Table 8. Chemical composition of alfalfa, Waseca lime plots, 1974.

Lime Treatment	P	K	Ca	Mg	Al	Fe	Zn	Cu	Mn	B
	---------% in dry matter------				----------ppm in dry matter----------					
					First Cutting					
0	0.40	2.75	1.73	0.29	348	383	47.6	5.4	45.9	43.4
2.5	0.38	2.50	1.69	0.29	332	364	44.1	5.1	34.9	39.7
5.0	0.38	2.57	1.69	0.29	350	374	45.7	5.5	34.1	40.6
7.5	0.39	2.41	1.73	0.31	351	387	45.6	5.8	31.1	41.6
10.0	0.39	2.57	1.64	0.28	366	389	43.2	5.3	36.5	39.7
Significance	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
CV, %	5.5	8.2	3.8	4.4	12.0	8.9	9.7	39.9	17.4	5.5
					Second Cutting					
0	0.35	2.36	1.89	0.35	461	452	37.6	10.1	64.2b*	47.5
2.5	0.35	1.97	1.86	0.35	627	531	33.0	8.4	52.1ab	43.2
5.0	0.36	2.12	1.86	0.35	532	494	33.6	9.2	46.9a	44.2
7.5	0.38	2.11	1.88	0.36	850	703	35.3	9.1	44.9a	42.9
10.0	0.35	2.15	1.84	0.34	514	487	36.8	10.9	54.4ab	43.9
Significance	NS	NS	NS	NS	NS	NS	NS	NS	*	NS
CV, %	5.1	8.1	7.4	7.0	28.3	29.0	7.3	23.8	15.3	6.6
					Third Cutting					
0	0.34	2.55	1.67	0.32	275b	320	28.4	6.5	58.5b	43.0
2.5	0.35	2.35	1.62	0.34	256ab	329	26.9	7.8	40.2a	40.4
5.0	0.36	2.54	1.57	0.32	185a	267	27.8	6.8	37.2a	39.9
7.5	0.36	2.39	1.60	0.33	292b	336	28.3	8.1	32.9a	39.0
10.0	0.34	2.54	1.59	0.30	240ab	283	27.6	6.2	42.1a	39.4
Significance	NS	NS	NS	NS	*	NS	NS	NS	*	NS
CV, %	3.9	6.1	6.9	5.8	17.3	11.6	10.3	28.7	20.4	7.0

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

NITROGEN NEEDS FOR CORN AND ACCUMULATION OF NITRATES IN PROFILE, 1970 to 1974

W. E. Fenster, C. J. Overdahl, G. W. Randall and A. Castro

In the fall of 1969, nitrogen experiments were established with continuous corn on highly productive land to determine what rates of nitrogen would result in highest economic yields with a minimum of nitrate movement through the soil profile.

Waseca County Experiment

It is quite apparent that both nitrification and denitrification play major roles in ascertaining amounts of fertilizer nitrogen that should or should not be applied, in any given year, on fine textured, high organic matter soils. This is well illustrated in the Waseca experiment where, in 1971, nitrogen deficiency was noted with nitrogen applications up to and including 200 pounds per acre. After the soil had warmed up in the spring of 1971, excessive amounts of rain kept the soil waterlogged for a period of about 2 or 3 weeks after which time very little moisture fell for the rest of the season. These weather conditions were ideal for excess denitrification (loss of nitrogen to the atmosphere) early in the year and very little nitrification (the forming of nitrates from ammonium forms) later in the summer and early fall. The combination of these two biotic reactions caused severe N deficiency, even with N applications normally considered adequate for maximum corn production.

In 1972, no nitrogen response or deficiency was noted in the nitrogen treatments that exceeded 50 pounds of N per acre. Here the weather conditions varied quite markedly from 1971. The soil was moist early in the spring and periodic rainfalls throughout the summer created ideal conditions for nitrification for much of the growing season. On this particular year, therefore, the soils were able to produce nearly enough available nitrogen to sustain the corn crop in 1972. On any given year, it may be very difficult to accurately predict fertilizer nitrogen needs. This is mainly due to high or low rates of soil denitrification and/or nitrification which may take place. There is one saving feature, however, on the fine textured soils; if the applied nitrogen is not utilized the first year, it will remain within the rooting zone for corn and be available for subsequent crops.

The yield and tissue results from the Waseca experiment from 1970 through 1974 are given in tables 1 and 2. Low yields in 1974 were due to severe hail in June and early September frost. The stripped and tangled leaves appeared to prevent new leaves from unfurling. Four of the eight replications had the upper leaves removed to aid the new leaf emergence. The loss of the ragged, damaged leaves, however, caused a yield reduction, therefore, yields in table 1 are from the other four replications only.

Table 1. Waseca county corn yields as influenced by nitrogen treatments (8 replications).

N (lbs/A) annually	Yield (bu/A) 1970	1971	1972	1973	1974
0	82 a	43 a	118 a	111 a	56 a
50	109 b	63 b	138 b	154 b	87 b
100	143 c	93 c	134 b	146 b	97 bc
150	153 cd	131 d	144 b	169 c	103 cd
200	163 d	144 e	141 b	175 c	104 cd
400	169 d	151 f	144 b	168 c	113 d

Where letters differ, yields are statistically different.

All plots received a basic treatment of 0+150+200+20 Zn.

The soil is classified as Webster silty clay loam.

Table 2. Percentage nitrogen in tissue* (July) as related to nitrogen applications on continuous corn in Waseca county.

N (lbs/A)	1970 %	1971 %	1972 %	1973 %	1974 %
0	1.9	1.5	2.4	1.8	2.4
50	2.2	1.7	2.6	2.3	2.8
100	2.5	2.2	2.6	2.3	2.9
150	2.7	2.6	2.7	2.6	3.1
200	2.8	2.9	2.7	2.6	3.1
400	3.0	3.0	2.7	2.8	3.2
Date sampled	7/17	7/21	7/28	7/25	7/22

* sixth leaf at tasseling

Conducted under the leadership of: Dr. Gyles Randall, Soil Scientist, University of Minnesota, Waseca Experiment Station.

Martin County Experiment

Two adjacent nitrogen experiments, one on continuous corn and one established to continuous corn on a virgin soil, were also established in Martin County. The continuous corn experiment was established the same time (fall 1969) as the Waseca experiment and the one on the virgin soil was established one year later. In 1972, a hail storm severely damaged the corn crop. Because of this, the yields are quite low and no meaningful statistical analysis could be run. Also, because of this hail damage, it is apparent that the crop did not draw down the nitrogen in the soil at a normal or expected rate. Yield and tissue tests from these experiments are given in tables 3 and 4 for the years 1970 through 1974.

Table 3. Martin county corn yields as influenced by nitrogen treatments (8 replications).

N (lbs/A) annually	Yield (bu/A)								
	Continuous corn plots					Virgin plots			
	1970	1971	1972	1973	1974	1971	1972	1973	1974
0	120 a	130 a[1]	68[2]	112 a	100 a	179 a	103	157	151
50	128 ab	142 b	78	115 ab	126 b	190 bc	107	151	155
100	140 c	151 b	68	136 c	135 bc	187 bc	88	149	157
150	132 bc	144 b	76	132 bc	142 c	183 b	103	150	154
200	131 abc	147 b	69	121 abc	145 c	194 c	96	145	153
400	135 bc	153 b	64	121 abc	147 c	190 bc	103	142	154
			n.s.				n.s.	n.s.	n.s.

[1] Where letters differ for each experiment, yields are statistically different.

[2] A meaningful statistical analysis could not be run in 1972 because of severe hail damage.

All plots received a basic treatment of 0+150+200+20 Zn. The soil is classified as Webster silty clay loam.

Table 4. Percentage nitrogen in tissue* as related to nitrogen application on corn in Martin county.

N (lbs/A)	% Nitrogen in Tissue							
	Continuous corn				Virgin plots			
	1971	1972	1973	1974	1971	1972	1973	1974
0	2.5	2.4	2.0	2.1	2.8	2.9	2.6	2.4
50	2.7	2.9	2.3	2.4	2.7	2.8	2.5	3.0
100	2.6	2.8	2.4	2.8	2.8	2.8	2.7	3.0
150	2.9	2.7	2.4	3.0	2.8	2.8	2.7	3.1
200	2.9	2.9	2.6	3.1	2.8	2.9	2.8	3.0
400	2.9	2.7	2.6	3.3	2.9	2.8	3.0	3.1
Date sampled	7/21	7/28	7/25	7/22	7/21	7/28	7/25	7/22

* sixth leaf at tasseling

Additional Observations

The average yield of all treated plots in bu/acre between the virgin plots above the cultivated plots were:

1971	1972	1973	1974
41	29	26	21

It appears that the differences are narrowing somewhat each year.

Table 5. Amount of nitrate-nitrogen (ppm) in the soil profile on continuous corn - Waseca County - Lukken Farm 1974.

Soil Depth (ft.)	Treatment - lbs. of N per acre applied annually					
	0	50	100	150	200	400
0-1	14	11	14	23	19	45
1-2	5	5	8	11	12	39
2-3	5	5	6	11	11	32
3-4	5	6	6	7	10	21
4-5	7	5	6	7	9	15

Table 6a. Nitrate-nitrogen (ppm) in soil profile on long time continuous corn - Martin County - Thate Farm 1974.

Soil Depth (ft.)	Treatment - lbs. of N per acre applied annually					
	0	50	100	150	200	400
0-1	10	10	14	17	19	62
1-2	5	5	8	16	21	38
2-3	4	6	11	18	23	24
3-4	6	12	12	21	22	23
4-5	8	14	12	23	22	24
5-6	11	15	17	26	21	25

Table 6b. Amount of nitrate-nitrogen (ppm) in the soil profile on virgin plots - Martin County - Thate Farm 1974.

Soil Depth (ft.)	Treatment - lbs. of N per acre applied annually					
	0	50	100	150	200	400
0-1	12	14	18	26	31	88
1-2	6	7	10	26	30	64
2-3	7	9	21	20	30	60
3-4	9	9	18	16	25	35
4-5	8	8	19	14	18	25
5-6	8	5	15	13	16	19

EFFECT OF BROADCAST PHOSPHORUS AND POTASSIUM ON CORN YIELD ON HIGH TESTING SOILS (1974)

C. J. Overdahl, W. E. Fenster, G. W. Randall and A. Castro

This was the fifth year of the broadcast P and K experiment in Martin and Waseca counties.

The soil test level and plant analysis of the check plots are the best observation point in evaluating response. In Martin County in 1972 and Waseca County in 1973, there was a significant response to potassium. Starter fertilizer gave a highly significant response in 1973, and in Martin County in 1974, even though there is no response to broadcast applications.

The work in Waseca County was conducted under the leadership of Dr. Gyles Randall, Soil Scientist, at the Southern Experiment Station at Waseca.

Efforts of Bob Schoper, Jerry Lensing, Rick Quade, Floyd Bellin, Martin County Extension Agent, and Vern Quade, Martin County Assistant Extension Agent, are greatly appreciated.

Table 1. 1970 through 1974 corn yields, plant analyses and soil tests in Martin County according to broadcast phosphorus treatment. (200+0+300+20 Zn applied over all phosphorus plots)

P_2O_5	Yields bu/acre					% P leaves					Soil Test P lbs/acre				
lbs/A	1970	1971	1972	1973	1974	1970	1971	1972	1973	1974	1970	1971	1972	1973	1974
0	155	137a	136	160	151	.26	.28	.38	.27	.30	46	37	47	35	72
50	151	137a	127	157	146	.26	.27	.37	.27	.33	36	39	47	50	78
100	162	156b	136	160	153	.27	.30	.40	.29	.34	56	55	96	81	101
150	146	146ab	129	153	150	.28	.30	.40	.29	.35	65	63	94	85	102
200	145	154ab	130	158	149	.28	.30	.44	.30	.37	64	55	109	88	100
	ns	10%	ns	ns		ns	ns	ns	5%						

	1970	1971	1972	1973	1974
Avg. starter response	4*	2	7*	8**	13**
Avg. % N in leaves	-	2.7	2.7	2.8	2.8
Avg. K soil test	268	352	488	364	261
Avg. % K in leaves	1.70	1.88	1.83	1.93	1.94
Avg. soil pH	7.7	7.2	7.3	7.4	7.1
Avg. Zn leaves ppm	19 low	17 low	22 suf.	22 suf.	30
Avg. Zn soil ppm	-	5.3 high	-	-	12 high

Table 2. 1970 through 1974 corn yields, plant analyses and soil tests in Waseca County according to broadcast phosphorus treatment. (200+0+200 applied over all phosphorus plots)

P_2O_5	Yields bu/acre					% P leaves					Soil Test P lbs/acre				
lbs/A	1970	1971	1972	1973	1974	1970	1971	1972	1973	1974	1970	1971	1972	1973	1974
0	133	139	140	167	98	.31	.28	.29	.26	.32	34	27	39	36	28
50	136	133	142	164	99	.30	.27	.30	.28	.34	31	33	62	58	37
100	132	132	144	163	108	.28	.27	.32	.27	.36	31	40	91	62	63
150	136	135	141	162	104	.29	.30	.35	.28	.38	40	44	87	66	85
200	138	130	144	167	106	.29	.30	.33	.29	.39	53	45	79	76	96
	ns	ns	ns	ns	ns										

	1970	1971	1972	1973	1974
Avg. starter response	13*	4	4	2	2
Avg. % N in leaves	-	2.8	2.5	2.6	-
Avg. K soil test	307	276	387	384	296
Avg. % K in leaves	1.68	1.82	1.88	2.28	2.57
Avg. soil pH	6.4	6.1	6.1	6.0	6.0
Avg. Zn leaves ppm	26 suf.	16 low	22 suf.	26 suf.	25
Avg. Zn soil ppm	-	2.6 high	-	-	5.7 high

Table 3. 1970 through 1974 corn yields, plant analyses and soil tests in Martin County according to broadcast potassium treatment. (200+150+0+20 Zn applied over all potassium plots)

K_2O	Yields bu/acre					% K leaves					Soil Test K lbs/acre				
lbs/A	1970	1971	1972	1973	1974	1970	1971	1972	1973	1974	1970	1971	1972	1973	1974
0	156	148	120a	160	148	1.7	1.8	1.6	1.7	2.1	202	230	295	273	160
50	147	154	127ab	155	148	1.7	1.8	1.6	1.8	2.2	212	258	360	303	245
100	152	149	129ab	157	153	1.6	2.1	1.8	2.2	2.5	222	278	328	318	275
200	147	143	130ab	151	151	1.8	2.1	1.9	2.0	2.2	270	328	415	380	290
400	160	149	132b	158	149	1.8	1.9	2.1	2.1	2.6	243	320	490	533	375
	ns	ns	10%	ns											

	1970	1971	1972	1973	1974
Avg. starter response	16**	3	1	9**	8*
Avg. % N in leaves	-	2.8	2.8	2.8	3.2
Avg. P soil test	50	62	99	68	71
Avg. % P in leaves	.25	.29	.40	.27	.34
Avg. soil pH	6.4	6.1	6.1	6.1	6.4
Avg. Zn leaves ppm	22	22	30	26	40
Avg. Zn soil ppm	-	8.4 high	-	-	13 high

Table 4. 1970 through 1974 corn yields, plant analyses and soil tests in Waseca County according to broadcast potassium treatment. (200+150+0 applied over all potassium plots)

K_2O	Yields bu/acre					% K leaves					Soil Test K lbs/acre				
lbs/A	1970	1971	1972	1973	1974	1970	1971	1972	1973	1974	1970	1971	1972	1973	1974
0	134	123	136	154a	98	1.6	1.4	1.4	1.5	2.2	260	210	282	255	210
50	129	120	138	156ab	106	1.7	1.7	1.5	1.8	2.5	275	213	322	287	223
100	139	131	139	160ab	102	1.7	1.7	1.7	2.0	2.5	260	220	318	295	280
200	132	116	141	161ab	102	1.8	1.8	1.9	2.2	2.6	262	223	352	330	320
400	134	120	143	162b	106	2.2	1.9	2.1	2.5	2.9	312	310	478	455	398
	ns	ns	ns	10%	ns										

	1970	1971	1972	1973	1974
Avg. starter response	10*	7*	4	3	5
Avg. % N in leaves	-	2.7	2.6	2.6	-
Avg. P soil test	53	52	79	76	63
Avg. % P in leaves	.27	.31	.36	.28	.34
Avg. soil pH	6.4	6.0	6.0	5.9	5.7
Avg. Zn leaves ppm	26 suf.	14 low	24 suf.	28 suf.	33
Avg. Zn soil ppm	-	3.0 high	-	-	5.8 high

HIGH PHOSPHORUS AND POTASSIUM RATES FOR CONTINUOUS CORN

Gyles W. Randall, Samuel D. Evans and Wallace W. Nelson

As part of a regional effort being coordinated by the Tennessee Valley Authority, studies were initiated in the fall of 1973 to determine the long-term effects of high rates of P and K fertilizers on continuous corn production.

Ten P and K treatments (Table 1) were broadcast-applied and plowed down at three branch experiment stations (Southern Experiment Station, Waseca; Southwest Experiment Station, Lamberton; and West Central Experiment Station, Morris). 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.

The soil types used and their respective initial soil test pH, P and K values are: Lamberton - Nicollet cl, 5.9, 37, 250; Morris - Aastad cl, 7.7, 19, 460; and Waseca - Webster cl, 5.9, 51, 210.

Soil samples (both profile and plow layer), plant tissue samples (small whole plant and ear leaf), early plant height and weight, lodging counts, final population, grain and silage yields and grain moisture were taken to evaluate the P and K treatments.

Results obtained during 1974 show very little effect of the treatments on the above mentioned parameters. Soil test P and plant tissue P were increased by the P treatments at the Morris location. The treatments did not influence the soil test and plant analyses values from the Lamberton and Waseca locations. Small plant growth, lodging, yields and maturity generally were not affected at any of the locations (Tables 1 and 2). A detailed report of this project is available from the authors upon request.

Table 1. Early plant growth characteristics as influenced by high P and K rates at the three experimental sites in 1974.

Treatment		Weight			Height		
No.	Description	La	Mo	Wa	La	Mo	Wa
	lbs. $P_2O_5+K_2O$/A	g/dry plant			---- inches ----		
1	0 + 0	11.4	2.6	7.4	31.8	16.7	35.5
2	0 + 100	9.8	2.3	7.9	30.9	17.2	36.0
3	50 + 100	10.4	2.6	7.3	30.6	17.0	34.6
4	100 + 100	10.7	2.8	8.0	31.5	17.1	36.3
5	150 + 100	11.0	2.9	8.5	31.8	17.6	36.9
6	100 + 0	11.4	2.7	8.7	31.1	16.9	37.0
7	100 + 50	10.6	2.5	7.9	32.1	16.6	37.0
8	100 + 150	10.6	2.8	7.7	31.4	17.5	36.1
9	150 + 100	11.0	2.8	8.7	31.3	17.0	36.4
10	100 + 150	10.8	2.6	7.9	31.6	17.5	35.8
	Significance:	ns	ns	ns	ns	ns	ns
	CV (%) :	13.		10.	4.		4.

Table 2. Corn yields and moisture at harvest as influenced by high P and K rates in Minnesota in 1974.

Treatment		Silage Yield			Grain Yield			Grain Moisture		
No.	Description	La	Mo	Wa	La	Mo	Wa	La	Mo	Wa
	lbs. $P_2O_5+K_2O$/A	T DM/A			bu/A @ 15.5%			----- % ------		
1	0 + 0	3.74	5.78	7.17	79.7	92.9	124.8	15.5	24.4	15.3
2	0 + 100	3.81	5.69	7.33	69.5	89.6	125.9	15.6	26.3	14.6
3	50 + 100	3.60	5.46	7.00	62.5	91.9	128.6	15.7	25.7	15.3
4	100 + 100	3.64	5.39	6.57	74.8	94.6	127.9	15.5	23.8	15.0
5	150 + 100	4.03	5.71	7.11	76.7	98.6	129.6	15.1	25.7	14.2
6	100 + 0	4.20	5.19	7.17	80.4	91.3	129.9	15.4	26.7	15.2
7	100 + 50	3.83	5.60	7.19	77.9	95.5	132.0	14.8	23.7	15.1
8	100 + 150	3.98	5.35	7.85	80.1	93.1	125.7	14.4	25.6	14.4
9	150 + 100	3.46	5.43	7.60	69.7	97.8	131.8	15.1	25.0	14.9
10	100 + 150	3.62	5.66	6.99	74.5	101.2	125.7	15.2	24.0	14.5
	Significance:	ns	ns	ns	+	ns	ns	ns	**	ns
	CV (%) :	16.		9.	11.		4.	8.		4.
	BLSD (.05) :								1.9	

FERTILIZATION OF GRASSES FOR SEED PRODUCTION

John Grava, R.P. Schoper and D.S. Fairchild

Grass seed production practices that improve efficiency are important whether fertilizer supplies are limited or not. But with the present shortage and high prices it is important that information on proper use of fertilizer is available and that the grower uses fertilizer efficiently. Questions on fertilization concern rate of fertilizer to be applied and time of application.

Weather Conditions During 1973/74 Growing Season

The total amount of precipitation, for the period from August 1, 1973 to July 31, 1974 (Table 1), was 21.72 inches which is slightly above normal for Roseau. September of 1973 was cool and wet with 5.67 inches (3.27 inches above normal) of rainfall recorded. Snowfall was nearly normal but the temperature during winter was 2.4°F below normal. Wet and cold weather prevailed during last week of April and during May. Nearly 7 inches of precipitation were measured at Roseau during April and May. Fields were extremely wet which made fertilizer application by conventional means most difficult and often impossible. Although the rainfall during June amounted only to 1.56 inch (1.86 inch below normal), sample soil moisture from spring rains and nearly normal air temperatures provided conditions for production of high seed yields. Relatively low soil temperature (Fig. 1) during May and early June, however, may have slowed down biological activity and thus affected transformation and availability of nitrogen. This may account for the striking differences in vegetative growth and plant color due to fertilizer treatments, observed in most experiments on June 25, and the substantial yield responses to fertilizer obtained in 1974. Hot and dry weather conditions during July apparently had no adverse effect on bluegrass, orchardgrass and timothy seed yields. However, they caused serious damage to new seedings. Maximum soil temperature near 80°F or above was measured at the 3-inch depth on several days during July.

Weather data for 1964/65, considered to be an excellent season for seed production, are given in Table 1 for comparison.

Date of Fertilization Experiments

Fall is considered to be the best time to fertilize grass seed production fields. The four main reasons for this are:

* Fall fertilized field trials (Mid-September, Mid-October), have produced equally good or better yields than those fertilized on or before May 1. Earlier applications of fertilizer (August 25) or later ones (May 20) have resulted in reduced seed yields.

* Soils often are too wet in the spring to carry heavy equipment. Such conditions existed in spring 1974.

* Soils generally are drier in the fall and fertilizer can be spread without permanent damage to the soil. If some compaction does occur, soil structure is restored by spring through freezing and thawing action.

* Time is at premium in the spring.

While fall fertilization has been accepted by most in the production of bluegrass seed, some growers have questioned its applicability for timothy. A review of 21 references on work conducted elsewhere failed to shed sufficient light on the subject. In a few isolated cases, spring application of nitrogen to timothy seemed to be slightly superior to fall application.

In 1974, five date of fertilization trials were conducted with cool season grasses on growers' fields in Lake of the Woods and Roseau counties. Soil test results for the experimental sites are given in Table 2.

Park Kentucky bluegrass seed yield on a loamy sand was increased by nearly 500 lbs/acre with the application of 120 + 40 + 40 lbs/acre of N, P_2O_5, K_2O on October 10 (Table 3). There was no advantage of applying the same amount of nutrients at once in spring or in split applications.

Lorain timothy seed yield was more than doubled by fertilization (Table 4). While spring fertilization resulted in higher nitrogen concentration of grass tissue than fall treatment, the 55 lbs/acre of more seed produced with the April 30 treatment was not significantly different. Split applications of fertilizer resulted in slightly higher N concentration of tissue but showed no advantage in seed yield over single applications.

Climax timothy seed yield (Table 5) was increased by about 100 lbs/acre by some fertilizer treatments. Very good fertilizer response in plant height and color was observed on June 25 but no differences were detected between the various plots that had received fertilizer, either in fall or spring. Timothy tissue from spring and the split applications had slightly higher N concentration than that from fall fertilization.

Seed yields of Heidemij timothy on a silty clay loam were relatively low (Table 6). The stand was uneven and the field was heavily infested with quackgrass. Fertilization resulted in higher yields and N concentration of tissue. This timothy variety would be expected to benefit more from spring fertilization than either Climax or Lorain. The data seem to indicate a trend (although non-significant) of higher yield and increased N concentration of tissue from spring fertilization.

Fertilization of Nordstern orchardgrass on a loam soil resulted in yield increases ranging from 328 to 485 lbs/acre of seed (Table 7). Plants in the April 30 plots were taller and had darker green color than those of the October 10 fertilization date. However, the 157 lbs/acre higher yield reported for the spring fertilization was not significantly different at the 5% level.

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. Previous experimental work had indicated that N rates of 20 or 30 pounds per acre may cause severe lodging of bluegrass on peat. Present recommendations call for 15 lbs/acre of N for bluegrass and timothy on organic soils.

In 1974, nitrogen treatments increased the seed yield of Park bluegrass on peat by 142 to 305 lbs/acre (Table 8). The application of 40 lbs/acre of N resulted in 163 lbs/acre more seed, compared to the yield obtained with the 20 lbs/acre N treatment. There was no benefit, as measured in yield, to increase the N rate from 40 to 80 lbs/acre. It also should be noted, that during the two previous years, seed yields of bluegrass on this field, were not affected by nitrogen treatments. It is assumed, that the yield responses obtained in 1974 resulted from the low temperature and excess moisture during spring.

Very high seed yields of Newport Kentucky bluegrass were obtained on peat (Table 9). However, fertilizer treatments had no effect on the seed yield on this field.

Nordstern orchardgrass on loam showed striking seed yield increases, primarily due to N applications. A maximum seed yield of 639 lbs/acre was obtained with 150 pounds of N per acre. This nitrogen rate, as would be expected, also resulted in the highest level of N in orchardgrass tissue. This experiment was located on the same field adjacent to the date of fertilization trial reported in Table 7.

Summary and Conclusions

Eight field experiments with Kentucky bluegrass, timothy and orchardgrass were conducted on growers' fields in northwestern Minnesota. Main objective of the study was to determine the effects of date of fertilization, single and split applications of nitrogen, and fertilizer rates on chemical composition of plant tissue and seed yield of grasses.

Fertilization resulted in striking differences in vegetative growth and plant color, and substantially increased the seed yield. Excessive moisture in early spring and low soil temperature during May and early June may have affected nutrient release, especially nitrogen, to plants.

Fertilization of bluegrass in Mid-October was superior to spring applications. Spring and split applications of fertilizer resulted in higher N% of timothy tissue, but in seed yield, showed no advantage over single Mid-October treatments.

Acknowledgments

Grateful acknowledgments are made to the following cooperators for their valuable assistance during 1974 in obtaining the information pertaining to grass seed production:

Messrs. Everett and George Helmstetter, Lake of the Woods county;
Messrs. Gustav and Roy Kveen, Art Bicker, Clarence and Douglas Erickson, Charles Habstritt, Roseau county;
Dr. Laddie Elling, Messrs. David Dahlgren, John Magnusson, Jerome Lensing, University of Minnesota.

Table 1. Precipitation and Temperature Data for the Growing Seasons of 1973-74 and 1964-65 as Measured at Roseau Weather Station.*

Period	Precipitation (inches)		Air Temperature (^{o}F)		
	Total	Departure from Normal	Average	Departure from Normal	GDD $T_b=40^{o}F$
1973/74					
Aug. to Oct.	8.95	+2.03	57.0	+2.3	1567
Nov. to Apr.	6.03	+1.54	14.4	-2.4	72
May to July	6.74	-2.55	60.1	-0.2	1847
Total	21.72	+0.73	--	--	3486
Average	--	--	36.5	-0.7	
1964/65					
Aug. to Oct.	7.11	+0.06	51.4	-3.6	1048
Nov. to Apr.	4.64	+0.02	12.6	-4.1	46
May to July	10.06	+0.74	59.3	-0.5	1770
Total	21.81	+0.82	--	--	2864
Average	--	--	34.0	-3.2	
Normal (1941-70)	20.99		37.2		

* Calculated from Climatological Data, Minnesota, Vol. 79 and 80, 1973 and 1974; Vol. 70 and 71, 1964 and 1965, U.S. Dept. of Commerce.

FIG. 1

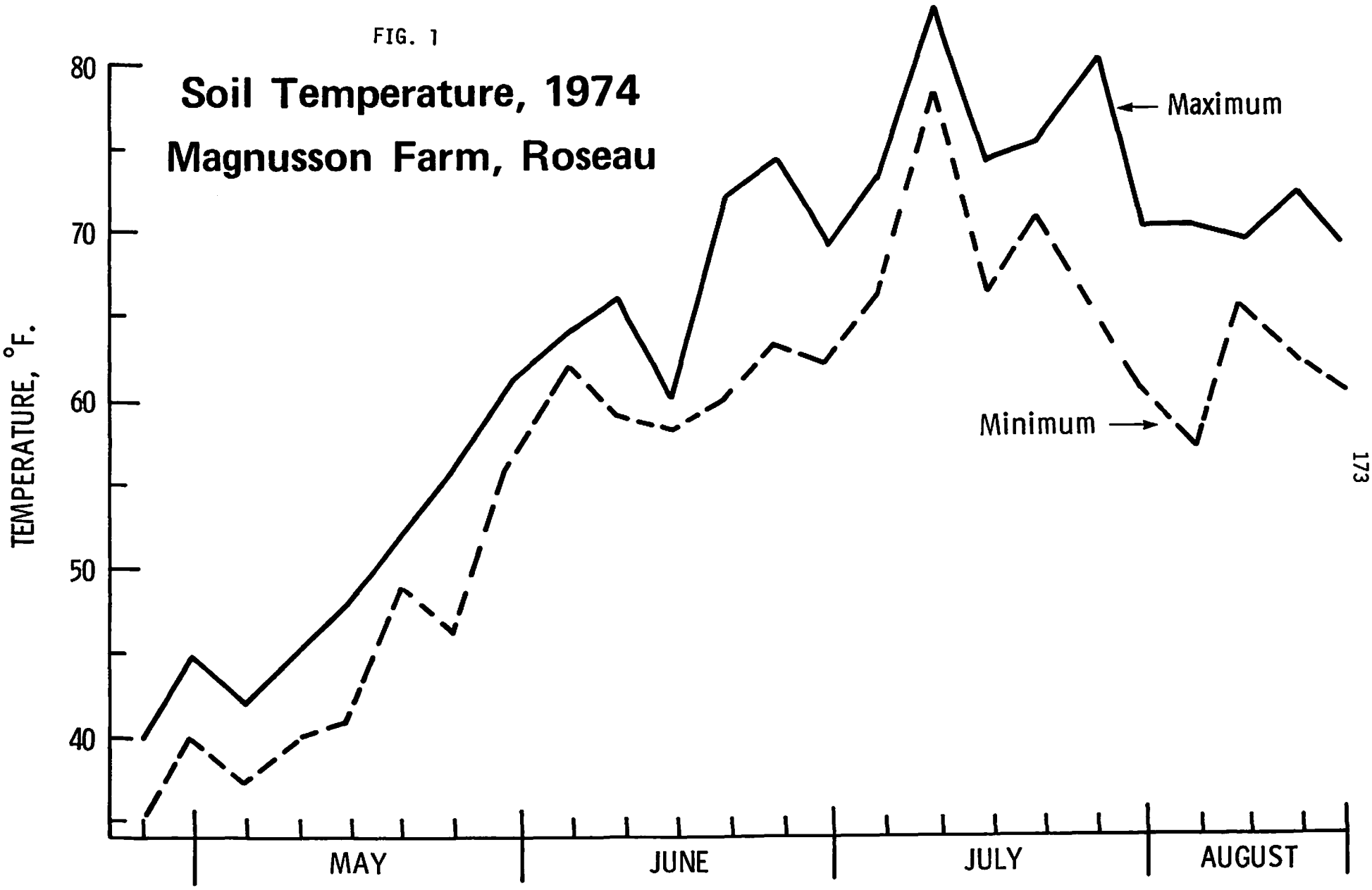
Soil Temperature, 1974
Magnusson Farm, Roseau
TEMPERATURE, °F.
80
70
60
50
40
Maximum
Minimum
MAY
JUNE
JULY
AUGUST

Table 2. Soil Test Results of Samples Collected from 0-3 inch depth on October 12, 1973.

Location	pH	Extractable P, pp2m	Exchangeable K, pp2m	Texture
Helmstetter Bros., Park K. Bluegrass	7.8	110	370	LS
R. Kveen, Lorain Tim.	8.0	90	340	SIL
A. Bicker, Climax Tim.	8.0	22	380	SICL
C. & D. Erickson, Heidemij Tim.	7.9	23	330	SICL
Ch. Habstritt, Park K. Bluegrass	7.5	38	140	P
G. Kveen, Newport K. Bluegrass	7.1	33	170	P
Helmstetter Bros., Nordstern Orchardgrass	7.7	24	150	L

Table 3. Effect of Date of Fertilization on the Seed Yield of Park Kentucky Bluegrass on a Loamy Sand Soil. Helmstetter Bros. Farm, Lake of the Woods County-1974.

Date	Seed Yield lbs/acre
Check	135 a
Oct. 10	632 b
Apr. 29	408 b
Split I. (60+40+40, 10/10 & 60#/A N, 4/29)	464 b
Split II. (60+40+40, 10/10 & 60#/A N, 5/14)	613 b
Significance	**
C.V. %	17.0

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 are not significantly (5% level) different.

Table 4. Effect of Date of Fertilization on Seed Yield and N Concentration in Tissue of Lorain Timothy on Bearden Silt Loam (1969 seeding). Roy Kveen farm, Roseau County - 1974.

Date	Seed Yield lbs/acre	N Percent in dry matter
Check	203 a	1.80 a
Oct. 10	494 bc	2.49 b
Apr. 30	549 c	3.01 d
Split I (60+40+40, 10/10 & 60#/A N, 4/30)	436 b	2.88 cd
Split II (60+40+40, 10/10 & 60#/A N, 5/15)	481 bc	2.73 bc
Significance	**	**
C.V. %	14.3	6.1

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 5. Effect of Date of Fertilization on Seed Yield and N Concentration in Tissue of Climax Timothy on a Silty Clay Loam Soil (4th seed year). Art Bicker farm, Roseau County - 1974.

Date	Seed Yield lbs/acre	N Percent in dry matter
Check	260 a	1.73 a
Oct. 10	360 b	2.67 b
Apr. 30	355 b	2.94 c
Split I (60+40+40, 10/10 & 60#/A N, 4/30)	323 b	2.98 c
Split II (60+40+40, 10/10 & 60#/A N, 5/15)	317 b	2.85 bc
Significance	*	**
C.V. %	11.4	5.2

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 6. Effect of Date of Fertilization on Seed Yield and N Concentration in Tissue of Heidemij Timothy on a Silty Clay Loam Soil (1970 seeding). Clarence and Douglas Erickson Farm, Roseau County - 1974.

Date	Seed Yield lbs/acre	N Percent in dry matter
Check	58 a	1.63 a
Oct. 10	155 ab	2.63 b
Split I (0+40+40, 10/10 & 120#/A N, 4/30)	223 b	3.28 b
Split II (60+40+40, 10/10 & 60#/A N, 4/30)	174 ab	2.59 b
Split III (60+40+40, 10/10 & 60#/A N, 5/15)	143 ab	2.70 b
Split IV (60+40+40, 10/10 & 60#/A N, 5/30)	108 ab	3.01 b
Significance	*	**
C.V. %	38.7	15.7

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 7. Effect of Date of Fertilization on Seed Yield of Nordstern Orchardgrass on Loam Soil (1972 seeding). Helmstetter Bros. Farm, Lake of the Woods County - 1974.

Date	Seed Yield lbs/acre
Check	131 a
Oct. 10	459 b
Apr. 30	616 b
Split I (60+40+40, 10/10 & 60#/A N, 4/30)	598 b
Split II (60+40+40, 10/10 & 60#/A N, 5/15)	453 b
Significance	*
C.V. %	27

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 8. Effect of Fertilization on the Seed Yield of Park Kentucky Bluegrass on Peat (1970 seeding). Ch. Habstritt, Roseau County - 1972, 1973 and 1974.

Treatment N P_2O_5 K_2O lbs/acre	1972	1973 Seed Yield lbs/acre	1974
Check	347	218	220 a
0+40+40	386	233	217 a
20+40+40	342	227	362 b
40+40+40	362	220	525 c
80+40+40	391	267	565 c
Significance	NS	NS	**
C.V. %	22	18	19

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

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

Table 9. Effect of Fertilization on the Seed Yield of Newport Kentucky Bluegrass on Peat (1971 seeding). Gus Kveen, Roseau County - 1974.

Treatment N P_2O_5 K_2O lbs/acre	Seed Yield lbs/acre
Check	695
0+40+40	601
20+40+40	699
40+40+40	815
80+40+40	704
Significance	NS
C.V. %	11.2

Fertilizer treatments were made on Oct. 10, 1973.

Table 10. Effect of Fertilization on Seed Yield and N Concentration in Tissue of Nordstern Orchardgrass on Loam Soil (1972 seeding). Helmstetter Bros., Lake of the Woods County - 1974.

Treatment N P_2O_5 K_2O	Seed Yield[1/]	N Percent in dry matter
lbs/acre	lbs/acre	
Check	131 a	1.56
0+40+40	128 a	1.66
60+40+40	253 ab	1.63
90+40+40	386 abc	2.11
120+0+0	432 bc	--
120+40+40	459 bc	1.91
150+40+40	639 c	2.75
Significance	*	
C.V. %	26.4	

1/ Average of 2 plots.

Fertilizer materials were top dressed on Oct. 10, 1973.

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

A KENTUCKY BLUEGRASS VARIETY—FERTILIZATION—RESIDUE MANAGEMENT STUDY[1/]

Laddie J. Elling and John Grava

Two field experiments were conducted on the Y.B. Magnusson farm, Roseau county in 1974 to investigate effects of fertilization and cultural treatments on seed yield of six bluegrass varieties. The stands were established in 1971. The soil is an alkaline (pH 7.9) sandy loam having very high level of extractable phosphorus (123 lbs/acre) and high level of exchangeable potassium (250 lbs/acre).

Date of Nitrogen Application--Residue Mangement Experiment

The five N treatments used in this experiment were as follows: Check, 100 lbs/acre of N applied at once either on October 9 or on April 22, two split-applications (50 lbs/acre N on Oct. 9 and 50 lbs/acre N on April 22, or 50 lbs/acre N on Oct. 9 and 50 lbs/acre N on May 15). Ammonium nitrate (34-0-0) was used as the N source. Residue management treatments consisted of: (a) July Burn with straw (the plot was covered with straw from crop; this was let dry and then burned); (b) July Desiccate-Burn (the plot was clipped and the loose material raked off, and then on July 18 the aftermath was sprayed with Paraquat; the plot was burned on August 1). Treatments were replicated 3 times.

Analysis of variance indicated significant "F" values for the following: fertilization** (highly significant), varieties***, fertilization x management interaction* (significant).

Striking increases of seed yield, over the check, were obtained with the application of 100 lbs/acre of N (table 1). Somewhat inconsistent yield responses to time of N application were obtained with some varieties, for example, Pennstar. Generally, nitrogen applications made in fall were the most effective. Split applications of N, however, showed no advantage over single application. The residue management treatments were equally effective.

Fertilizer Rate--Residue Management Experiment

In this experiment, three different fertilizer rates were used: 50+25+25, 100+50+50, 150+75+75 lbs/acte of NPK, expressed as N, P_2O_5 and K_2O. Ammonium nitrate was the source of N and PK were supplied with a 0-26-26 blended fertilizer. Fertilizer materials were applied with a 3-foot Gandy fertilizer spreader on October 9. The following three residue management treatments were used: (a) July Burn (residue was burned in place); (b) July Clip-Torch (the stubble and aftermath were removed and then plot area was burned with propane burner); (c) July Clip (the stubble and aftermath were mowed and raked off). Treatments were replicated 3 times.

Significant "F" values were obtained for the the following: fertilizer**, cultural treatment**, varieties**, varieties x cultural treatment**.

1/ A cooperative study with the Department of Agronomy and Plant Genetics and the Department of Soil Science, participating.

Application of the two highest fertilizer rates (100+50+50 and 150+75+75) resulted in the production of highest seed yields of all six varieties (table 2). Nitrogen, most likely, was the main booster of seed yields because P and K levels in the soil were high. Because of possible lodging, 100 lbs/acre of N appears to be the maximum rate for Park bluegrass. Nugget seems to have benefited more from the highest fertilizer rate (150+75+75) than other varieties. Cultural treatments, July Burn and July Clip--Torch, had essentially the same effect on seed yield. July Clip, however, produced the lowest seed yields.

Table 1. Effect of date of Nitrogen application and residue management on seed yield of six Kentucky Bluegrass varieties--1974; Magnusson farm, Roseau County.

Variety	Nitrogen treatment, N lbs/acre				
	None	100 Oct. 9	100 April 22	50 Oct. 9 50 April 22	50 Oct. 9 50 May 15
	Seed yield lbs/acre				
	(a) July burn with straw				
Park	285	598	558	607	538
Pennstar	83	660	264	321	467
Fylking	62	380	315	288	380
Merion	143	371	431	380	431
Nugget	279	705	565	723	698
NK Exp.	89	473	440	407	535
	(b) July dessicate-burn				
Park	306	526	505	669	535
Pennstar	65	395	270	517	419
Fylking	41	318	228	431	371
Merion	103	259	315	410	282
Nugget	356	571	598	755	591
NK Exp.	110	250	268	277	309

LSD 5% level 178

1% level 235

Table 2. Effect of fertilizer rate and residue management on seed yield of six Kentucky Bluegrass varieties, 1974, Magnusson Farm, Roseau County.

Variety	Plant Nutrients Applied, lbs/acre		
	50+25+25	100+50+50	150+75+75
	----------Seed yield, lbs/acre----------		
	(a) July burn		
Park	401	642	740
Nugget	550	703	734
Pennstar	183	256	419
Merion	207	373	453
Fylking	91	164	178
NK Exp.	232	283	294
	(b) July clip-torch		
Park	458	712	638
Nugget	531	608	793
Pennstar	128	229	247
Merion	220	336	393
Fylking	92	260	232
NK Exp.	223	309	237
	(c) July clip		
Park	372	470	595
Nugget	434	598	601
Pennstar	159	196	254
Merion	204	213	275
Fylking	122	180	204
NK Exp.	245	394	367

LSD 5% level 194
1% level 258

Fertilizer treatments were made on October 9, 1973.

LITTER FALL AND LITTER DECOMPOSITION FOLLOWING FOREST FIRE

D.F. Grigal

In an earlier report[1], we discussed two studies of the effects on nutrient cycling of the Little Sioux Forest Fire, which burned 15,000 acres in northeastern Minnesota in May 1971. We have discussed some of the preliminary results from one of those studies in another report[2]. In this report, we will discuss some of the effects of the fire on mass and nutrient return to the forest floor via litter fall, and on the rate of litter decomposition.

We compared both litter fall and litter decomposition on two lake watersheds in the burn with the same processes in two watersheds outside the burn boundaries. Rate of litter fall in the burn was 300% that in the control areas during the first year following the fire, 150% during the second year, and only 75% by the third year. During the first year, most of the increased fall on the burn was from browned needles of conifers which had been killed by the fire. This component of litter fall decreased to levels much lower than those in the controls in both the second and third year following the fire. The wood component of litter fall, primarily small branches and bark, showed increased rates of fall the first two years after fire but by the third year the rate had fallen to control leaves. Deciduous leaf fall, initially much lower on the burn, increased each year following the fire and by the third year had nearly reached levels in the controls. In general, the nutrient concentrations in the litter falling either on or off the burn did not differ significantly. The needles which fell during the first year following the fire fell "prematurely", in the sense that they had not matured on the trees but fell as a direct result of the fire. These needles were significantly higher in nitrogen and phosphorus, and significantly lower in calcium, than were the mature needles which fell off the burn.

Litter decomposition, measured in mesh bags containing aspen leaves, was not significantly different on or off the burn. In both cases the leaves lost 40% of their original mass during the first year following the fire and an additional 20% during the second year. The only nutrient element which was significantly different in the decomposed litter on and off the burn was phosphorus, which was significantly higher in the litter on the burn. Other nutrient elements behaved

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1 1972. A Report on Field Research in Soils. Department of Soil Science, University of Minnesota, St. Paul. Soil Series 88.

2 1973. A Report on Field Research in Soils. Department of Soil Science, University of Minnesota, St. Paul. Soil Series 89.

similarly both on and off the burn, with calcium concentrations remaining about the same throughout the study period, magnesium and especially potassium levels dropping to levels much lower than in fresh litter, nitrogen showing a very large increase in the decomposing litter, and phosphorus showing an initial decline and then an increase to levels found in fresh litter.

The results of these studies show that while some of the processes associated with nutrient cycling were altered by the fire, these processes were not halted or irreversibly changed. Instead, as time passes those processes which changed following fire are becoming more and more similar to processes off the burn.

FERTILIZATION OF GRASSLANDS ON ORGANIC SOILS

GULLY, MINNESOTA - 1974

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

Organic soils cover an area in Minnesota estimated at seven million acres. Although this total is a significant portion of Minnesota's acreage, they have to this point been utilized to a small degree for agricultural production due to the degree of management necessary for their cultivation.

It is estimated that of the seven million total acres, four million have been or potentially could be, put into some form of agricultural production. One crop which seems to be especially promising is grassland farming. Grassland farming would include both pasture and hay production and holds the advantages of needing only minimal drainage for good growth, being suited to the cold, short growing seasons of northern Minnesota, and being relatively free of difficult management problems.

In the spring of 1974 a trial on an organic soil near Gully, Minnesota was established to deal with one of the primary management factors, soil fertility. The specific objectives of this study were:

1. To determine the effects of fertilization on the quantity and quality of grass produced on organic soils.
2. To investigate the nutrient requirements of grasses growing on organic soils.
3. To chemically evaluate the effects of fertilization on harvested grass.
4. To evaluate the influence of fertilization on the nitrogen, phosphorus and potassium release and movement in organic soils.

The soil classified as a Terric Borohemist had soil test values for phosphorus and potassium as indicated in Table 1. Available phosphorus values ranged from 7 pp2m in the upper inch to 3 pp2m at a 6 inch depth and below. Exchangeable potassium levels ranged from 120 pp2m at a 1 inch depth to 20 pp2m at a 6 inch depth and below.

The botanical composition of the sod area used for the trial was 94 percent quackgrass (Agropyron repens) and 6 percent timothy (Phleum pratense).

Table 1. Initial soil test values, grassland fertilization trial. Gully, Minnesota - 1974.

Soil Depth	Available P*	Exchangeable K*
inches	pp2m	pp2m
0- 1	7	120
1- 2	5	110
2- 3	4	65
3- 6	4	30
6- 9	3	20
9-12	3	20
12-18	3	20
18-24	3	20

*Based on University of Minnesota Soil Test Lab procedures.

NITROGEN TRIALS

Twelve nitrogen treatments, broadcast as ammonium nitrate, arranged in a randomized complete block design were replicated four times. Each plot, 20 feet by 20 feet in size, were then split into two subplots 10 x 20 feet. One subplot was used to simulate pasture management (cut 4 times an average height of 8-10 inches) and the other hay management (cut 2 times at an average height of 24 inches.

In Table 2, total dry matter yields as well as yields by individual cuttings under pasture management are reported. It is interesting to note the excellent response to nitrogen on the first three cuttings, while only limited nitrogen response is recorded on the fourth cutting. This is likely due to increased soil temperatures causing an increased rate of organic matter mineralization. Another apparent observation is the excellent response to the splitting of nitrogen applications as is illustrated in Figure 1. This method of management not only results in superior yields, but also creates a favorable distribution of forage, maximum yields coming during mid-summer, for beef production.

Table 2. Dry matter yields for grassland (4 cuttings) for various dates of harvest and nitrogen fertilizer treatments. Gully, Minnesota - 1974.

Treatment lbs/A			Grass Production lbs dry matter/A				
N	P_2O_5	K_2O	May 29	June 19	July 24	Sept 3	Total
0	0	0	406a+	904ab	927a	749a	2986a
0	100	300	345a	809a	1014ab	976bcd	3143a
100	0	0	588abc	1012b	925a	880abc	3405a
50	100	300	629abcd	1189c	1262bc	1028cd	4108b
100	100	300	765bcde	1253c	1098ab	1072d	4188bc
150	100	300	942de	1470d	1235bc	1072d	4719d
200	100	300	988e	1697ef	1484c	810ab	4979de
* 50	100	300	543ab	991b	1977d	1107d	4617bcd
*100	100	300	888cde	1247c	1905d	1063cd	5103de
*150	100	300	877cde	1555de	1996d	976bcd	5404e
*200	100	300	873cde	1560de	1933d	985bcd	5351e
** 50	100	300	528ab	1835f	1994d	1159d	5516e
Significance			**	**	**	**	**
BLSD (.05)			317	169	295	182	603

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

* 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.