nitrogen experiment was urea. A randomized complete block design, replicated four times was used with each plot split with navy bean varieties.

NITROGEN EXPERIMENT

Nitrogen fertilizer significantly increased bean yields with Seafarer at Rosemount from 1181-1913 lbs/A (Table 1), with the highest yield at 90 lbs. N/A. Sanilac bean yields were increased from 1117-1762 lbs/A with highest yield at 90 lbs. N/A.

At Lamberton no significant increases were demonstrated with either variety. Seafarer beans increased from 1181-1759 lbs/A with the highest yields at 120 lbs. N/A.

Table 1. Yield of navy beans as affected by various rates of nitrogen.

Nitrogen Rate lbs N/A applied	Yield (lbs/A)			
	Rosemount		Lamberton	
	Seafarer	Sanilac	Seafarer	Sanilac
0	1168 a*	1117	1181	1042
30	1457 ab	1308	1249	1260
60	1661 bc	1474	1480	1290
90	1913 c	1762	1698	1158
120	1752 bc	1639	1759	1198
Significance	**	NS	NS	NS
BLSD (.05)	352	--	--	--

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

RHIZOBIAL STRAIN EXPERIMENT

Rhizobium phaseoli strain 127 K 14 was applied to seed as one treatment (seed was handplanted from coin envelopes to avoid contamination in this experiment). *Rhizobium phaseoli* strains 127 K 12, 127 K 14, and 127 K 17 were applied to the seed furrow as a granular inoculant at about 1,000 times the normal seed rate.

At both Lamberton and Rosemount no significant increases were found with either variety over the uninoculated check (Table 2). Apparently existing strains were adequate because nodulation occurred on the uninoculated check and no significant yield increases were found due to added strains.

Table 2. Yield of navy beans as affected by various strains of *Rhizobium phaseoli*.

Treatment		Yields (lbs/A)			
		Rosemount		Lamberton	
Method of application	Strain	Seafarer	Sanilac	Seafarer	Sanilac
Check	Check	1846	1759	1475	1334
Seed coated	127 K 14	1934	1637	1288	1220
Granular	127 K 12	1808	1862	1508	1391
Granular	127 K 14	1932	1771	1547	1271
Granular	127 K 17	2015	1850	1342	1330
Significance		NS	NS	NS	NS

FERTILIZATION OF GRASS PASTURES
Crookston, Minnesota - 1975

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The experiment described in the 1974 Blue Book was continued in 1975 using the same location and fertilizer treatments. The full 20' X 20' plot area was used for pasture management simulation in 1975. The plots were clipped on June 6 and July 17 when the plants were approximately 8 to 10 inches high. Due to lack of rain there was little plant growth after the July 17th cutting date.

The dry matter yields are listed in Table 13. There were significant differences between treatments at both cutting dates and when the dry matter yields were totaled. Generally, treatment differences that were present in the 1974 data continued in 1975. Phosphorus was the only nutrient that gave significant yield increases over the control when applied alone without combination with another nutrient. Maximum dry matter yields were realized at the 90-60-60 treatment rate.

TABLE 13. Dry Matter yields of grass as influenced by cutting date and fertilizer treatment in 1975.

Treatment $N-P_2O_5-K_2O$ lbs/A	Dry Matter Yields lbs/A June 6	July 17	Total
0-0-0	568	643	1211
0-60-0	1198	1184	2382
0-0-60	592	668	1260
0-60-60	1410	1301	2711
30-60-60	2023	1225	3248
60-60-60*	2010	993	3003
90-60-60*	3324	1326	4650
120-60-60*	2880	1281	4161
150-60-60*	3095	1388	4483
150-0-0*	558	854	1412
Significance	**	**	**
BLSD (.05)	529	417	593
CV (%)	22.8	25.1	5.8

* Plots received 30 lbs N/A of the nitrogen after the first cutting.

THE EFFECT OF FERTILIZATION ON THE PRODUCTION OF QUACKGRASS ON AN ORGANIC SOIL

R.P. Schoper, G. Malzer, and C. Simkins

A field experiment was established on a peatland area near Gully in the spring of 1974 to study the effects of nitrogen, phosphorus and potassium fertilization on the quantity and quality of quackgrass grown. In an earlier report[1], the materials and methods of the trial were discussed.

NITROGEN TRIALS

In Table 1, total dry matter yields for the 75 growing season are reported. It is of interest to note the excellent dry matter response due to the application of nitrogen. It should also be noted that while dry matter yields increased with the rate of nitrogen applied, total dry matter yields did not increase due to the splitting of nitrogen applications. Splitting of nitrogen treatments, in 1974 and 1975, did result in variable seasonal forage production as illustrated in Figure 1.

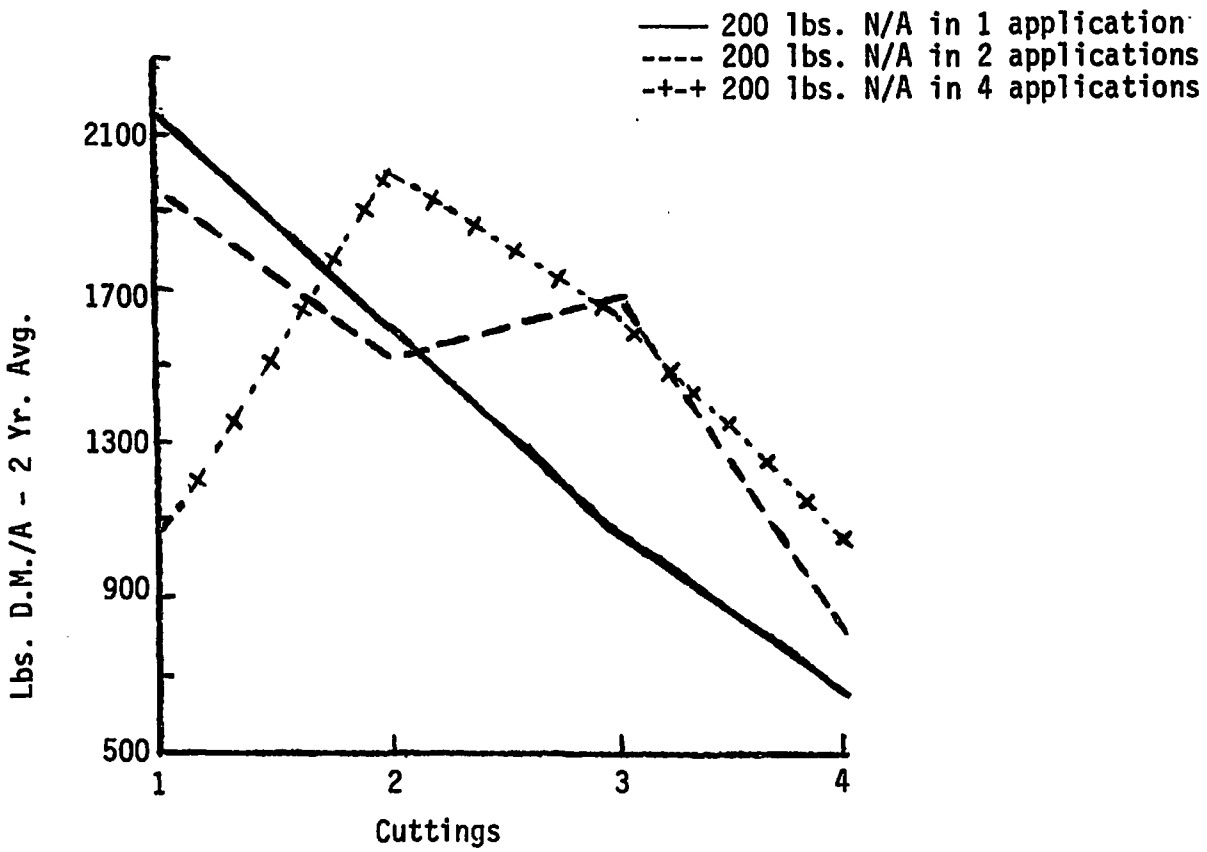
Table 1. Dry matter yields of quackgrass for various dates of harvest and nitrogen fertilizer treatments. Gully, Minnesota - 1975.

Treatments lbs/A			Grass Production lbs. dry matter / A				
N	P_2O_5	K_2O	June 3	July 9	Aug. 13	Sept. 18	Total
0	0	0	940	795	394	276	2405
0	100	300	1184	982	525	409	3100
100	0	0	1549	1079	376	304	3308
50	100	300	1945	1014	432	352	3743
100	100	300	2353	1144	509	380	4386
150	100	300	3142	1452	517	399	5510
200	100	300	3269	1501	517	381	5668
* 50	100	300	1904	1095	1334	371	4704
*100	100	300	2350	1144	1275	381	5150
*150	100	300	2981	1485	1350	399	6215
*200	100	300	3331	1644	1265	514	6754
** 50	100	300	1750	2109	1242	904	6005
Significance			**	**	**	**	**
BLSD (.05)			522	331	149	176	720

*Plots received an additional 50 lbs. N/A following the second cutting.
**Plots received an additional 50 lbs. N/A following the first, second and third cuttings.

[1] 1975. A Report on Field Research in Soils. Department of Soil Science, University of Minnesota, St. Paul. Soil Series 95.

Figure 1. The relationship between time of nitrogen application and dry matter yield of quackgrass under pasture management. Gully, Minnesota - 1974, and 1975.



The protein levels for quackgrass under pasture management (Table 2), even without the addition of nitrogen, were excellent. A general increase in the protein percentages is evident due to the increasing rates of nitrogen.

Table 2. Protein content of quackgrass for various dates of harvest and nitrogen fertilizer treatments. Gully, Minnesota - 1975.

Treatments lbs/A			----------Protein Content - percent----------			
N	P_2O_5	K_2O	June 3	July 9	Aug. 13	Sept. 18
0	0	0	19.4	18.0	18.2	19.6
0	100	300	18.1	17.8	17.8	18.2
100	0	0	21.8	19.8	20.3	20.3
50	100	300	18.8	17.8	18.0	18.5
100	100	300	19.5	18.3	18.7	18.9
150	100	300	20.9	20.0	18.4	18.8
200	100	300	23.3	21.1	20.4	20.8
* 50	100	300	18.9	19.7	20.2	21.2
*100	100	300	20.3	19.0	20.8	21.2
*150	100	300	23.9	21.1	22.1	22.3
*200	100	300	24.7	20.4	24.1	22.5
** 50	100	300	20.2	20.2	23.8	27.3
Significance			**	**	**	**
BLSD (.05)			2.1	1.9	1.9	1.7

*Plots received an additional 50 lbs. N/A following the second cutting.

**Plots received an additional 50 lbs. N/A following the first, second, and third cuttings.

PHOSPHORUS TRIAL

In 1975, dry matter yields under pasture management were significantly increased due to the application of phosphorus in three out of four cuttings (Table 3). The optimum rate, as in 1974, would appear to be 100 lbs. P_2O_5/A. Table 4 includes the summary for percent phosphorus in the whole plant tissue for the four cuttings.

Table 3. Dry matter yields of quackgrass for various dates of harvest and phosphorus fertilizer treatments. Gully, Minnesota - 1975.

Treatments lbs/A			Grass Production lbs. dry matter/A				
N	P_2O_5	K_2O	June 3	July 9	Aug. 13	Sept. 18	Total
0	0	0	1173	1181	401	475	3230
150	0	300	1386	1186	887	622	4081
150	50	300	2494	1746	1096	622	5958
150	100	300	2710	1588	1150	737	6185
150	150	300	2779	1818	1250	665	6512
150	200	300	2851	1851	1173	579	6454
Significance			**	*	**	NS	**
BLSD (.05)			580	459	296		1138

Table 4. Phosphorus analysis of quackgrass for various dates of harvest and phosphorus fertilizer treatments. Gully, Minnesota - 1975.

Treatments lbs/A			----------Phosphorus Content---percent----------			
N	P_2O_5	K_2O	June 3	July 9	Aug. 13	Sept. 18
0	0	0	0.34	0.36	0.31	0.27
150	0	300	0.32	0.29	0.23	0.23
150	50	300	0.41	0.40	0.29	0.30
150	100	300	0.57	0.52	0.40	0.38
150	150	300	0.54	0.52	0.41	0.39
150	200	300	0.59	0.57	0.43	0.40
Significance			*	**	*	*
BLSD (.05)			0.09	0.02	0.06	0.09

Soils samples were taken on September 18 to determine the effects of phosphorus applications upon phosphorus concentrations in the soil profile. The results shown in Table 5, would suggest some movement of phosphorus down to the 6 to 9 inch depth.

Table 5. The effect of various rates of applied phosphorus on levels of available phosphorus in the soil profile. Gully, Minnesota - 1975.

Phosphorus Treatments	Soil depth - inches 0-1	1-2	2-3	3-6	6-9	9-12
lbs/A	----------	----------	----------	pp2m	----------	----------
0	4	2	2	2	4	3
50	10	4	4	3	4	2
100	30	17	12	12	12	5
150	34	21	11	4	5	2
200	44	46	34	10	10	4

POTASSIUM TRIAL

Dry matter increases were demonstrated with the use of broadcast potassium in 1975 (Table 6). The optimum rate would appear to be 150 lbs. K_2O/A. Table 7 includes the plant analysis for percent potassium in the tissue and Table 8 shows the effect of potassium applications upon exchangeable potassium levels in the soil profile.

Table 6. Dry matter yield of quackgrass for various dates of harvest and potassium fertilizer treatments. Gully, Minnesota - 1975.

Treatments lbs/A			Grass Production lbs. dry matter/A				
N	P_2O_5	K_2O	June 3	July 9	Aug. 13	Sept. 18	Total
0	0	0	933	998	332	363	3212
150	100	0	2353	1572	926	674	4433
150	100	75	2418	1638	964	778	4818
150	100	150	2587	1738	1142	882	4594
150	100	225	2614	1430	1296	726	5366
150	100	300	2429	1463	1242	795	5055
150	100	450	2868	1671	1319	864	5628
Significance			**	**	**	**	**
BLSD (.05)			251	211	159	558	601

Table 7. Potassium analysis of quackgrass for various dates of harvest and potassium fertilizer treatments. Gully, Minnesota - 1975.

Treatments lbs/A			----------Potassium Content---percent----------			
N	P_2O_5	K_2O	June 3	July 9	Aug. 13	Sept. 18
0	0	0	2.56	2.84	1.90	1.62
150	100	0	2.16	2.32	1.75	1.75
150	100	75	3.70	2.61	1.75	2.06
150	100	150	4.10	3.69	2.43	2.20
150	100	225	4.39	3.82	3.10	2.26
150	100	300	4.47	3.61	3.63	2.51
150	100	450	4.76	3.74	4.42	2.83
Significance			*	**	**	*
BLSD (.05)			0.96	0.34	0.22	0.53

Table 8. The effect of various rates of applied potassium on levels of exchangeable potassium in the soil profile. Gully, Minnesota - 1975.

Potassium Treatments	Soil depth - inches 0-1	1-2	2-3	3-6	6-9	9-12
0	80	50	20	20	20	20
150	65	50	30	25	25	25
300	130	75	70	75	50	30
450	520	500	345	175	105	45

INFLUENCE OF NITROGEN RATE AND TIMING OF APPLICATION ON THE PRODUCTION AND QUALITY OF FORAGE GRASSES ON ORGANIC SOILS

G.L. Malzer, R.P. Schoper and J. Lensing

Three rates of nitrogen 0, 150, and 300 #/acre were applied as NH_4NO_3 to existing stands of orchardgrass, quackgrass, and reed canarygrass growing on organic soils in Roseau County, Minnesota. The three grass experiments were separated, but were all contained within the same area of organic soil and were within reasonable proximity to each other. The 150 and 300 #N/A treatments were applied in four different manners: 1) the entire amount applied at once in early spring, 2) applied in two equal amounts one in early spring and the second after the first clipping, 3) applied in three equal portions including early application and after the first and second clipping, and 4) as four equal amounts applied early spring and then after the first, second and third clippings.

The experiments were set up to evaluate two management programs, a hay management with a two clipping sequence and pasture management with a four clipping sequence. Only the information obtained from the four clipping program will be included in this report. Clippings in 1975 were taken on June 11, July 8, August 12, and September 16. On these dates, all plots were cut back to about a 7 cm height.

Initial soil tests were taken, and to insure that P and K were not limiting all nitrogen treatments received 100 #/A of P_2O_5 and 100 #/A of K_2O applied as an early spring application. Two additional treatments were also included, a "true check" containing no N, P, and K and the high rate of nitrogen applied in four split applications with no phosphorus or potassium within the experimental areas.

Treatments were evaluated by determining dry matter production at each clipping (Table 1). Samples from each plot were obtained at harvest and analyzed for crude protein-Kjeldahl nitrogen (Table 2). These values allowed the calculation of total N removal (Table 3). Samples are also being analyzed for acid detergent fiber but results are not available at this time.

GENERAL RESULTS

Orchardgrass - Significant dry matter increases were found even at the higher rate of N application (300 #/A). Splitting of nitrogen application had no influence on total dry matter production except at the 300 pound rate where two equal portions did increase total production. There was no advantage to more than two splits when evaluating total production. Splitting of N applications did significantly influence distribution of dry matter production and protein content between clippings. Applications of 150 #N/A when applied early had no influence on dry matter production on the third and fourth clipping. The 300 #N/A treatment did not result in a dry matter increase on the fourth clipping. Protein contents at each clipping was directly related to the amount and time of nitrogen application. Protein content in general for orchardgrass was lower than either quackgrass or reed canarygrass.

Quackgrass - The first two clippings in general followed the same trends as orchardgrass. The quackgrass area after the second clipping for some unexplained reason was severely stunted and produced no growth at the time the third clippings were taken. Even without the third clipping, total yields were similar to orchardgrass, but had much higher crude protein contents. Quackgrass appeared to be much more efficient in obtaining nitrogen from the soil as can be seen in Table 3. When no nitrogen was applied, the quackgrass check plots utilized twice as much nitrogen from the soil than did either orchardgrass or reed canarygrass. This resulted in a much higher N uptake than either of the other grasses.

Reed canarygrass - Yield responses were similar to those of orchardgrass although total production was lower. Crude protein contents were higher for the reed canarygrass treatments than for orchardgrass resulting in similar amounts of total N removed.

Table 1. Dry matter production of orchardgrass, quackgrass, and reed canarygrass as influenced by rate and time of nitrogen application (organic soil--Roseau County, Minnesota).

N applied (#/A)	Clipping 1	Clipping 2	Clipping 3	Clipping 4	Total
Orchardgrass					
0	1753 ab	1271 a	672 a	310 ab	4006 a
150 - (1 - 150)	3290 f	1657 b	889 ab	344 ab	6179 b
150 - (2 - 75)	2665 cde	2343 dc	961 abc	324 ab	6293 b
150 - (3 - 50)	2332 bcd	2262 de	1251 bcd	512 bc	6356 b
150 - (4 - 38)	2083 abc	2165 de	1357 de	789 de	6393 b
300 - (1 - 300)	2516 cde	1825 bc	1281 cd	364 ab	5986 b
300 - (2 - 150)	3073 ef	2079 cd	1476 de	661 cd	7288 c
300 - (3 - 100)	3081 ef	2451 e	1477 de	985 e	7963 c
300 - (4 - 75)	2762 def	2135 d	1680 e	971 e	7547 c
+0	1639 a	1113 a	641 a	283 a	3676 a
+300 - (4 - 75)	2949 ef	2104 cd	1633 de	823 de	7507 c
Signif.	**	**	**	**	**
BLSD (.05)	611	291	382	209	810
C.V.	16.9	11.2	22.6	26.9	9.8
Quackgrass					
0	2070 a	1873 b		1906	5849 ab
150 - (1 - 150)	3132 cd	2228 d		1670	7030 cde
150 - (2 - 75)	2798 bc	2399 ef		1234	6430 bcd
150 - (3 - 50)	2673 bc	2479 f		1667	6819 cde
x150 - (3 - 38)	2608 b	2215 d		1570	6393 bcd
300 - (1 - 300)	3541 d	2316 de		1675	7531 e
300 - (2 - 150)	3129 cd	2320 de		1742	7190 de
300 - (3 - 100)	2909 bc	2320 de		1854	7083 de
x300 - (3 - 75)	2823 bc	2331 de		1764	6120 abc
+0	2041 a	1501 a		1682	5225 a
x+300 - (3 - 75)	2877 bc	2009 c		1219	6104 abc
Signif.	**	**		NS	**
BLSD (.05)	494	125			933
C.V.	12.5	12.2		19.4	9.5
Reed canarygrass					
0	619 a	969b	628 ab	493 ab	2708 a
150 - (1 - 150)	1722 f	1438 c	532 a	487 ab	4178 b
150 - (2 - 75)	1305 cde	2278 e	742 bc	632 bc	4957 c
150 - (3 - 50)	1047 bc	2015 d	1250 fg	632 bc	4944 c
150 - (4 - 38)	759 ab	1639 c	909 cd	990 de	4297 b
300 - (1 - 300)	2078 g	2324 ef	951 de	564 abc	5916 de
300 - (2 - 150)	1435 def	2530 f	1082 ef	653 c	5700 d
300 - (3 - 100)	1382 cdef	2314 ef	1351 g	896 d	5943 de
300 - (4 - 75)	1478 ef	2329 ef	1411 g	1172 f	6391 e
+0	520 a	725 a	556 a	469 a	2271 a
+300 - (4 - 75)	1136 cd	2200 de	1363 g	1069 ef	5769 d
Signif.	**	**	**	**	**
BLSD (.05)	339	236	182	147	579
C.V.	17.4	8.1	11.9	12.8	7.8

+ - No phosphorus and potassium applied

x - Did not receive a fourth nitrogen application due to poor plant growth.

Table 2. Crude protein content of orchardgrass, quackgrass, and reed canarygrass as influenced by rate and time of nitrogen application (organic soil--Roseau County, Minnesota).

N applied (#/A)	Clipping 1	Clipping 2	Clipping 3	Clipping 4
Orchardgrass				
0	15.9 ab	12. 9 a	14.0 a	17.2 a
150 - (1 - 150)	20.8 de	15.0 abc	14.7 ab	18.4 ab
150 - (2 - 75)	16.0 ab	20.3 ef	16.1 bc	18.6 ab
150 - (3 - 50)	15.1 a	17.2 cd	19.3 de	18.4 ab
150 - (4 - 38)	16.0 ab	16.0 bc	17.3 c	22.8 c
300 - (1 - 300)	26.0 f	19.5 e	17.5 cd	19.2 b
300 - (2 - 150)	21.6 e	22.4 f	21.6 fg	23.6 c
300 - (3 - 100)	17.4 abc	21.6 ef	23.0 g	25.9 d
300 - (4 -75)	18.0 bc	19.4 de	20.9 ef	26.7 d
+0	15.8 ab	13.9 ab	13.8 a	17.4 a
+300 - (4 - 75)	18.7 cd	20.2 ef	22.9 g	25.8 d
Signif.	**	**	**	**
BLSD (.05)	2.4	2.2	1.9	1.7
C.V.	9.6	9.2	7.8	6.0
Quackgrass				
0	20.2 a	19.5 a		20.3 a
150 - (1 - 150)	27.7 def	24.2 bcd		24.6 b
150 - (2 - 75)	26.9 bcde	25.2 bcd		25.8 b
150 - (3 - 50)	24.7 b	23.2 b		23.4 ab
x150 - (3 - 38)	24.5 b	24.4 bcd		23.4 ab
300 - (1 - 300)	29.9 f	26.3 cd		26.4 b
300 - (2 - 150)	28.6 ef	26.1 cd		25.7 b
300 - (3 - 100)	27.6 cdef	25.9 cd		26.3 b
x300 - (3 - 75)	24.9 bc	23.9 bc		26.3 b
+0	20.2 a	19.8 a		20.6 a
x+300 - (3 - 75)	25.1 bcd	26.7 d		25.9 b
Signif.	**	**		**
BLSD (.05)	2.7	2.6		3.1
C.V.	7.7	7.6		8.7
Reed canarygrass				
0	19.6 a	16.7 a	17.5 ab	18.4
150 - (1 - 150)	25.5 e	18.2 abc	18.1 ab	21.1
150 - (2 - 75)	24.1 cde	22.6 de	20.9 d	21.8
150 - (3 - 50)	23.4 cd	20.6 cd	21.7 de	22.7
150 - (4 - 38)	20.5 ab	18.2 abc	18.8 bc	21.3
300 - (1 - 300)	30.9 g	23.9 ef	20.1 cd	22.8
300 - (2 - 150)	28.1 f	25.5 f	23.4 ef	21.8
300 - (3 - 100)	24.9 de	22.8 def	27.2 g	24.8
300 - (4 - 75)	22.3 bc	19.7 bc	24.3 f	21.7
+0	20.1 a	17.3 ab	16.6 a	17.9
+300 - (4 - 75)	24.5 de	20.8 cd	23.8 f	22.5
Signif.	**	**	**	NS
BLSD (.05)	1.9	2.8	1.8	
C.V.	5.1	8.1	5.4	12.6

+ - No phosphorus and potassium applied.

x - Did not receive a fourth nitrogen application due to poor plant growth.

Table 3. Total pounds of nitrogen removed by orchardgrass, quackgrass, and reed canarygrass as influenced by rate and time of nitrogen application (organic soil--Roseau County, Minnesota).

N applied (#/A)	Clipping 1	Clipping 2	Clipping 3	Clipping 4	Total
Orchardgrass					
0	45 a	26 a	15 a	8 a	94 a
150 - (1 - 150)	109 e	40 b	21 a	10 a	180 b
150 - (2 - 75)	69 bc	76 fg	25 ab	9 a	179 b
150 - (3 - 50)	56 ab	63 cde	38 bc	15 a	173 b
150 - (4 - 38)	53 ab	55 c	37 b	28 bc	174 b
300 - (1 - 300)	105 de	56 cd	36 b	11 a	208 c
300 - (2 - 150)	106 de	74 fg	51 cd	25 b	256 d
300 - (3 - 100)	85 cd	84 g	53 d	40 d	263 d
300 - (4 - 75)	80 c	66 def	56 d	41 d	243 d
+0	41 a	25 a	12 a	8 a	88 a
+300 - (4 - 75)	88 cde	68 ef	58 d	34 cd	248 d
Signif.	**	**	**	**	**
BLSD (.05)	22	10	13	7	27
C.V.	20.8	13.0	25.3	25.8	10.8
Quackgrass					
0	67 a	59 a		65 abcd	187 a
150 - (1 - 150)	141 c	86 b		63 abcd	209 cde
150 - (2 - 75)	120 bc	94 b		50 a	266 bcd
150 - (3 - 50)	106 b	91 b		62 abcd	260 bc
x150 - (3 - 38)	103 b	87 b		58 abc	248 b
300 - (1 - 300)	169 d	97 b		70 bcd	337 f
300 - (2 - 150)	143 c	96 b		71 bcd	311 ef
300 - (3 - 100)	128 bc	96 b		77 d	301 de
x300 - (3 - 75)	113 b	89 b		74 cd	275 bcd
+0	66 a	48 a		55 ab	169 a
x+300 - (3 - 75)	115 b	86 b		50 a	251 b
Signif.	**	**		**	**
BLSD (.05)	25	15		17	35
C.V.	15.9	12.6		16.5	10.0
Reed canarygrass					
0	20 a	26 a	18 a	14 ab	78 a
150 - (1 - 150)	70 e	41 b	15 a	17 abc	143 b
150 - (2 - 75)	50 bc	82 def	25 b	22 c	179 c
150 - (3 - 50)	39 b	67 c	43 c	23 c	172 c
150 - (4 - 38)	25 a	48 b	28 b	33 d	134 b
300 - (1 - 300)	102 f	89 f	30 b	21 bc	243 e
300 - (2 - 150)	65 de	102 g	40 c	23 c	230 de
300 - (3 - 100)	55 cd	85 ef	59 e	36 de	234 e
300 - (4 - 75)	53 cd	74 cde	55 de	41 e	222 de
+0	17 a	20 a	15 a	13 a	65 a
+300 - (4 - 75)	45 bc	73 cd	52 d	38 de	208 d
Signif.	**	**	**	**	**
BLDS (.05)	13	11	6	7	22
C.V.	16.6	10.7	11.3	16.5	8.2

+- No phosphorus and potassium applied.

x - Did not receive a fourth nitrogen application due to poor plant growth.

FERTILIZATION OF GRASSES FOR SEED PRODUCTION

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While fertilizer costs have doubled or tripled since 1972, prices received by growers for most grass seed have increased very little. Therefore, it is most important that information on efficient use of commercial fertilizer is available.

Research was continued during 1975 on fertilizer rate, time of application and effectiveness of single and split application. Six experiments with Kentucky bluegrass, timothy and orchardgrass were conducted on growers' fields in Roseau and Lake of the Woods counties.

A. WEATHER CONDITIONS DURING 1974/75 GROWING SEASON

Following comments are based on measurements taken at the Magnusson farm at Roseau as well as on climatological data for northwest Minnesota (Climatological Data, Vol. 80 and 81, 1974 and 1975). August of 1974 was cool and extremely wet with a total rainfall of nearly 11 inches. The weather during September was very dry and cool and dry during October. The area had nearly normal snow-cover during winter. April was cool with normal precipitation. At the Magnusson farm, the following rainfall was recorded during May-July, 1975.

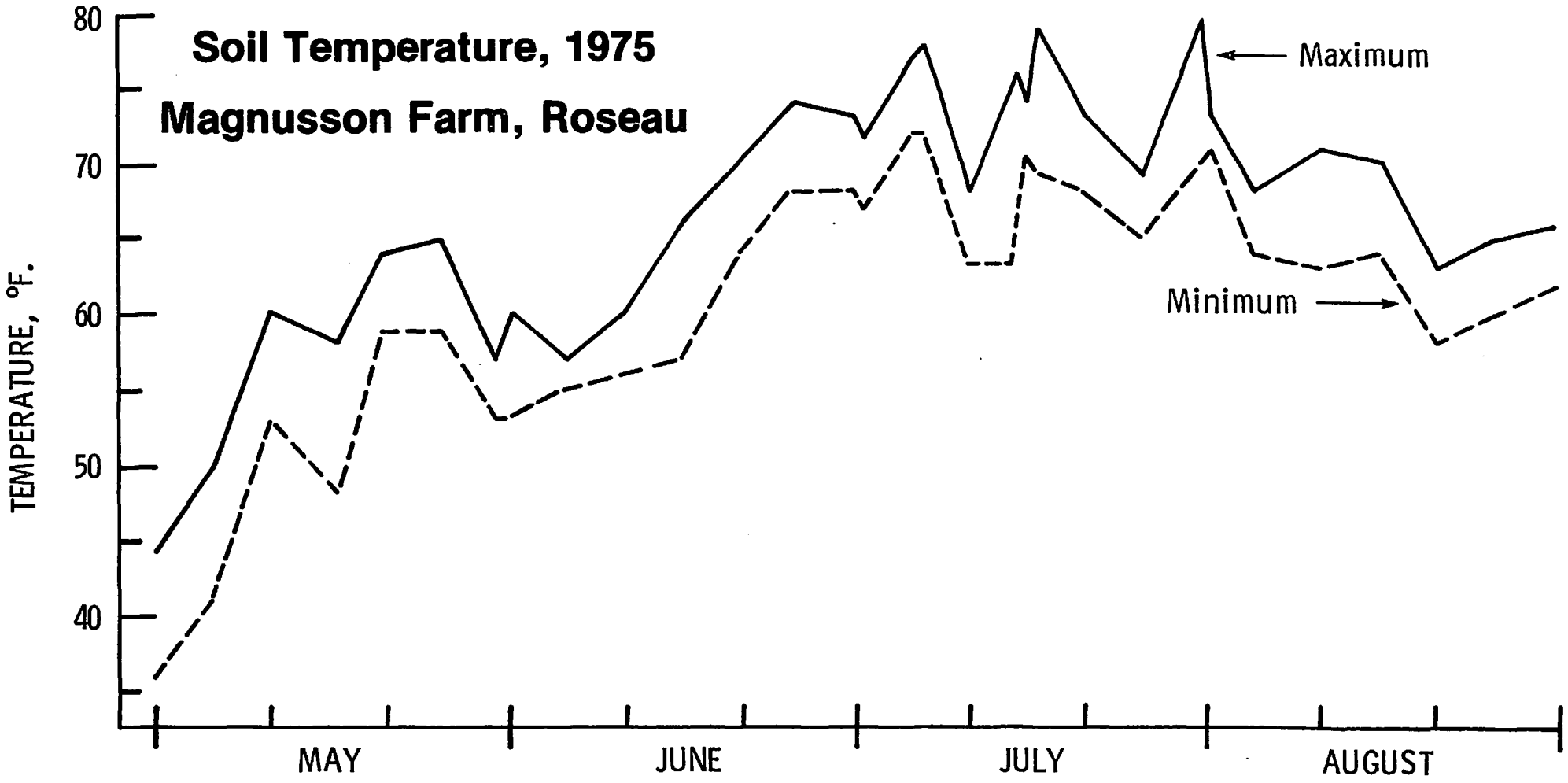
Month	Rainfall, inches
May	1.34
June	5.97
July	2.74

May was relatively dry (rainfall 1 inch below normal) with average air temperature of 54.2° F (2.3° F above normal). June was wet and cool. On July 1, a heavy rain (1.55 inch) fell at Roseau but after that weather was quite dry. The soil warmed up relatively fast during May (Fig. 1). But then during the first half of June, the soil temperature ranged from mid-50's to mid-60's. Soil temperature (under sod at 3 inch depth), during second half of June and during July ranged from high 60's to high 70's, which is about normal for the mineral soil on Magnusson farm.

B. DATE OF FERTILIZATION

In 1975, three date of fertilization trials were conducted with cool season grasses on growers' fields in northwestern Minnesota.

Prepared for presentation at the Grass Seed Institute,
Roseau, March 24, 1976


Soil Temperature, 1975
Magnusson Farm, Roseau
TEMPERATURE, °F.
80
70
60
50
40
Maximum
Minimum
MAY
JUNE
JULY
AUGUST

Park Kentucky bluegrass seed yield on a loamy sand was increased by 468 Lbs/Acre with the application of 120+40+40 Lbs/Acre of N, P_2O_5 and K_2O on October 9 (Table 1). Fertilizer applications made on April 24 resulted in nearly 150 Lbs/Acre of less seed than the October treatment. Nitrogen concentration of grass tissue was increased considerably by fertilization. The highest N concentration was found in tissue from spring treatments. Split application of nitrogen (1/2 in October and 1/2 in April) resulted in about the same seed yield and N% in tissue as the single application made in October. The second split application was equally effective to that made in April. All fertilizer treatments caused slight lodging of Park bluegrass (Table 4).

Timfor timothy seed yield was increased by about 300 Lbs/Acre by fertilization (Table 2). However, no differences in yield were detected among the fertilizer treatments. Nitrogen concentration in tissue was increased by fertilization with split applications showing the highest values. Slight to moderate lodging resulted from fertilization (Table 4).

Climax timothy seed yield was increased by 164 to 197 Lbs/Acre by fertilization (Table 3). The most effective were the October and the split applications. Nitrogen concentration in tissue also was considerably increased by fertilization. The highest N values were obtained in tissue from spring and split treatments. Fertilization resulted in slight to moderate lodging of Climax timothy (Table 4).

Table 1. Effect of Date of Fertilization on the Seed Yield and N Concentration in Tissue of Park Kentucky Bluegrass on a Loamy sand Soil. Helmstetter Bros. Farm, Lake of the Woods County - 1975.

Date		Seed yield lbs/acre	N percent in dry matter
Check		79 a	1.57 a
Oct. 9		547 c	2.32 b
Apr. 24		398 b	2.60 c
Split I	(60+40+40, 10/9 & 60#/A N, 4/24)	543 c	2.39 bc
Split II	(60+40+40, 10/9 & 60#/A N, 5/15)	420 b	2.43 bc
Significance		**	**
BLSD (0.05)		96	0.21

All plots, except the check, received a total of 120+40+40 Lbs/Acre of plant nutrients (N, P_2O_5, K_2O).

Values having same letter(s) are not significantly (5% level) different.

Table 2. Effect of Date of Fertilization on Seed Yield and N Concentration in Tissue of Timfor Timothy on a Silt Loam Soil, 1973 Seeding. Dell Hedlund Farm, Roseau County - 1975

Date		Seed yield lbs/acre	N percent in dry matter
Check		397 a	2.19 a
Oct. 9		721 b	3.37 b
Apr. 24		713 b	3.55 b
Split I	(60+40+40, 10/9 & 60#/A N, 4/24)	687 b	3.49 bc
Split II	(60+40+40, 10/9 & 60#/A N, 5/15)	691 b	3.72 c
Significance		**	**
BLSD (0.05)		90	0.32

All plots, except the check, received a total of 120+40+40 Lbs/Acre of plant nutrients (N, P_2O_5, K_2O).

Values having same letter(s) are not significantly (5% level) different.

Table 3. Effect of Date of Fertilization on Seed Yield and N Concentration in Tissue of Climax Timothy on a Silty Clay Loam Soil (5th Seed Year) Art Bicker Farm, Roseau County - 1975

Date		Seed yield lbs/acre	N percent in dry matter
Check		376 a	1.99 a
Oct. 9		540 bc	3.12 b
Apr. 24		450 ab	3.61 c
Split I	(60+40+40, 10/9 & 60#/A N, 4/24)	542 bc	3.35 bc
Split II	(60+40+40, 10/9 & 60#/A N, 5/15)	573 c	3.63 c
Significance		**	**
BLSD (0.05)		99	0.45

All plots, except the check, received a total of 120+40+40 Lbs/Acre of plant nutrients (N, P_2O_5, K_2O).

Values having same letter(s) are not significantly (5% level) different.

Table 4. Effect of Date of Fertilization on Lodging of Grasses*

Date	Location		
	Park K. bl. gr., Helmstetter Bros.	Timfor timothy, Hedlund	Climax timothy, Bicker
Check	1**	1	1
Oct. 9	2 1/2	3	3+
Apr. 24	3	4-	4
Split I	2	3+	3+
Split II	3	4	4-

* Rating of 1 = no lodging; rating of 5 = severe lodging; observations were made on July 1, 1975

** Average of 4 replications

C. FERTILIZER RATE STUDIES

A field experiment with Park Kentucky bluegrass on peat, initiated in fall of 1971, was conducted to study the effect of different nitrogen rates on seed yield. This was done in response to inquiries by growers and others concerning N rates for bluegrass on peat. Previous experimental work had indicated that N rates of 20 to 30 pounds per acre may cause severe lodging of bluegrass on peat.

In 1975, nitrogen treatments increased the seed yield of Park bluegrass on peat by 56 to 283 Lbs/Acre (Table 5). The highest seed yield, of 418 Lbs/Acre, was obtained with the 80 pound N treatment. Fertilization with nitrogen also increased the N concentration in bluegrass tissue.

It should be noted that similar yield increases at this location were obtained in 1974. It was assumed that those yield responses were related to low temperature and excess moisture during spring of 1974.Incidently, the seed yield of bluegrass on this field was not affected by N treatments during 1972 and 1973 (see Table 5).

The seed yield of Newport Kentucky bluegrass also was increased by nitrogen fertilization. Forty to 80 Lbs/Acre of N treatments resulted in the highest yields (Table 6). It should be noted that in 1974, in a different area on this field, yields of 601 to 815 Lbs/Acre were obtained and N had no effect on yield.

Table 5. Effect of Fertilization on the Seed Yield of Park Kentucky Bluegrass on Peat, 1970 Seeding.
Charles Habstritt Farm, Roseau County 1972-1975

Treatment* N P_2O_5 K_2O lbs/acre	1972	1973	1974	1975	1975
	Seed yield lbs/acre				N percent in dry matter
Check	347	218	220 a	135 a	1.79 a
0+40+40	386	233	217 a	191 b	1.77 a
20+40+40	342	227	362 b	296 c	1.96 ab
40+40+40	362	220	525 c	333 d	2.20 bc
80+40+40	391	267	565 c	418 e	2.43 c
Significance	NS	NS	**	**	**
BLSD (0.05)				24	0.28

* Fertilizer treatments were made on Sep. 21, 1971; Sep. 19, 1972; Oct. 10, 1973; Oct. 10, 1974.

Values having same letter(s) are not significantly (5% level) different.

Table 6. Effect of Fertilization on the Seed Yield and N Concentration in Tissue of Newport Kentucky Bluegrass on Peat, 1971 Seeding.
Gus Kveen Farm, Roseau County 1975.

Treatment* N P_2O_5 K_2O lbs/acre	Seed yield lbs/acre	N percent in dry matter
Check	243 a	1.93 a
0+40+40	272 a	1.84 a
20+40+40	326 ab	2.11 b
40+40+40	411 bc	2.25 bc
80+40+40	469 c	2.28 c
Significance	**	**
BLSD (0.05)	110	0.16

* Fertilizer treatments were made on Oct. 10, 1974.

Values having same letter(s) are not significantly (5% level) different.

The yield of Nordstern orchardgrass on a mineral soil was increased by varying rates of nitrogen (Table 7). The field had received a basic treatment of 36+36+34 in mid-September. Additional N was applied as ammonium nitrate on May 7. The 120 to 160 Lbs/Acre N rates appeared to be most effective. Nitrogen concentration of tissue also was related to the N rate. While no lodging was observed in plots receiving 40 or 80 Lbs/Acre of N, the higher N rates resulted in slight to severe lodging of plants (Table 8).

Table 7. Effect of N Application on Seed Yield and N Concentration in Tissue of Nordstern Orchardgrass on Loam Soil, 1972 Seeding. Helmstetter Bros. Farm, Lake of the Woods County-1975.

N rate lbs/acre	Seed yield lbs/acre	N percent in dry matter
40	241 a	2.36 a
80	444 b	3.01 b
120	602 bc	3.79 c
160	656 c	4.47 d
200	678 c	4.37 cd
Significance	**	**
BLSD (0.05)	199	0.63

All plots received 36+36+34 Lbs/Acre of plant nutrients (N, P_2O_5, K_2O) on Sep. 12, 1974, and additional N (to bring the rate up to 40, 80, etc. Lbs/Acre) as 34-0-0 on May 7, 1975.

Values having same letter(s) are not significantly (5% level) different.

Table 8. Effect of N Rate on Lodging of Orchardgrass*.

N rate lbs/acre	Lodging**
40	1
80	1
120	3
160	4+
200	5

* Rating of 1 = no lodging;
Rating of 5 = severe lodging
Observations were made on July 1, 1975

** Average of 3 replications

SUMMARY AND CONCLUSIONS

Six field experiments with Kentucky bluegrass, timothy and orchardgrass were conducted on growers' fields in northwestern Minnesota. The main objective of these studies was to determine the effects of fertilization, single and split applications of nitrogen on chemical composition of plant tissue and seed yield of grasses.

Sufficient moisture and cool weather from April to harvest resulted in relatively high seed yields. Fertilization, especially nitrogen, stimulated vegetative growth, caused slight to moderate lodging and substantially increased the seed yield of grasses.

Fertilization of Kentucky bluegrass in mid-October was superior to spring application. Seed yields of two timothy varieties were increased significantly by fertilization with the fall and spring applications being about equally effective.

Spring and split applications of fertilizer resulted in higher N% of grass tissue, but in seed yield, showed no advantage over the mid-October treatment.

Nitrogen applications to Park and Newport varieties of Kentucky bluegrass on peat resulted in increased N% of tissue and higher seed yields. Maximum yields were obtained with the 40 to 80 Lbs/Acre rates of N.

Acknowledgments

Grateful acknowledgments are made to the following cooperators for their valuable assistance during 1975 in obtaining the information pertaining to grass seed production.

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SOYBEAN NITROGEN FERTILIZER STUDIES

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

Ammonium nitrate and urea were compared at Morris and Waseca at the rate of 50 and 100 pounds N per acre when applied in the fall and spring. In addition, urea at the rate of 200 pounds N per acre was applied in the fall. Fall applied N was plowed-down and spring applied N was applied to the surface and disked in before planting. Clay, Evans and Hodgson varieties were planted at Morris on May 10 in 30-inch rows and Corsoy and Hodgson varieties were planted at Waseca on May 13. Seed yields are shown in Table 1.

At Morris, the seed yield of Clay and Evans varieties was increased significantly while the seed yield of Hodgson variety was not increased significantly. At Waseca, the seed yield of both Corsoy and Hodgson varieties was increased significantly only in 15-inch rows (seed yield was not significantly increased in 30-inch rows). Seed yields were increased about 30% by decreasing the row spacing from 30 to 15 inches and yields were increased about 14% by adding nitrogen fertilizer.

At Waseca several soybean genotypes were compared for their response to 200 pounds of nitrogen per acre as urea. Planting was done on May 13 in 15-inch rows. The seed yield of 8 genotypes was increased significantly while the yield of 5 genotypes was decreased significantly.

Table 1. Effect of nitrogen fertilizer on soybean seed yield at Morris and Waseca.

Nitrogen Fertilizer	Morris			Waseca			
				Corsoy		Hodgson	
	Clay	Evans	Hodgson	15" rows	30" rows	15" rows	30" rows
lbs/acre	bu/acre						
Control	26.8	27.1	33.3	72.0	54.6	64.2	50.7
50-amm. nitrate (fall applied)	27.9	28.8	33.0	64.6	57.6	61.8	55.0
100-amm. nitrate (fall applied)	29.2	32.9	35.1	67.4	56.1	60.0	52.0
50-urea (fall applied)	33.0*	33.8*	32.3	61.5	54.9	68.4	49.0
100-urea (fall applied)	34.0*	32.1	38.3	67.3	57.0	67.7	57.2
200-urea (fall applied)	30.8	32.0	35.4	73.4	56.3	63.0	53.2
50-amm. nitrate (spring applied)	28.5	30.1	31.3	73.1	58.6	68.6	51.5
100-amm. nitrate (spring applied)	29.0	29.7	33.3	71.2	61.7	69.7	54.8
50-urea (spring applied)	28.1	29.8	31.3	72.7	57.0	62.2	54.3
100-urea (spring applied)	32.0	36.5*	36.1	81.5*	57.7	73.8*	57.3

* Seed yield is significantly greater than control yield.

Table 2. Effect of nitrogen fertilizer on soybean seed yield at Waseca.

Soybean** Genotype	Fertilizer N(urea) applied 0 Nitrogen	200 lb. N/ha	Nitrogen Response
	bu/acre		
Corsoy	72.0	73.4	1.4
12-149	71.7	63.0*	- 8.7
13-1035	64.7	59.6	- 5.1
M205Dt	63.8	69.9*	6.1
Dt-2	63.0	48.9*	-14.1
13-1030	62.9	48.9*	-14.0
12-055	62.7	65.3	2.6
M201Dt	62.2	59.3	- 2.9
Hodgson	60.5	57.8	- 2.7
12-286	60.3	51.3*	- 9.0
68-48	59.4	50.0*	- 9.4
65-115-1	59.0	60.8	1.8
68-94	58.8	60.7	1.9
12-182	58.6	59.9	1.3
12-131	58.3	60.0	1.7
12-415	58.0	54.4	- 3.6
13-1031	56.0	51.9	- 4.1
13-803	55.9	56.7	0.8
13-825	54.0	54.9	0.9
Corsoy	53.4	60.7*	7.3
68-2	53.1	51.4	- 1.7
12-139	52.6	62.0*	9.4
13-821	52.0	53.5	1.5
67-148	52.0	60.4*	8.4
12-418	51.8	53.7	1.9
12-434	51.7	62.6*	10.9
13-702	51.7	62.6*	10.9
M206Dt	50.7	52.4	1.7
13-653	50.3	54.8	4.5
13-720	50.3	54.8	4.5
13-789	49.3	55.3*	6.0
L-2	45.0	50.5	5.5
Evans	44.9	44.6	- 0.3
65-295	43.4	50.6*	7.2
Clay	40.0	39.3	- 0.7

*Seed yield of fertilizer nitrogen treated plot significantly greater than control.

**12- and 13- genotypes obtained from Dr. D.E. Green, Iowa State University; M- genotypes obtained from Dr. J.W. Lambert, University of Minnesota.

EFFECT OF INOCULATING SOYBEANS WITH RHIZOBIUM JAPONICUM

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

Rhizobium japonicum strains 110, 138 and 140 were prepared commercially as normal humus inoculants and also as granular-based-humus inoculants. Inoculum was applied as the normal seed inoculant and inoculum rates of 250, 500, and 1000 times the normal seed rate was applied in the furrow with the seed (all seed and treatments were hand planted to avoid contamination). The soils contained rhizobia from previous soybean crops and the uninoculated controls were well nodulated and seed yields were not increased significantly in any case (Table 1). The seed yields of the nodulating and nonnodulating isolines of Chippewa background were 48.1 and 35.6 bushels per acre, respectively at Morris and 47.5 and 37.0 bushels per acre, respectively at Waseca. The 12.5 and 10.5 bushel yield advantage of the nodulating isoline compared to the nonnodulating isoline indicate the yield responses that should be obtained if nodulation failures were present due to lack of rhizobia in the soil. The rhizobia in the soil from previous soybean crops provided adequate nodulation since no yield increase was demonstrated with inoculation.

Table 1. Effect of inoculating soybeans with Rhizobium japonicum in Minnesota.

Treatment	Location	
	Morris	Waseca
	----------bu/acre----------	
Control	45.4	42.8
110 seed[1]	46.7	44.7
110-250 x[2]	43.7	44.8
110-500 x	45.8	42.6
110-1000 x	46.1	42.4
138 seed	44.1	42.0
138-250 x	45.9	43.1
138-500 x	45.1	44.7
138-1000 x	46.6	43.9
140 seed	49.7	43.6
140-250 x	47.8	44.4
140-500 x	46.4	44.4
140-1000 x	45.2	43.1

[1]Normal seed inoculation with peat-base inoculants.
[2]250 x, 500 x, and 1000 x are these amounts times the normal rate with granular inoculants.

THE RESIDUAL EFFECT OF FIVE YEARS OF BROADCAST POTASH
MARTIN COUNTY 1975

C. J. Overdahl and W. E. Fenster

Soybeans were grown on the plots previously in continuous corn for five years at the Fred Dahl farm. Yields were measured and soil tests were made in the area sampled for yield. There was no significant effect of previous broadcast potash applications on soybean yield.

Yields and soil tests are shown in the following table.

Table 1. Residual effect of K on soybean yield and the corresponding K soil test.

Annual Treatment lbs. K_2O/A 1970 to 1974	Seed Yield	Soil Test K lbs/A
0	55.4	245 a
50	54.9	264 ab
100	52.6	309 bc
200	52.5	364 c
400	53.6	483 d
Significance	ns	**
BLSD (.05)	-	63

Avg. P test 57, avg. pH 6.4.

Soil tests for K in 1974 were lower than in 1973. The 1975 tests are higher than 1974, but down 40 to 60 pounds compared to 1973. It is not possible to relate a definite downward trend on check plots, even after 6 years.

FOLIAR FEEDING OF SOYBEANS

H.L. Meredith

Much interest has been generated throughout the Midwest relative to foliar feeding of soybeans following the news release based on research by Iowa State.

The Iowa report states 19 gallons per acre per application of a 25-6-9-1.5 sulfur were applied to soybeans to obtain the yield increase reported. The plots were in 14-inch rows, received two irrigations via sprinkler system and four applications of the nutrient mix (100-24-36-6 sulfur). Yield was increased from 53 to 76 bushels per acre with the Corsoy and 57 to 79 bushels per acre with Amsoy.

Soybeans contain 38-40 percent protein, 0.6 percent P, 1.7 percent K and 0.6 percent sulfur.

The N + P_2O_5 + K_2O requirements for soybeans then is:

Soybean Yield Bu/A	N	P_2O_5	K_2O
50	190	40	60
70	266	56	84
90	342	72	108
110	418	88	132
130	494	104	156

If we assume the soil will produce 50 bushels of soybeans and foliar applications would supply all of the required nutrients above this yield level, the requirements would be:

Soybean Yield Bu/A	N	P_2O_5	K_2O
50	---	---	---
70	76	16	24
90	152	32	48
110	228	48	72
130	304	64	96

If one made three applications of a 25-6-9, 75-18-27 would be added or almost the exact nutrients contained in 20 bushels of soybeans (50 bu to 70 bu). If one assumes a density of 11 pounds per gallon this equates to about 210 pounds per acre or about 5 acres per plane load for each application. The economics of a break-even proposition figures out to be about 8 bushels of soybeans. Not a program for everyone.

An interesting article in Science (Vol. 189, p. 565, 1975) by Sinclair and de Wit helps to explain why soybean yields may be increased by foliar nutrient applications after formation. Of 24 crop seeds selected from important legume and cereal crops, soybeans had the highest nitrogen requirement for seed production and were one of the lowest producers of seed per unit of photosynthate.

Soybeans were classified as plants with "self-destruct" mechanisms. It was theorized that the root system of nodulated sobyeans is incapable of N uptake from the soil at a sufficient rate for maximum yields. At pod formation, large quantities of N are translocated from the leaves, the leaves become senescent (grow old) and photosynthesis is reduced. The root system no longer takes up high rates of N and seed development is not maximized.

The leaf may be kept physiologically alive for a longer period by foliar sprays approximately equal to the nutrients in the soybean. If the foliar nutrients prolong the life of the leaves, the pod filling period may remain active until frost. Where all conditions are favorable, yield increases may be in order.

INVESTIGATIONS RELATING TO WILD RICE FERTILIZATION AND PADDY SOILS

A PROGRESS REPORT
January 2, 1976

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Research was continued during 1975 on fertilization, nutrient requirement, sulfur effects and water quality. A nitrogen rate study was conducted on mineral soil at Grand Rapids with two varieties in first production year. In another N trial on peat, yield measurements were taken of fourth production year crop. Two strip - trials with potassium were conducted in growers' paddies in Aitkin and Clearwater counties. Plant samples were collected and analyzed to learn more about nutrient requirement of the plant. Soil temperature, Redox potential and quality of paddy water were monitored during growing season to obtain information on the environment in which wild rice grows.

A. NITROGEN RATE AND VARIETY STUDY

An experiment was conducted on mineral soil at the North Central Experiment Station, Grand Rapids. The experimental paddy had been flooded during 1974 but only cattails and a few wild rice plants grew in the area eventually used for the 1975 trial. Three rates of nitrogen were used: 0, 40, 80 Lb/A. Urea (46-0-0) was applied with a 3-foot Gandy spreader on May 13 and incorporated into the soil by rototilling. Phosphorus and potassium were not applied because soil tests had indicated very high availability of these nutrient elements (5/13/75: pH 5.5-5.7; P 67-75; K 230-250). Two varieties, the early maturing K2 and the late maturing "Johnson" wild rice were grown. A split-plot design was used in this experiment with the varieties as main plots and N rates as sub-plots. Individual plots were 10 Ft. wide and 12 Ft. long. Replications (6) were separated by 3-foot wide alleys. Wild rice was seeded by hand on May 15 and rototilled into the soil. Water level in the paddy was maintained at about 12 inches. Plant population in this experiment was 4-5 plants per square foot. No visible N deficiency symptoms were observed. In mid-July, plants in 0 nitrogen plots, were slightly shorter than those receiving N treatments. There was only slight lodging in the experiment and infection with Helminthosporium was not serious.

Five plants were selected at random from each plot at early grain formation for weight measurements and plant analysis. Four applications of malathion were made to control rice worm. Two 4 X 4 Ft. square areas from each plot were hand-harvested for yield determinations. The K2 variety was harvested on September 3 and the "Johnson" on September 17.

Temperature of paddy soils may affect chemical and biological activities that are so important in determining nutrient availability and plant growth. Soil temperature in the paddy at Grand Rapids was relatively high during the

growing season (Fig. 1). At planting time, the temperature ranged from 48 to 60°F. The soil warmed up rapidly and by May 20 the temperature ranged from 65 to 72°F. Slightly lower temperatures were recorded during the first half of June. From June 25 through first week of August the temperature was in the 70's. The maximum temperature of 81°F. was recorded on July 7. During August and early September, the soil temperature was in the 60's.

Redox potential (Eh) of flooded paddy soil was determined by placing platinum electrodes into the root zone. Readings of Eh ranged from -225 to -280 mv indicating a strongly reduced condition in the mineral soil.

The main differences in grain yields were found between the two varieties (Table 1). While the K2 yielded about 1000 Lb/Acre of grain (7% moisture) a yield of only 521-672 Lb/Acre was produced by the "Johnson" variety. This appeared to be due to unfavorable weather conditions during grain formation of the late maturing "Johnson" wild rice. In September, just before harvest, minimum air temperature was in 40's and 30's.

Yield of grain was not increased by the application of nitrogen. Actually the yields of both varieties were slightly lowered by the 80 Lb/Acre of N treatment. This additional N probably stimulated vegetative growth (Table 2) and delayed the maturity, particularly that of the late maturing "Johnson" wild rice.

Fertilization with nitrogen increased slightly the dry matter weight, N concentration and total uptake of N by wild rice (Tables 2, 3, 4). A single plant contained from 563-690 milligrams of nitrogen.

Fig. 1

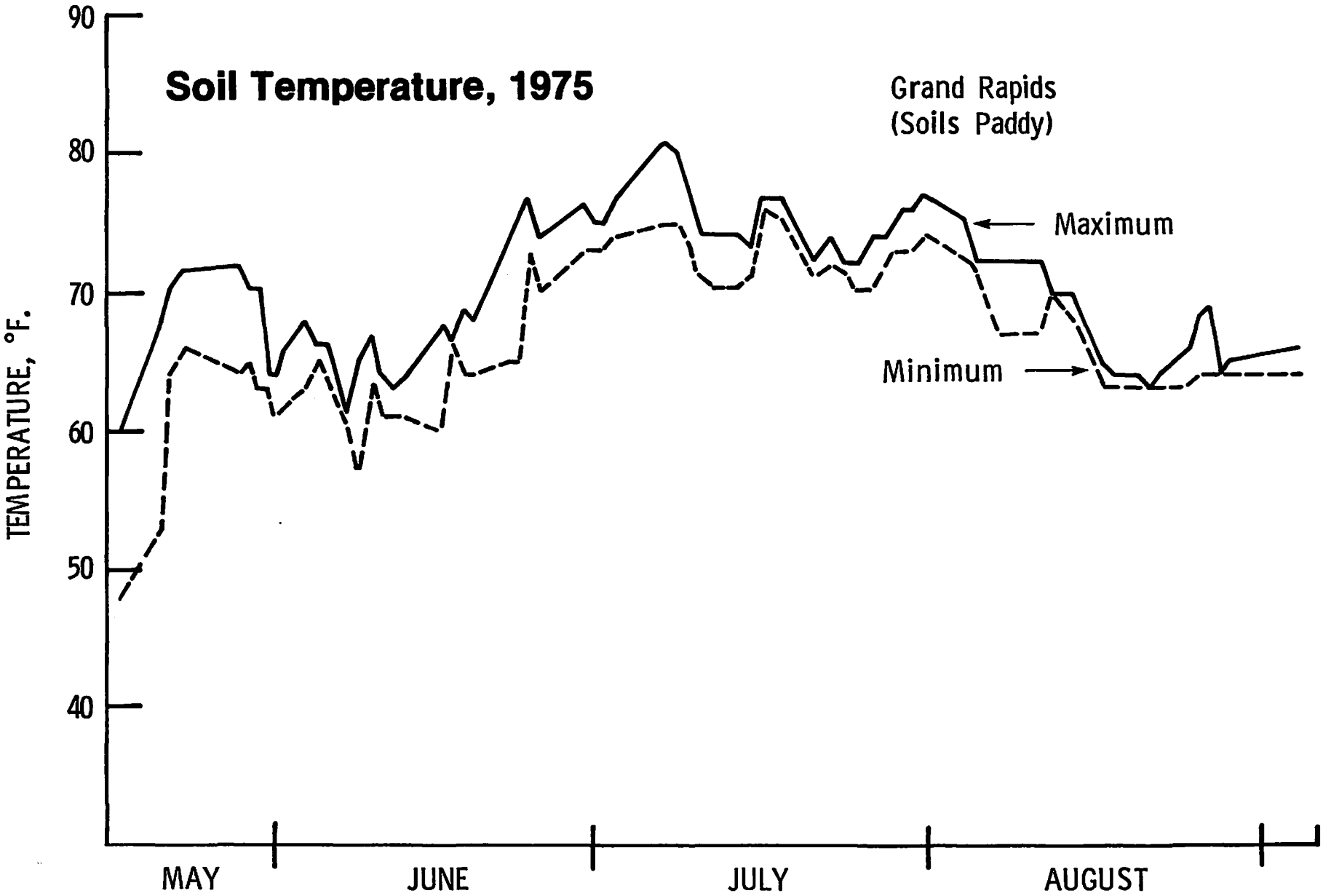
Soil Temperature, 1975
Grand Rapids
(Soils Paddy)
Maximum
Minimum
TEMPERATURE, °F.
90
80
70
60
50
40
MAY
JUNE
JULY
AUGUST

Table 1. Effect of nitrogen application on the yield of two wild rice varieties.

Variety	N Rate, Lb/Acre		
	0	40	80
	Grain yield*, Lb/Acre		
K2	1084	1088	981
"Johnson"	672	560	521

* 7% Moisture

(a) Variety	Grain yield
K2	1051 a
"Johnson"	584 b
Significance	**
BLSD (.05)	96

(b) N Rate	
0 Lb/Acre	878 b
40 Lb/Acre	824 ab
80 Lb/Acre	751 a
Significance	*
BLSD (.10)	98

Table 2. Effect of nitrogen application on dry matter weight of two wild rice varieties at early grain formation.

Variety	N Rate Lb/Acre	Panicles	Stems	Leaves	Total
		Dry matter, grams per plant			
K2	0	5*	21	9	35
	40	5	19	10	34
	80	6	21	9	36
"Johnson"	0	4	20	9	33
	40	4	19	9	32
	80	5	23	11	39

* Average of 30 plants

Table 3. Effect of nitrogen application on N concentration of different plant parts at early grain formation.

Variety	N Rate Lb/Acre	Panicles	Stems	Leaves
		N% in dry matter		
K2	0	1.78*	1.10	2.91
	40	1.89	1.21	3.17
	80	1.93	1.31	2.95
"Johnson"	0	1.85	1.24	2.66
	40	1.88	1.32	2.74
	80	1.89	1.22	2.92

* Average of 30 plants

Table 4. Effect of nitrogen application on total uptake of N by wild rice at early grain formation.

Variety	N Rate Lb/Acre	Panicles	Stems	Leaves	Total
		N in milligrams per plant			
K2	0	98*	225	253	576
	40	94	236	303	634
	80	109	273	270	652
"Johnson"	0	83	243	237	563
	40	72	249	259	580
	80	90	278	322	690

* Average of 30 plants

B. NITROGEN RATE AND THINNING

A trial was conducted on peat with "Johnson" wild rice (1971 seeding) on a paddy (W 21) owned by Clearwater Rice, Inc. Strips, 100 Ft. wide, were thinned with an airboat and ammonium nitrate was applied on July 11 across the thinning strips. Plant population at harvest ranged from 1.9-2.2 plants/square foot for the no-thin compared to 0.9-2.8 plants for the 5th blade treatment. Two 4 X 4 Ft. square areas from each strip were harvested for yield determinations. Thinning had no appreciable effect on grain yield (Table 5). Forty pounds per acre of N increased the yield by 254-430 Lb/Acre compared to check. However, the 80 Lb/Acre N rate decreased the yield of grain. This may have been due to delayed maturity caused by excessive N.

Table 5. Yield of wild rice as affected by N rate and thinning - 1975 Clearwater Rice, Inc.

N Rate Lb/Acre	Thinning None	Thinning 5th blade	Average
	— Grain, Lbs/Acre—		
0	687	590	639
40	941	1020	981
80	711	685	698
Average	780	765	

C. POTASSIUM TRIALS

The role of potassium in wild rice production is subject to frequent inquiries. The possibility that losses caused by lodging and disease may be lessened, as in other crops, by K applications is most intriguing to growers. Some growers have experimented with K fertilization but the results have been inconclusive. In our own experiments, moderately high rates of potassium (200 Lb/Acre K_2O) have not produced any striking results. In 1974 on peat, plots receiving 200 Lb/Acre K_2O combined with 0-40 Lb/Acre N, had healthier plants and less lodging than plots receiving 0 or 40 Lb/Acre K_2O rate. This, however, was not true for the 120+40+200 treatment. Since it is possible that rather large amounts of K are required for the nutrient to become beneficial to the crop, it was decided to include in this study some rather high K_2O rates.

Two field trials were established on growers' paddies. The cooperators applied fertilizer in 40-60 Ft. strips in fall of 1974.

Trial 1 was conducted on paddy No. 2 W owned by Clearwater Rice, Inc. with "Johnson" variety (1972 seeding). A basic application of 12+29+38 Lb/Acre (N, P_2O_5, K_2O) was made in the fall, and 40 Lb/Acre of N as urea topdressed on July 11. Muriate of potash (0-0-60) was applied in 40 X 516 Ft. strips in fall and then rototilled into the soil. The stand was thinned with an airboat. Infection with Helminthosporium was not related to K treatments and, in general, damage from blight was not serious. This probably was due to weather conditions unfavorable for development of the disease organism.

Trial 2 was conducted on paddy E-1 owned by Kosbau Bros., Aitkin county with K2 variety. A basic application of 12+48+48 was made in the fall. Potassium fertilizer (0-0-60) was applied in 60 Ft. wide strips in the fall but it was not incorporated into the soil. Dithane M-45 was sprayed inadvertently on the trial area. Wild rice was seriously damaged by hail.

In these trials, yields were determined by harvesting two 4 X 4 Ft. square areas from each strip.

Wild rice in trial 1, yielded 687-1010 Lb/Acre of grain (Table 6). The first two increments of potassium (42 and 210 Lb/Acre K_2O) increased grain yield by

112-181 Lb/Acre. The yield was not affected by higher K rates. Similarly, total K uptake by wild rice at late flowering was somewhat higher in plants receiving 42-210 Lb/Acre K_2O compared to the check. Application of high K rates had no appreciable effect on dry matter production, K concentration of tissue or the total uptake of K by the plant (Tables 7-10).

In trial 2, the grain yield ranged from 391 to 507 Lb/Acre showing no consistent relationship with K treatments (Table 11). The K uptake by the plant appeared to be increased by potassium applications (Table 13).

Generally, in these two trials, high rates of potassium fertilizer had little or no effect on disease resistance, lodging resistance and yield. This may have been due to weather conditions and the moderate rates of N used (12 and 51 Lb/Acre).

Table 6. Effect of K application on grain yield of wild rice on peat - 1975. Clearwater Rice, Inc.

Treatment* K_2O, Lb/Acre	Grain yield Lb/Acre
0	687**
42	799
210	868
420	912
630	902
840	891
1050	991
1260	1010

* All strips received a basic treatment of 51+29+38.
** 7% moisture

Table 7. Effect of K application on dry matter weight of wild rice - 1975. Clearwater Rice, Inc.

Treatment* K_2O, Lb/Acre	Dry matter	
	At jointing	At late flowering
	Grams per plant	
0	10**	34
42	13	43
210	10	35
420	8	34
630	6	35
840	9	31
1050	9	49
1260	8	39

* All strips received a basic treatment of 51+29+38.
** Average of 5 plants

Table 8. Effect of potassium application on K concentration of wild rice tissue at jointing stage - 1975.
Clearwater Rice, Inc.

Treatment* K_2O, Lb/Acre	Whole plant	2nd leaf
	K% in dry matter	
0	4.52**	3.65
42	4.33	3.37
210	5.21	3.06
420	4.74	3.89
630	4.75	3.48
840	4.83	4.11
1050	4.99	4.01
1260	5.10	3.84

* All strips received a basic treatment of 51+29+38.
** Average of 5 plants

Table 9. Effect of potassium application on K concentration of wild rice tissue at late flowering - 1975.
Clearwater Rice, Inc.

Treatment* K_2O, Lb/Acre	Panicles	Stems	Leaves
	K% in dry matter		
0	1.82**	3.77	2.79
42	1.93	3.66	3.57
210	2.18	5.66	3.83
420	1.72	4.87	3.94
630	2.18	4.99	3.55
840	2.33	5.21	3.57
1050	2.20	6.48	4.38
1260	2.07	4.23	3.10

* All strips received a basic treatment of 51+29+38.
** Average of 5 plants

Table 10. Effect of potassium application on K uptake by wild rice - 1975. Clearwater Rice, Inc.

Treatment* K_2O, Lb/Acre	Stage of development: Jointing	Stage of development: Late flowering
	—K-uptake, milligrams per plant —	
0	459	1094
42	537	1498
210	508	1617
420	394	1442
630	291	1449
840	449	1334
1050	423	1670
1260	396	1429

* All strips received a basic treatment of 51+29+38.

Table 11. Effect of K application on grain yield of wild rice on peat - 1975 Kosbau Bros., Aitkin Co.

Treatment* K_2O, Lb/Acre	Grain yield Lb/Acre
0	391**
60	412
120	369
180	507
300	481

* All strips received a basic treatment of 12+48+48.
** 7% moisture

Table 12. Effect of potassium application on K concentration of wild rice tissue at early grain formation - 1975. Kosbau Bros., Aitkin Co.

Treatment* K_2O, Lb/Acre	Panicles	Stems	Leaves
	K% in dry matter		
0	1.80**	4.08	3.66
60	2.21	4.40	3.81
120	1.86	4.90	3.70
180	1.88	4.99	3.55
300	2.09	4.83	2.99

* All strips received a basic treatment of 12+48+48.
** Average of 5 plants

Table 13. Effect of potassium application on K uptake by wild rice at early grain formation - 1975.
Kosbau Bros., Aitkin Co.

Treatment* K_2O, Lb/Acre	K uptake Milligrams per plant
0	1388**
60	1468
120	2066
180	1810
300	2006

* All strips received a basic treatment of 12+48+48.
** Average of 5 plants

D. CROP FAILURE AND SULFUR

Poor stand and crop failure, in some instances, may result from high concentrations of sulfur in the water and in the soil. At least that is what occurred in one commercial paddy at Gully in 1974. Since sulfur may present a problem in other soils as well, several growers were asked to contact us in cases where crop failures appeared to be related to presence of sulfur.

Soil samples were collected from three sites located in Polk county. Sites 1 and 2 were in a paddy fallowed during 1975. Wild rice was very poor in 1974 in area represented by site 1. Site 2 was within the area where crop had been good. There are 3 springs within the paddy. Another soil profile (site No. 3) was sampled in a paddy that had a good wild rice crop in 1975.

Soil analyses (Table 14) did not provide any clues as to the reasons for crop failure in 1974, site No. 1.

Sulfate concentrations in samples collected in 1975 from the areas having poor crop (site 1) and good crop (site 2) in 1974,were about the same and did not exceed 36 ppm S. Samples of both profiles had pH values of more than 7.5, indicating strongly alkaline reaction. It should be pointed out that in the soil profile from Gully area, investigated in 1974, sulfate concentrations ranged from 165 to 1800 ppm S and pH values, in some horizons, were as low as 5.0 (Table 15). Since fallow appears to decrease sulfate concentration in the soil it is not possible to attribute the wild rice failure during 1974 on site No. 1 to presence of sulfur compounds in the soil.

An attempt was made to investigate what effect fallow may have on chemical properties of paddy soils. To achieve this, soil samples were collected in October, 1975 from approximately the same site where similar samples had been collected in fall of 1974. Wild rice had died out in the sampling area in 1974 and the paddy was in fallow during 1975.

Table 14. Soil test values of three profiles of organic soils, Robert Rouland wild rice paddies, Polk county.

Horizon	Depth, inches	Type of Fiber	Texture	pH	O.M.	Extr. P pp2m	Exch. K pp2m	S ppm	Sol. Salts mmhos
			Site No. 1 - Haug muck, wild rice crop in 1974: very poor						
Oa	0-8	Sap.	M	7.5	VH	17*	80	34	2.1
Oa	8-15	Sap.	M	7.8	VH	7*	20	9	0.9
IIAb	15-22		H Sil	7.9	VH	15*	40	36	0.5
IIC1	22-29		H Sil	Not sampled					
IIC2	29-44		VFSL	8.0	L	30*	80	29	0.5
IIC3	44-54		VFS	8.0	L	17*	170	12	0.5
			Site No. 2 - Haug muck, crop in 1974: good						
Oa	0-8	Sap.	M	7.6	VH	17*	100	34	2.5
Oa	8-13	Sap.	M	7.7	VH	23*	20	11	0.9
IIC1	13-21		Sil	7.9	L	32*	30	31	0.5
IIC2	21-27		Sil	8.2	L	27*	30	32	0.5
IIC3	27-49		VFS	8.1	L	28*	100	9	0.4
			Site No. 3 - Cathro muck, wild rice crop in 1975: good						
Ap	0-8	Sap.	M	7.8	VH	10*	90	18	1.1
Oa	8-20	Sap.	M	7.9	VH	7*	30	10	0.7
Oa	20-24	Sap.	M	7.9	VH	8*	20	10	0.6
IIAb	24-29		H Sil	Not sampled					
IIC1	29-45		Sil	Not sampled					
IIC2	45-49		VFSL	Not sampled					

* 1:50 soil to solution ratio
Samples were collected on Oct. 17, 1975 by Donald Barron, Soil Conservation Service;
Soil tests by University of Minnesota Soil Testing Laboratory

Soil tests, shown in table 15, indicated following trends: sulfate concentration after fallow was nearly 3 times lower than in the previous year in most horizons. Even greater decrease had occurred at the 30-36 inch depth. There was also a lowering of the soluble salt level, particularly at the 24-30 and 30-36 inch depths. The soil pH values in 1975 also were slightly lower than those obtained the previous year. Generally, fallow appears to have had some beneficial effect as shown by the lower sulfur and soluble salt levels.

Table 15. Effect of fallow on soil test values of a Cathro muck. Gunvalson and Imle wild rice paddy, Pennington county

Depth, inches	Texture	pH		Sulfur ppm		Soluble salts mmhos	
		1974	1975	1974	1975	1974	1975
0-12	P	6.2	5.9	165	56	2.7	2.1
12-24	P	5.0	4.9	185	56	2.2	1.8
24-30	P	5.3	5.2	195	58	3.4	1.8
30-36	P	6.5	5.8	1800	58	3.0	1.8
36+	LVFS	7.4	7.1	360	138	2.9	1.6

Samples were collected on Oct. 24, 1974 and Oct. 17, 1975 by Donald Barron, Soil Conservation Service.

E. NUTRIENT UPTAKE

The amounts of various nutrient elements contained in a plant reflect fairly well its nutrient requirement. They are calculated by using dry matter weight and concentrations of chemical elements in plant tissue. Then the amount of a plant nutrient contained in total crop is obtained by converting the nutrient uptake per plant to plant population per acre.

In 1975, plant samples were collected at early grain formation from experimental plots at Grand Rapids receiving 40 Lb/Acre N. After drying, plants were separated in flowering parts, stems and leaves. Plant analysis was performed by the Research Analytical Laboratory, University of Minnesota.

Both varieties, K2 and "Johnson" were equal in dry matter production and had about the same concentration of chemical elements and total nutrient uptake (Table 16, 17, 18).

It is interesting to note that a good crop of wild rice may produce nearly 6.5 tons of dry matter per acre. Stems comprise 57% of the total weight, with 28% being leaves and 15% panicles. Wild rice also takes up relatively large amounts of some plant nutrients. The crop at Grand Rapids contained: 223-244 Lb/Acre of nitrogen, 72-83 Lb/Acre of phosphorus and 417-458 Lb/Acre of potassium. In view of these large nutrient requirements of wild rice, it is fortunate that flooding increases the availabilty of many nutrient elements. Otherwise, the grower would be faced with truly staggering fertilizer costs.

Table 16. Dry matter weight and amount of chemical elements contained in various plant parts of two wild rice varieties

Dry matter, chemical element	Variety							
	K2				"Johnson"			
	Panicles	Stems	Leaves	Total	Panicles	Stems	Leaves	Total
	Grams per plant							
Dry matter	5.0	19.2	9.6	33.8	3.8	18.8	9.4	32.0
	Milligrams per plant							
Nitrogen	94	236	303	634	72	249	259	580
Phosphorus	17	124	75	216	13	111	62	186
Potassium	61	862	269	1192	50	782	253	1085
Calcium	12	30	88	130	8	28	85	121
Magnesium	9	29	21	59	6	24	17	47
Manganese	3.2	16.2	19.2	38.6	2.5	15.8	17.3	35.6
Iron	1.0	8.3	11.7	21.0	1.0	7.3	8.2	16.5
Aluminum	0.3	2.2	3.4	5.9	0.2	1.8	2.0	4.0
Zinc	0.2	1.3	0.3	1.8	0.2	1.3	0.3	1.8
Boron	0.07	0.12	0.12	0.31	0.05	0.11	0.18	0.34
Copper	0.009	0.034	0.018	0.061	0.011	0.047	0.019	0.077

Table 17. Dry matter weight and total chemical element uptake by wild rice plant

Dry matter, chemical element	Variety	
	K2	"Johnson"
	Grams per plant	
Dry matter	33.8	32.0
	Milligrams per plant	
Nitrogen	634	580
Phosphorus	216	186
Potassium	1192	1085
Calcium	130	121
Magnesium	59	47
Manganese	39	36
Iron	21	17
Aluminum	6	4
Zinc	1.8	1.8
Boron	0.3	0.3
Copper	0.06	0.08

Table 18. Dry matter production and total plant nutrient uptake per acre by two wild rice varieties

Dry matter, chemical element	Variety	
	K2	"Johnson"
	Pounds per acre	
Dry matter	12,986	12,371
Nitrogen	244	223
Phosphorus	83	72
Potassium	458	417
Calcium	50	46
Magnesium	23	18
Manganese	15	14
Iron	8	6
Aluminum	2	2
	Ounces per acre	
Zinc	11	11
Boron	2	2
Copper	0.5	0.5

Grand Rapids - 1975, 1st year paddy on a mineral soil;
N rate & variety experiment, 40 Lb/Acre N treatment;
plant population: 4 plants/square foot; early grain formation.

F. CHEMICAL COMPOSITION OF PADDY WATER

The quality of paddy water is of interest not only to the grower but also to several state and federal agencies. The grower may be concerned, for example, with the concentration of sulfate in the water. Public agencies may want to know the levels of nitrogen and phosphorus present in the water when it is released during draining of paddies.

Water samples were collected from several paddies during 1973-75 growing seasons. Chemical determinations were made by the Research Analytical Laboratory, University of Minnesota. Information on location of paddies, sampling date and chemical composition of water are given in tables 19 and 20.

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Table 19. List of wild rice paddies from which water samples were collected during 1973-1975

Sample No.	Location		Sampling date
1.	Manomin W. R. Co., Aitkin Co., paddy 21 (K-plots)	Organic soil	7/13/73
2.	Jacobson Bros., Aitkin Co., SW of Intersection	" "	7/13/73
3.	Orjala & Davis, Aitkin Co., paddy 8	" "	7/13/73
4.	" " " , " " , " "	" "	7/25/73
5.	Clearwater Rice Company, paddy 12E	" "	7/18/73
6.	" " " , " 5W	" "	7/18/73
7.	Leech Lake Indian Reservation, Cass Lake, 5 yr. old paddy		7/19/73
8.	Washkish (South of Olson's paddies)		7/26/73
9.	Grand Rapids Exp. Sta., paddy 2	Mineral soil	9/13/73
10.	Gunvalson & Imle, Gully, good rice	Organic soil	7/17/74
11.	Grand Rapids Exp. Sta., soils paddy	Mineral soil	8/7/74
12.	Clearwater Rice Co., paddy 2W (K-study)	Organic soil	5/22/75
13.	" " , " " " "	" "	7/15/75
14.	Kosbau Bros., Aitkin Co., (K-study)	" "	6/18/75
15.	Grand Rapids Exp. Sta., soils paddy	Mineral soil	6/18/75
16.	" " " " , " "	" "	7/15/75
17.	" " " " , " "	" "	7/28/75
18.	" " " " , " "	" "	8/7/75
19.	" " " " , " "	" "	8/19/75
20.	Prairie River at Grand Rapids		8/7/75

Table 20. Chemical composition of water collected from wild rice paddies during growing seasons of 1973-1975

Sample No.	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
1.	57	114	3.00	.11	.05	.07	.034	.2	27.8	10.7	.2
2.	92	138	4.00	.32	.15	.65	.44	< .1***	29.9	15.3	4.9
3.	83	117	3.56	.22	.07	.32	.07	.4	28.6	11.1	.4
4.	90	89	3.34	.18	.004	.21	.007	.3	19.9	9.6	TR
5.	99	259	2.64	.58	.006	ND**	.032	.5	60.3	26.4	1.3
6.	213	374	7.02	1.40	.084	ND	2.28	< .1	96.2	32.5	10.9
7.	115	184	2.90	.35	.006	ND	.024	< .1	46.0	16.8	2.6
8.	85	104	3.80	.17	.004	.19	.006	.2	19.6	13.3	.4
9.	47	41	2.40	.20	.007	.18	.035		4.8	7.0	3.9
10.	236	355	10.80	.47	TR*	.51	.33	48.8	87.8	33.0	4.0
11.	70	86	1.41	.04	TR	.06	.007	3.7	25.0	5.7	1.2
12.	67	140	1.56	.25	.004	.33	.33	8.4#	37.8	11.0	19.1
13.	184	186	2.86	.37	.051	.20	.09	1.0	42.9	19.2	4.4
14.	9	24	3.29	1.13	.024	4.8	4.29	< 1.0	6.0	2.1	28.8
15.	60	59	0.90	.08	TR	.09	.004	< 1.0	16.2	4.6	1.9
16.	62	221	1.19	.15	TR	.33	.01	< 1.0	17.9	4.7	.3
17.	69	77	1.28	.11	TR	.10	.017	< 2.0	20.1	6.1	1.5
18.	74	79	1.15	.08	TR	.08	.027	< 2.0	21.2	6.3	2.8
19.	77	83	3.53	0.54	.065	.38	.101	< 2.0	21.7	6.9	4.6
20.	65	76	1.31	.14	.046	.04	.011	< 2.0	20.6	5.9	1.9

* TR = Trace; ** ND = Not Determined; *** < = Less Than
# 8.4 ppm Sulfate-S X 3 = 25.2 ppm Sulfate (SO_4)