Spring-applied N resulted in significantly higher leaf and grain N concentrations than did fall applications. Yield and grain moisture at harvest were unaffected by time of application; although fall-applied ammonium nitrate resulted in the lowest yields. Interactions (Source X Rate, Source X Time and Rate X Time) were not significant.

A general conclusion from the 1973 data would be that N should be of the NH_4 form rather than the NO_3 form when fall-applied to higher rainfall areas of southeastern and south-central Minnesota.

Experiment II

Excessive rainfall over an extended period of time could result in denitrification reactions in poorly drained, high organic matter soils and subsequently, N-deficient corn later in the growing season. Long periods of high rainfall often occur in the spring in south-central Minnesota, and losses of N do occur. If these losses are great enough to create N deficiency in corn, a yield response from a second application of N may be expected.

To evaluate split applications of N fertilizer on these poorly drained, fine textured, high organic matter soils, an experiment was established on a LeSueur clay loam soil on the Roy Lukken farm, which is the site used by Fenster, Overdahl and Randall in other corn fertilization studies. The site for this experiment has 92% of its area within 50' of tile lines, which should provide adequate internal drainage. The experimental design was a randomized complete-block, replicated five times.

Corn had been grown continuously on this site since 1969. Broadcast rates of 66# P/A and 166# K/A were applied before fall plowing. The first application of N was applied and disked in on April 26. Three of the treatments received a split application of N to the soil surface on June 20 and were followed immediately by cultivation to incorporate the fertilizer. Ammonium nitrate was the N source for all treatments.

Corn (Northrup King PX 47E) was planted at 26,000 ppA in 30" rows on May 14. Row fertilizer (13+15+37 lbs. N+P+K/A) and insecticide (1 lb. active Furadan/A) was applied at planting time. Weeds were chemically controlled with a combination of Lasso + Atrazine applied preemergence plus one cultivation. The leaf opposite and below the ear was sampled on July 25 and was submitted for analysis by Kjeldahl methods. Yields were obtained by hand harvesting 16' of row from each of the center two rows of each plot.

Results

Leaf and grain N and yield were increased significantly over the check by the N rates (Table 2). Nitrogen concentrations in the leaf were increased by the 300 lb. rate over the single application

of 100 lbs. N/A but not the split application. Grain nitrogen (protein) was highest with the 300 lb. rate; however, yields from rates greater than 100 pounds were not increased significantly. Moisture content of the grain at harvest was reduced with the higher N rates.

Table 2. Effect of rate and application method of nitrogen on the leaf N concentration and yield of corn at Waseca in 1973. (Experiment II)

Application Date and Rate						
		Total N			Grain	
5-26-73	6-20-73	Applied	Leaf N	N	Yield	H_2O
lbs.N/A		lbs./A	%	%	bu/A	%
0	0	0	2.09	1.23	147.1	35.0
50	50	100	2.52	1.37	175.7	32.9
100	0	100	2.43	1.36	177.2	33.0
100	100	200	2.55	1.40	174.6	32.3
200	0	200	2.52	1.42	171.9	32.8
250	0	250	2.58	1.41	180.2	32.0
150	150	300	2.63	1.55	174.8	31.8
300	0	300	2.62	1.51	170.2	31.8
		Significance:	**	**	**	**
		CV(%):	4.6	5.8	5.0	2.8
		BLSD (.05):	0.14	0.10	10.8	1.1

Between the application dates in 1973, appreciable denitrification in these soils apparently did not occur. Consequently, split applications of N did not improve corn yields over single applications.

NITROGEN NEEDS FOR CORN AND ACCUMULATION OF NITRATES IN PROFILE, 1973

W. E. Fenster, C. J. Overdahl, G. W. Randall and B. D. McCaslin

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. 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. It is quite obvious that 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 are given in tables 1 and 2.

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

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

Where letters differ, yields are statistically different at the 10% level.

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 %
0	1.9	1.5	2.4	1.8
50	2.2	1.7	2.6	2.3
100	2.5	2.2	2.6	2.3
150	2.7	2.6	2.7	2.6
200	2.8	2.9	2.7	2.6
400	3.0	3.0	2.7	2.8
Date sampled	7/17	7/21	7/28	7/25

* sixth leaf at tasseling

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

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, 1971, 1972 and 1973.

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

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

[1] Where letters differ for each experiment, yields are statistically different at the 10% level.

[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 soils were 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 1971	1972	1973	Virgin plots 1971	1972	1973
0	2.5	2.4	2.0	2.8	2.9	2.6
50	2.7	2.9	2.3	2.7	2.8	2.5
100	2.6	2.8	2.4	2.8	2.8	2.7
150	2.9	2.7	2.4	2.8	2.8	2.7
200	2.9	2.9	2.6	2.8	2.9	2.8
400	2.9	2.7	2.6	2.9	2.8	3.0
Date sampled	7/21	7/28	7/25	7/21	7/28	7/25

* sixth leaf at tasseling

Tables 5, 6 and 7 show nitrate nitrogen levels found in the soil profile in relationship to nitrogen fertilizer treatments. Excess nitrates appear to accumulate only from treatments beyond where no nitrogen response is obtained.

Table 5. Amount of nitrate-nitrogen in the soil profile on continuous corn in Waseca county - Lukken Farm.

Soil Depth (Ft.)	Treatment - lbs. of N per acre applied annually					
	0	50	100	150	200	400
	ppm NO_3-N					
1971						
0-1	4	4	6	6	5	17
1-2	2	2	3	4	3	12
2-3	3	3	3	3	3	27
3-4	2	2	2	3	3	17
4-5	3	2	3	4	4	10
1972						
0-1	3	11	9	32	14	68
1-2	2	5	3	17	17	52
2-3	2	4	2	24	21	46
3-4	2	5	2	6	9	19
4-5	2	4	3	4	5	6
5-6	2	2	3	4	3	4
1973						
0-1	5	9	6	11	10	28
1-2	2	8	3	9	7	41
2-3	2	5	4	9	12	46
3-4	3	7	4	12	11	27
4-5	3	8	6	12	8	22

Table 6. Amount of nitrate-nitrogen in the soil profile on continuous corn plots in Martin county - Thate Farm.

Soil Depth (Ft.)	Treatment - lbs. of N per acre applied annually					
	0	50	100	150	200	400
	ppm NO_3-N					
1970						
0-1	8	7	6	8	9	12
1-2	6	5	6	6	6	9
2-3	6	9	7	13	7	19
3-4	12	17	9	44	22	28
4-5	12	21	11	29	24	18
5-6	7	20	13	24	17	14
1971						
0-1	9	9	9	12	23	60
1-2	5	5	8	17	23	45
2-3	5	13	13	43	26	30
3-4	6	15	15	30	20	26
4-5	7	14	14	28	17	18
5-6	10	13	14	23	17	18
1972						
0-1	5	7	8	13	21	33
1-2	3	4	6	13	21	42
2-3	3	9	8	27	19	53
3-4	6	14	13	23	20	40
4-5	9	21	15	22	26	37
5-6	10	24	17	22	24	32
1973						
0-1	6	5	7	9	12	21
1-2	3	5	6	13	8	19
2-3	3	3	7	25	14	30
3-4	4	4	16	26	24	30
4-5	7	10	11	23	29	24
5-6	9	10	12	22	26	25

Table 7. Amount of nitrate-nitrogen in the soil profile on new ground (virgin) plots in Martin county - Thate Farm.

Soil Depth (Ft.)	Treatment - lbs. of N per acre applied annually						
	0*	0	50	100	150	200	400
	1970	1971 →					
				ppm NO_3-N			
1970 & 1971							
0-1	6	17	19	24	15	31	40
1-2	4	10	23	32	29	47	32
2-3	5	7	9	8	14	14	11
3-4	3	3	5	4	5	4	5
4-5	3	3	3	4	5	6	3
5-6	3	4	3	4	4	6	4

* no nitrogen treatments in 1970, profile sampled just after plowing.

1972							
0-1		10	17	17	30	24	22
1-2		6	14	24	38	33	42
2-3		6	18	25	32	28	56
3-4		6	11	15	16	21	46
4-5		5	9	11	12	16	31
5-6		5	7	9	9	13	22
1973							
0-1		11	14	10	13	13	27
1-2		5	7	12	14	20	42
2-3		5	10	34	30	51	55
3-4		8	20	32	21	31	44
4-5		10	13	22	16	23	32
5-6		10	10	16	16	20	23

EFFECT OF BROADCAST PHOSPHORUS AND POTASSIUM ON CORN YIELD ON HIGH TESTING SOILS (1973)

C. J. Overdahl, W. E. Fenster, G. W. Randall and B. D. McCaslin

This was the fourth 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, 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.

Table 1. 1970, 1971, 1972 and 1973 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	1970	1971	1972	1973	1970	1971	1972	1973
0	155	137a	136	160	.26	.28	.38	.27	46	37	47	35
50	151	137a	127	157	.26	.27	.37	.27	36	39	47	50
100	162	156b	136	160	.27	.30	.40	.29	56	55	96	81
150	146	146ab	129	153	.28	.30	.40	.29	65	63	94	85
200	145	154ab	130	158	.28	.30	.44	.30	64	55	109	88
	N.S.	10%	N.S.	N.S.	N.S.	N.S.	N.S.	*				

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

Efforts of Dean Fairchild, Bob Schoper, Charles Behrens, Floyd Bellin, Martin Co. Extension Agent and Vern Quade, Martin Co. Assistant Extension Agent, are greatly appreciated.

Table 2. 1970, 1971, 1972 and 1973 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	1970	1971	1972	1973	1970	1971	1972	1973
0	133	139	140	167	.31	.28	.29	.26	34	27	39	36
50	136	133	142	164	.30	.27	.30	.28	31	33	62	58
100	132	132	144	163	.28	.27	.32	.27	31	40	91	62
150	136	135	141	162	.29	.30	.35	.28	40	44	87	66
200	138	130	144	167	.29	.30	.33	.29	53	45	79	76

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

Table 3. 1970, 1971, 1972 and 1973 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	1970	1971	1972	1973	1970	1971	1972	1973
0	156	148	120a	160	1.7	1.8	1.6	1.7	202	230	295	273
50	147	154	127ab	155	1.7	1.8	1.6	1.8	212	258	360	303
100	152	149	129ab	157	1.6	2.1	1.8	2.2	222	278	328	318
200	147	143	130ab	151	1.8	2.1	1.9	2.0	270	328	415	380
400	160	149	132b	158	1.8	1.9	2.1	2.1	243	320	490	533
	N.S.	N.S.	10%	N.S.								

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

Table 4. 1970, 1971, 1972 and 1973 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	1970	1971	1972	1973	1970	1971	1972	1973
0	134	123	136	154a	1.6	1.4	1.4	1.5	260	210	282	255
50	129	120	138	156ab	1.7	1.7	1.5	1.8	275	213	322	287
100	139	131	139	160ab	1.7	1.7	1.7	2.0	260	220	318	295
200	132	116	141	161ab	1.8	1.8	1.9	2.2	262	223	352	330
400	134	120	143	162b	2.2	1.9	2.1	2.5	312	310	478	455
	N.S.	N.S.	N.S.	10%								

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

EFFECTS OF NITROGEN FERTILIZATION ON YIELD AND PERCENT PROTEIN OF SEMIDWARF AND STANDARD HEIGHT SPRING WHEAT

W. E. Lueschen, R. E. Heiner, and G. W. Randall

Experiments were established in 1971, 1972 and 1973 at the Southern Experiment Station to evaluate nitrogen fertilization of three standard height and seven semidwarf hard red spring wheat varieties. Soil type for these experiments was a LeSueur clay loam. Adequate P and K fertilizers were applied each year to prevent these elements from limiting yield and quality. Wheat plots followed soybeans each year and ammonium nitrate was used as the source of N all three years. Nitrogen was applied and incorporated just prior to seeding 4/16/71, 4/19/72, and 4/20/73 with a seeding rate of approximately 90 pounds of seed per acre for all varieties. Nitrate-nitrogen soil tests were run on samples from the experimental area prior to seeding in 1972 and 1973. The results indicated 95 and 50 pounds of nitrate-nitrogen present in the soil in 1972 and 1973, respectively. Rates of nitrogen (lbs. N/A) were 40, 80, and 120 in 1971; 0, 40, and 80 in 1972; and 0, 40, 80, and 120 in 1973. Varieties in nitrogen rates was partially due to nitrate soil test results. The three standard height varieties were Chris, Polk, and Waldron. In 1971 and 1972 semidwarf varieties included Fletcher, Era, WS1809, WS1812, Bounty 208, Bonanza, and RR68. In 1973 Fletcher and WS1812 were replaced with Olaf and II-64-33. Each plot consisted of a 6' x 50' strip which was harvested with a standard combine.

Results

Yields were increased significantly in all three years by the addition of nitrogen fertilizer (table 1). In general, response was limited to the lower rates of N (40-80 lbs.). Although the semidwarf varieties yielded significantly more each year than the standard height varieties, response to N was similar for both types. These data also indicated that nitrate soil tests gave a reasonable estimate of nitrogen needs. Supplemental nitrogen recommendations based on the nitrate soil test indicated a need for 40 and 100 pounds of N/A for 1972 and 1973, respectively. Yield response to nitrogen was much greater in 1973 than in 1972. These results could have been predicted from the nitrate tests although it appeared that the nitrate test and subsequent recommendations would lead to N rates higher than necessary for optimum yields when wheat followed soybeans.

Rates of nitrogen also influenced protein content of the grain with a similar response for the standard height and semidwarf varieties (table 2). Each increment of additional nitrogen increased protein content slightly. Fletcher, WS1809, and WS1812 were exception to this in both 1971 and 1972. All other varieties responded similarly.

Table 1. Effect of N rate and variety on yield of hard red spring wheat at Waseca, 1971-3.

Yield										
Variety	1971			1972			1973			
	lbs. N/A			lbs. N/A			lbs. N/A			
	40	80	120	0	40	80	0	40	80	120
Chris	65	64	67	64	64	64	46	59	57	58
Waldron	65	65	67	62	66	67	55	65	64	70
Polk	60	65	61	60	61	65	52	59	57	59
Fletcher*	70	72	76	64	68	72	-	-	-	-
WS1809*	62	62	70	75	75	78	54	61	60	63
Era*	74	80	77	72	75	78	53	62	66	66
WS1812*	59	64	66	66	68	68	-	-	-	-
Bounty 208*	64	63	70	76	84	87	50	62	61	60
Bonanza*	60	57	64	70	75	77	47	57	57	58
RR68*	66	67	68	70	72	73	55	62	61	62
Olaf*	-	-	-	-	-	-	58	67	68	72
II-64-33*	-	-	-	-	-	-	52	60	63	67
10 Varieties	64	60	68	67	71	73	52	61	61	64
Std. Height	63	65	65	62	63	65	51	61	59	62
Semidwarf	65	66	70	70	74	76	53	63	62	64
BLSD N Rate		6.8			3.31			4.0		
BLSD Var.		3.6			2.68			2.2		
BLSD Var. x N Rate		4.8			N. S.			5.7		

* Semidwarf Varieties

4 Reps 1971-72; 3 Reps 1973

Table 2. Effect of N rate and variety on percent protein of hard red spring wheat at Waseca, 1971-2.

Variety	1971 lbs. N/A			1972 lbs. N/A			1973 lbs. N/A			
	40	80	120	0	40	80	0	40	80	120
Chris	16.8	16.4	17.4	15.3	15.6	16.2	15.9	16.1	17.4	17.4
Waldron	16.3	16.5	17.0	15.7	15.9	15.9	16.7	16.8	17.5	17.6
Polk	15.9	16.3	16.3	14.9	15.4	15.3	15.9	16.2	17.1	16.9
Fletcher*	15.3	15.2	15.4	14.7	14.3	14.5	-	-	-	-
WS1809*	16.6	16.8	16.8	14.7	14.9	14.9	15.9	15.9	16.5	16.8
Era*	13.9	14.0	15.0	13.1	13.5	14.0	15.3	15.3	16.1	16.3
WS1812*	15.7	15.5	15.5	14.2	14.2	14.2	-	-	-	-
Bounty 208*	14.9	16.0	15.9	14.1	14.4	14.8	15.7	15.7	16.0	17.0
Bonanza*	14.7	15.5	15.8	13.3	13.8	14.3	15.7	15.8	16.5	16.9
RR68*	15.0	16.0	16.1	14.4	15.0	14.9	15.7	15.8	16.5	17.2
Olaf*	-	-	-	-	-	-	15.8	16.0	16.8	16.9
II-64-33*	-	-	-	-	-	-	16.0	16.1	16.8	16.9
10 Varieties	15.5	15.8	16.1	14.4	14.7	14.9	15.9	16.0	16.7	17.0
Std. Height	16.3	16.4	16.9	15.3	15.6	15.8	16.2	16.4	17.3	17.3
Semidwarf	15.2	15.6	15.8	14.1	14.3	14.5	15.7	15.8	16.5	16.9
BLSD N Rate (.05)		.35			.40			.18		
BLSD Var. (.05)		.37			.26			.19		
BLSD Var. x N (.05)		NS			.45			NS		

* Semidwarf Varieties
4 Reps 1971-72; 3 Reps 1973

LIME PLOTS, WASECA, 1973[1]

John Grava, C.J. Overdahl, D.S. Fairchild, G.W. Randall

A field experiment was established at the Southern Experiment Station in spring of 1971 to study the effects of liming on yield and chemical composition of corn, and chemical properties of soil. In 1971, lime treatments did not affect corn yield and had no effect on the chemical composition of leaf tissue. This investigation was continued in 1972 and 1973.

Two other experiments were established on this field, one with soybeans and another one with alfalfa. Dolomitic limestone used in these two experiments had the following quality characteristics:

Passing 8 - Mesh Sieve 96.3%
Passing 60- Mesh Sieve 38.7%
Calcium Carbonate Equivalent 96.4%.

The lime rates used were as follows: 0, 2.5, 5.0, 7.5, 10.0 tons per acre. The treatments were replicated six times. Limestone was applied on April 26, 1972. Individual plots were 20 feet wide and 30 feet long.

CORN

Average soil pH's for depths from 0 to 48 inches from areas receiving no lime are given in Table 1. Approximately at a depth of 30 inches limy till is recorded with a pH of 6.8. This relatively shallow limy material partially explains why there has been no response to lime, though the surface pH is 5.6.

Table 1. Average soil pH's at various depths, within the corn area receiving no lime, Waseca, 1973.

Soil depth	Soil pH	SMP buffer index
inches		
0-6	5.6	6.1
6-12	5.7	6.1
12-18	5.9	6.4
18-24	6.3	-
24-30	6.3	-
30-36	6.8	-
36-42	7.1	-
42-48	7.5	-

1/ See "A Report on Field Research in Soils," Soil Series 88, March 1972, pp. 140-141; Soil Series 89, March 1973, pp. 154-159 for results obtained in previous years.

Table 2 reports soil pH's, from samples collected in June of 1973, from depths of 0-18 inches with various lime rate. Lime was originally applied in April of 1971. The surface soil pH was increased from an initial level of 5.5 to 6.0-6.2 with from 2.5 to 10.0 tons of lime/A.

All corn plots received the following in 1973: (a) 187+80+89 lbs/A of plant nutrients, expressed as N, P_2O_5, K_2O; (b) herbicide: broadcast 2.5 lbs Lasso + 2.5 lbs Atrazine per acre; and (c) insecticide: Furadan 1 lbs/A. Pioneer 3780 was planted on May 17 at 26,800 plants/A.

Table 2. The effect of various lime rates on soil pH, two years after application at Waseca. (Corn plot)

Lime treatments	Soil depth	Soil pH	SMP buffer index
tons/A	inches		
0	0-6	5.5	6.1
	6-12	5.7	6.2
	12-18	5.7	6.2
	18-24	6.1	-
2.5	0-6	6.0	-
	6-12	6.0	-
	12-18	6.1	-
	18-24	5.9	6.4
5.0	0-6	6.1	-
	6-12	6.1	-
	12-18	6.1	-
	18-24	6.0	-
7.5	0-6	6.1	-
	6-12	6.3	-
	12-18	6.1	-
	18-24	6.2	-
10.0	0-6	6.2	-
	6-12	6.1	-
	12-18	6.3	-
	18-24	6.3	-

The yield of corn and chemical composition of sixth leaf at tasseling are given in Tables 3 and 4. Lime treatments had no effect on corn yields in 1973. The Mg content of the corn leaves was significantly increased with increasing dolomite liming rates. Lime rates significantly reduced the Mn content of the corn leaves.

Table 3. Yield of corn, Waseca lime plots, 1973.

Rate of lime	Yield
tons/A	bu/A
0	169
2.5	166
5.0	167
7.5	171
10.0	164
Significance	N.S.
CV, %	3.5

Table 4. Chemical composition of sixth corn leaf at tasseling, Waseca lime plots, 1973.

Rate of lime	N	P	K	Ca	Mg	Zn	Cu	Mn	B	Fe	Al
tons/A	------% in dry matter----------					----------ppm in dry matter----------					
0	2.7	0.29	2.33	0.66	0.32a+	32.2	6.57a	73.6c	5.80	136	43.8
2.5	2.7	0.31	2.29	0.66	0.35b	31.7	6.90ab	52.8b	6.22	137	43.3
5.0	2.7	0.32	2.35	0.66	0.37c	36.0	7.43b	48.1ab	5.92	139	41.3
7.5	2.7	0.31	2.32	0.67	0.36c	32.4	7.55b	44.0ab	6.62	139	48.7
10.0	2.6	0.30	2.20	0.67	0.39d	30.9	6.88ab	39.2a	6.10	127	37.8
Significance	N.S.	N.S.	N.S.	N.S.	**	N.S.	*	**	N.S.	N.S.	N.S.
CV, %	4.2	5.6	6.4	6.5	3.2	15.6	7.9	14.8	15.1	8.4	14.3

+ numbers followed by different letters are significantly different at the 5.0% level of population.

SOYBEANS

Table 5 shows that at a depth of 6-12 inches a pH of 6.1 was recorded compared to a surface pH of 5.7 in areas receiving no lime. A neutral reaction was indicated at a depth of 30 inches.

Wells soybeans were planted on May 22 in 30 inch rows. All plots received 1 lb/A Treflan + 2.5 lbs/A Amiben.

The yields of soybeans and chemical composition of the upper-most mature trifoliate leaf are reported in Tables 6 and 7. Yields were excellent in 1973 ranging from 49 to 53 bu/A. However, the soybean yields were not affected by lime treatments. A significant reduction in the Mn content of the soybean leaf tissue was again noted with lime treatments.

Table 5. Average soil pH's at various depths within the soybean area receiving no lime, Waseca, 1973.

Soil depth	Soil pH	SMP buffer index
Inches	5.7	6.1
0-6	5.7	6.2
6-12	6.1	-
12-18	6.2	-
18-24	6.3	-
24-30	6.3	-
30-36	7.0	-
36-42	7.6	-
42-48	7.7	-

Table 6. Yield of soybeans, Waseca lime plots, 1973.

Rate of Lime	Yield
tons/A	bu/A
0	52
2.5	51
5.0	49
7.5	53
10.0	53
Significance	N.S.
CV, %	7.9

Table 7. Chemical composition of soybean trifoliate leaves, Waseca lime plots, 1973.

Rate of Lime	P	K	Ca	Mg	Zn	Cu	Mn	B	Fe	Al
tons/A	-----% in dry matter-------				----------ppm in dry matter----------					
0	0.40a+	2.33	1.37	0.40	59.1	5.25	94.2c	62.5	233	108.8
2.5	0.42b	2.32	1.34	0.42	58.7	5.12	72.3a	60.7	222	95.3
5.0	0.40a	2.26	1.39	0.43	60.3	5.42	78.7b	60.4	223	99.7
7.5	0.42b	2.29	1.30	0.41	59.6	5.83	75.9ab	59.4	223	96.2
10.0	0.40a	2.23	1.39	0.42	58.0	4.98	72.7a	58.1	214	95.2
Significance	*	N.S.	N.S.	N.S.	N.S.	N.S.	*	N.S.	N.S.	N.S.
CV, %	3.1	6.0	8.5	8.0	8.3	17.2	16.4	4.8	9.2	18.3

+ Numbers followed by different letters are significantly different at the 5.0% level of population.

ALFALFA

Table 8 shows the soil pH's, from areas receiving no lime, in the interval 0-12 inches averaged 5.5. At depths of 12-48 inches the soils became more alkaline, ranging from 6.0 up to 8.0.

Vernal alfalfa was seeded in May of 1972. All plots received a broadcast application of 0+46+60 in 1972. In 1973 three cuttings of alfalfa were harvested. Additional fertilizer of 0+45+90 was applied after the first and third cuttings in 1973. Alfalfa yields reported in Table 9 indicate no significant increase with increasing rates of lime. Plant tissue samples collected from each cutting showed no consistent interaction between lime treatments and plant nutrients (Table 10). A slight reduction in the Mn content of the third cutting of alfalfa was indicated. This interaction had been observed in previous lime experiments at Lamberton and Waseca.

Table 8. Average soil pH's at various depths, within the alfalfa areas receiving no lime, Waseca, 1973.

Soil depth	Soil pH	SMP buffer index
inches		
0-6	5.6	6.1
6-12	5.4	6.1
12-18	6.0	-
18-24	6.4	-
24-30	6.7	-
30-36	7.0	-
36-42	7.6	-
42-48	8.0	-

Table 9. Yield of alfalfa, Waseca lime plots, 1973.

Rate of lime	First cutting	Second cutting	Third cutting	Total
tons/A	----------tons/A----------			
0	1.6	1.4	1.4	4.4
2.5	1.8	1.4	1.4	4.6
5.0	1.7	1.4	1.5	4.6
7.5	1.7	1.3	1.4	4.4
10.0	1.7	1.4	1.4	4.5
Significance	N.S.	N.S.	N.S.	N.S.
CV, %	10.2	12.2	7.8	6.0

Table 10. Chemical composition of alfalfa, Waseca lime plots, 1973.

Lime treatment	P	K	Ca	Mg	Zn	Cu	Mn	B	Fe	Al
	------% in dry matter--------				----------ppm in dry matter----------					
					First Cutting					
0	0.32	2.60	1.19	0.21	32.0	6.78	24.4	39.3	134	101.8ab+
2.5	0.31	2.57	1.15	0.21	28.9	5.72	17.8	36.7	142	104.8ab
5.0	0.32	2.49	1.12	0.21	29.2	6.08	17.2	37.4	119	84.2a
7.5	0.32	2.44	1.25	0.22	28.9	6.10	18.9	38.5	158	129.7b
10.0	0.32	2.52	1.13	0.21	29.2	5.47	16.3	36.2	118	84.5a
Significance	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	*
CV, %	4.9	7.1	7.7	6.5	8.0	23.1	32.2	7.3	20.4	24.4
					Second Cutting					
0	0.27a	2.15	1.47	0.27	25.3	7.35	30.6	36.6	109	72.5
2.5	0.28ab	2.12	1.47	0.28	21.8	7.15	24.5	33.6	100	72.8
5.0	0.30c	2.08	1.60	0.29	24.2	8.28	27.4	38.3	160	126.0
7.5	0.30c	1.99	1.55	0.28	23.0	7.78	19.8	36.0	120	91.3
10.0	0.29bc	2.15	1.45	0.27	24.1	7.35	32.1	35.7	108	73.8
Significance	*	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
CV, %	4.5	10.3	7.0	6.5	8.5	12.1	33.8	7.6	34.6	44.0
					Third Cutting					
0	0.31	2.74	1.22	0.24	25.3	5.50	33.9b	33.7	100	86.8
2.5	0.31	2.58	1.23	0.24	22.4	7.08	20.9a	33.2	100	85.5
5.0	0.32	2.76	1.09	0.23	21.6	5.58	19.5a	30.0	95	59.8
7.5	0.31	2.61	1.19	0.24	21.7	5.90	14.7a	31.0	98	96.0
10.0	0.31	2.82	1.12	0.23	23.6	5.03	30.8	30.6	101	58.5
Significance	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	*	N.S.	N.S.	N.S.
CV, %	6.7	8.0	12.7	8.9	8.9	37.2	24.0	11.1	14.7	46.4

+ Numbers followed by different letters are significantly different at the 5% level of population.

SULFUR NEEDS IN SOUTHERN MINNESOTA

D.S. Fairchild and G.W. Randall

Interest in sulfur as a plant nutrient has increased markedly over the past few years and reports of sulfur deficiencies are rising. Concern over these deficiencies may in part be due to: (1) increased use of high-analysis, sulfur-free fertilizers, (2) increased crop yields, (3) decreased atmospheric sulfur, and (4) decreased use of sulfur in fungicides and insecticides.

In the spring of 1972, a study was initiated to determine whether or not additions of sulfur to starter fertilizer would affect early plant and yield of corn. The experiment was located at the Waseca Experiment Station on a Cordova silty clay loam. The initial soil test indicated 14 ppm of extractable sulfur. The following sulfur treatments were applied in the spring of 1972 and 1973:

1. no sulfur
2. 5 lbs/A sulfur with starter
3. 15 lbs/A sulfur with starter
4. 15 lbs/A sulfur as broadcast

Potassium sulfate was used as the sulfur source.

As shown in Table 1, no significant increases in small plant weights or yields resulted from varying sulfur treatments in 1972 or 1973. Corn yields were excellent in both years, ranging from 155-171 bushels per acre.

Table 1. Sulfur treatments and corresponding small plant weights and corn yields at Waseca in 1972 and 1973.

Fertilizer Treatment	Small Plant Weights		Yields	
	1972	1973	1972	1973
lbs S/A	------ gms ------		------Bu/A ------	
0	105	99	156	171
5 (starter)	106	93	161	169
15 (starter)	104	95	155	158
15 (broacast)	96	99	166	163
significance	N.S.	N.S.	N.S.	N.S.

Total nitrogen of the corn grain was determined in 1972 and 1973 in order to study the effects of sulfur on the crude protein content of the grain. Crude protein was calculated by multiplying the total nitrogen by 6.25. No significant change in crude protein was noted with varying sulfur treatments in 1972 (Table 2).

In 1973 crude protein in the corn grain ranged from 9.00 - 10.1 percent. A significant reduction in the crude protein content was noted with 15 lbs/A of sulfur with the starter fertilizer. This same sulfur treatment resulted in the lowest yields and crude protein in both 1972 and 1973.

Table 2. The effect of sulfur fertilizer treatments on the crude protein content of corn grain grown at Waseca in 1972 and 1973.

Fertilizer Treatment	Crude Protein 1972	Crude Protein 1973
lbs S/A	----- % -------	
0	9.11	9.83 b*
5 (starter)	9.27	9.90 b
15 (starter)	8.94	9.00 a
15 (broadcast)	8.97	10.10 b
significance	N.S.	*

*Numbers followed by the same letter are not significantly different at the 5.0% level of significance.

Table 3 indicates that only 6-7 pounds S/A of sulfur was removed in the corn grain when yields ranged from 155-166 bushels per acre. These relatively small amounts of sulfur removal could be adequately supplied from existing free and adsorbed sulfates, atmospheric sulfur and mineralization of organic matter.

Table 3. Amounts of sulfur removed per acre in corn grain with varying sulfur treatments at Waseca in 1972.

Fertilizer Treatment	Sulfur Removed
lbs. S/A	lbs S/A
0	6.6
5	6.9
15 (starter)	6.6
15 (broadcast)	7.1

Conclusions

1. Two years of research showed no yield increases with varying rates or placement of sulfur fertilizer.

2. No increases in early plant growth were noted with sulfur applied as a starter fertilizer.

3. Amounts of sulfur removed in the corn grain were relatively small although corn yields ranged from 155-171 bushels per acre.

NITROGEN SOURCE COMPARISON WITH KENTUCKY BLUEGRASS

John Grava and D.S. Fairchild

A field experiment was conducted on a loam soil on the Helmstetter Bros. farm, Lake of the Woods county to study effects of two N sources on the seed yield and N concentration in tissue of Park Kentucky bluegrass. Urea (46-0-0) and ammonium nitrate (34-0-0) were applied at two rates: 40 and 100 lbs/acre of N. All plots received 0+40+40 lbs/acre of P_2O_5 and K_2O. Nitrogen treatments were made on September 15, 1972 and on April 25, 1973. Treatments were replicated four times. The nitrate-N in the upper two feet of soil, on September 20, 1972 was five lbs/acre, considered to be very low.

Bluegrass seed yields were affected to the same degree by ammonium nitrate and urea (Table 1). Higher yields and N concentration in tissue resulted from 100 lbs/acre rate compared to 40 pounds rate. Fall applications of N resulted in higher seed yield, but spring applications caused hgiher N concentrations in tissue.

Table 1. Effects of Nitrogen source, rate and time of application on seed yield and N concentration in tissue of Park Kentucky Bluegrass (Helmstetter Bros., Lake of the Woods Co. 1973).

Treatment	Seed Yields lbs/acre	N Percent In Dry Matter
(a) Source		
Urea	184	1.93
Ammonium nitrate	182	2.04
Significance	NS	NS
(b) Rate		
40 lbs/Acre N	151 a	1.67 a
100 lbs/Acre N	215 b	2.30 b
Significance	**	**
(c) Date		
Sept. 15	199 b	1.72 a
Apr. 25	167 a	2.25 b
Significance	*	**

Table 1. (con't.)

Treatment	Seed Yields lbs/acre	N Percent In Dry Matter
(d) Interaction		
40 lbs/Acre N - Urea	141	1.69 a
- Ammonium nitrate	161	1.65 a
100 lbs/Acre N- Urea	227	2.18 b
- Ammonium nitrate	202	2.42 b
Significance	NS	*

NITROGEN RATE STUDY WITH PARK KENTUCKY BLUEGRASS ON PEAT

John Grava and D.S. Fairchild

A field experiment was conducted on the Charles Habstritt farm, Roseau county to study the effect of different rates of N on seed yield of Park Kentucky bluegrass. This was done in response to inquiries by growers and others. Previous experimental work had indicated that N rates of 20 or 30 pounds may cause severe lodging of bluegrass. Present recommendations call for 15 lbs/acre of N to K bluegrass on peat.

The experiment consisted of seven treatments replicated six times. The P and K were supplied with 0-25-25 grade of fertilizer and ammonium nitrate (34-0-0) was used as the N source. The fertilizer treatments were made on Sept. 21, 1971 and Sept. 19, 1972.

Fertilization, as shown in Table 1, had no effect on the seed yield of Park Kentucky bluegrass.

Table 1. Effect of fertilization on the seed yield of Park Kentucky bluegrass* on peat (Ch. Habstritt, Roseau), 1972 and 1973.

Treatment N P_2O_5 K_2O	Seed Yield 1972	1973
lbs/acre	-----lbs/acre------	
Check	347	218
0 + 40 + 40	386	233
10 + 40 + 40	337	207
20 + 40 + 40	342	227
30 + 40 + 40	351	259
40 + 40 + 40	362	220
80 + 40 + 40	391	267
Significance	NS	NS
Cv, %	22	18

* 1970 seeding.

FOREST SOILS

MASS AND NUTRIENT DYNAMICS OF SHRUB SPECIES IN NORTHEASTERN MINNESOTA

D.F. Grigal

Two years ago, we reported on the initiation of a study of shrub dynamics in northeastern Minnesota[1]. We have nearly completed our investigations, including statistical analyses, of the temporal changes in mass and nutrient concentration of the shrubs. Nine individuals of each of five species of shrubs; Acer spicatum, Alnus crispa, Amelanchier sp, Corylus cornuta, and Salix sp; were destructively sampled at biweekly intervals from the period of leaf emergence through early December. Mass of leaves, current annual twig growth, last years' twig growth, flowers and fruits, and stem were determined for each individual. In addition, nutrient concentration of the samples was determined.

Because of the relatively small number of samples at each time period, the average mass of individual components was highly variable. In spite of this variability, a common trend in mass change over time was detected for all species. Total leaf mass generally increased to a midsummer peak and then decreased to the time of leaffall. Current annual twig mass increased until about September, declined through October, and then increased through the remainder of the sampling period. Last years' twig mass showed a continual increase with time. Stem mass, however, showed a decline in July, an increase to September, another decrease through mid-October, and finally an increase to the end of the sampling period. These changes are probably related to redistribution of mass within the plant, reflecting the dynamic nature of the shrubs.

When nutrient concentrations are considered, some nutrients behave similarly in a given component over all species, while others behave differently in almost every species. All species, for example, show a decline in nitrogen concentration of leaves over the sampling period, and an increase in N concentration in current annual twigs immediately following leaffall. In contrast to this constant behavior, Mg concentration in Alnus and Corylus leaves drops and then rises before leaffall; the concentration continually drops in Amelanchier leaves; and it rises linearly in Salix leaves and exponentially in Acer leaves.

When mass of individual components is considered along with nutrient concentration, a slightly different picture emerges. The total N mass in shrub leaves, for example, rises to a peak in late July and then begins to decline to leaffall. In current annual twigs, the N content remains constant until mid-November when it begins to rise. Magnesium content of leaves of all species increases to a peak and then decreases before leaffall. All these data serve to quantify the dynamic nature of shrub species. In addition, they highlight the point that nutrients are cycling not only through ecosystems but also within individuals which comprise the ecosystem.

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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.

EFFECT ON NITROGEN, PHOSPHORUS AND POTASSIUM FERTILIZERS ON NAVY AND PINTO BEAN YIELDS

D.S. Fairchild, G.E. Ham, P.J. Maker, M.J. Wiens, and A.C. Caldwell

Rates of nitrogen, phosphorus and potassium fertilizers were broadcast on the surface and incorporated in the spring before planting. Row fertilizer treatments (with and without) were superimposed on the plots at planting time. Broadcast fertilizer rates were as follows (lbs/acre): N = 0, 30, 60 and 90; P = 15, 30 and 45; K = 0, 100, 200 and 400. Navy beans were grown at Olivia and Staples while pinto beans were grown at Hector.

Bean yields were increased with nitrogen fertilizer at Hector and Staples but not at Olivia. The nitrate-nitrogen soil test value was over 100 at Olivia which may explain the lack of response to nitrogen. Phosphorus fertilizers did not increase seed yield at any location. Potassium fertilizer increased yields at Olivia but not at the other locations.

Table 1. Soil test information and fertilizer treatments for 1973.

	Hector	Olivia	Staples
pH	6.0	8.0	6.2
P (lbs/acre)	27	8	62
K (lbs/acre)	280	300	320
NO_3-N (lbs/acre)	72	117	
Zn (ppm)	10	2.4	3.0
S (ppm)	20	22	7

Side dress treatment:

analysis	($N-P_2O_5-K_2O$)	8-32-16	7-28-28	8-32-16
rate	(lbs/acre)	125	125	125

All plots received 60 N, 68 P_2O_5, 120 K_2O, 205 and 10 Zn (lbs/acre) unless the element was varied in the study.

Table 2. Effect of nitrogen, phosphorus and potassium fertilizers on navy and pinto beans.

Broadcast fertilizer rate	Hector Pinto beans		Olivia Navy beans		Staples Navy beans	
Nitrogen	No starter	Starter	No starter	Starter	No starter	Starter
lbs/acre	lbs/acre					
0	2613	2665	2798	2919	1007	1215
30	2844	3079*	2608	2875	1359*	1393*
60	3015*	3046*	3088	2834	1598*	1562*
90	3189*	3624*	2884	3038	1974*	1849*
Phosphorus						
lbs/acre						
0	3275	3114	2970	2725	1306	1560
15	3277	3256	2910	3067	1499	1623
30	3211	3167	3040	2917	1495	1492
45	3013	3590	2984	3178	1308	1534
Potassium						
lbs/acre						
0	2885	3231	3013	3030	1285	1339
100	3029	3225	3048	3186*	1164	1486
200	2836	3111	3058	3314*	1242	1307
400	2716	2764	2761*	2956	1071	1160

* Yield significantly different from check yield.

LIME PLOTS, DAKOTA COUNTY, 1973[1]

J. Grava, C.J. Overdahl, D.S. Fairchild, B.D. McCaslin

A field experiment was established in spring of 1971 on the Earl Almquist farm in Dakota County to study the effects of liming on yield and chemical composition of crops, and chemical properties under irrigation.

Corn was grown in 1971. Neither yields nor the chemical composition of corn were affected by lime treatments.

In 1972, Corsoy soybeans were grown. No fertilizer was applied to soybeans. The field was not irrigated in 1972 because of sufficient rainfall. Treflan was sprayed at the rate of two quarts per acre. Liming had no effect on soybean yield. The manganese concentration in trifoliate was lowered by the lime treatments. The contents of macro elements in soybean tissues were not affected by liming.

Soil samples were collected in October of 1973, 2.5 years after application of lime treatments. Table 1 indicates that 5 and 10 tons of lime per acre raised the soil pH from 6.2 to 6.6 in the 0-6 inch depth. Areas receiving 2.5 tons lime per acre had the same surface soil pH of 6.2 as the untreated area. Soil pH's of 5.5, 5.8, 6.0 and 6.1 are indicated at the 6-12" depth with 0, 2.5, 5 and 10 tons of lime per acre, respectively.

Table 1. Soil test results, 1973.

Lime treatment	Depth of sampling	pH	SMP buffer index	Extract-able P	Exchange-able K
tons/A	inches			------lbs/A--------	
0	0-6	6.2	--	83	330
	6-12	5.5	6.4	32	190
	12-18	5.5	6.6	7	80
	18-24	5.6	6.9	9	60
2.5	0-6	6.2	--	87	300
	6-12	5.8	6.5	53	200
	12-18	5.5	6.6	6	90
	18-24	5.6	7.0	8	60
5	0-6	6.6	--	57	200
	6-12	6.0	--	20	150
	12-18	5.7	6.8	7	60
	18-24	5.8	7.1	9	40
10	0-6	6.6	--	79	300
	6-12	6.1	--	32	190
	12-18	5.6	6.6	6	80
	18-24	5.7	6.9	9	60

1/ See "A Report on Field Research in Soils", Soil Series 88, March 1972, pp. 196-197; Soil Series 89, March 1973, pp. 200-202 for results obtained in previous years.

Table 2 shows no interaction between lime treatments and the concentration of N, P, K, Ca, Mg, Al, Fe, Zn, Cu, Mn and B in the sixth leaf of corn.

No yield measurements were taken at this site in 1973.

Table 2. Chemical Composition of sixth corn leaf at tasseling, Earl Almquist's farm, Dakota County, 1973.

Lime treatment	N	P	K	Ca	Mg	Zn	Cu	Mn	B	Fe	Al
tons/acre	----------% in dry matter---------					----------ppm in dry matter----------					
0	3.43	0.34	2.54	0.51	0.29	16.1	11.8	78.3	2.60	246	87.5
2.5	3.39	0.36	2.49	0.46	0.31	16.1	11.8	57.9	3.15	267	114.0
5.0	3.27	0.35	2.41	0.50	0.35	15.2	10.8	57.2	4.25	244	81.5
10.0	3.38	0.34	2.57	0.44	0.30	15.0	10.9	49.4	3.40	235	80.0
Significance	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
CV, %	3.2	6.3	4.9	10.5	9.7	5.2	5.7	11.6	12.1	10.3	30.4

PASTURE FERTILIZATION AND WEED CONTROL TRIALS
RED RIVER BASIN - 1972

C. A. Simkins, Oliver Strand, Robert Schoper and Marlin Johnson

Fertilizer and weed control trials initiated on pastures in the Red River Basin of Minnesota in 1971 were continued in 1972. The treatments used were as follows:

	Lbs/Acre N	P_2O_5	K_2O	
1.	0	0	0	
2.	0	0	0	weed control
3.	30	15	15	
4.	30	15	15	weed control
5.	150	50	50	
6.	150	50	50	weed control
7.	100	0	0	
8.	100	0	0	weed control

The weed control consisted of 1 lb. 2-4-D per acre sprayed after broadleaf weeds started to appear. Treatments 5 and 6 consisted of 100 lbs. of nitrogen per acre in the spring and 50 lbs. of nitrogen per acre after first cutting.

A summary of the yields as determined by hay cuttings, and protein as determined by Kjeldahl method, are shown in the following tables.

Location - Norman County - Cooperator: Gill Bros.
Species - Bluegrass
Soil Type - Borup
Soil Test - pH 8.0; phosphorus 23 lbs/A; potassium 280 lbs/A

Treatment lbs/acre	N	P_2O_5	K_2O	Tons Hay/Acre and Percent Protein: 1st Cutting hay	1st Cutting protein %	2nd Cutting hay	2nd Cutting protein %	Tons hay/acre Total
1.	0	0	0	.22	11.7	.46	12.1	.68
2.	0	0	0	.34	12.7	.48	11.7	.72
	(weed control)							
3.	30	15	15	.30		.64		.94
4.	30	15	15	.52		1.02		1.54
	(weed control)							
5.	150	50	50	.89		.78		1.67
6.	150	50	50	1.11	17.6	.96	15.7	2.07
	(weed control)							
7.	100	0	0	.69		.75		1.44
8.	100	0	0	1.07		1.31		2.38
	(weed control)							

2) Location - Norman County - Cooperator: Gill Bros.
Species - Bluegrass and quackgrass
Soil Type - Borup
Soil Test - pH 8.4; phosphorus 4 lbs/A; potassium 60 lbs/A

	Tons Hay/Acre and Percent Protein						
	1st Cutting		2nd Cutting		3rd Cutting		Total
Treatment	hay	protein %	hay	protein %	hay	protein %	Tons Hay/A
1	.26	10.2	.45	12.2	.42	13.6	1.13
2	.22	11.6	.65	9.1	.47	13.6	1.34
3	.45		.65		.52		1.62
4	.46		.78		.37		1.61
5	1.46		1.23		.54		3.23
6	1.40	14.6	1.45	14.1	.96	14.3	3.81
7	.25		.45		.52		1.32
8	.35		.43		.30		.98

SUMMARY - GILL BROS.

1. Protein increased 1-4 percent for 100 lbs. nitrogen application.

2. Bluegrass plus quack produced higher yields than nearly straight bluegrass.

3. 30-15-15 produced .3-.5 ton increase in yield.

4. 150-50-50 produced 2.0 ton increase in yield.

5. 30-15-15 had little effect after first cutting.

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3) Location - Marshall County - Cooperator: Prestebak
Species - Bluegrass, quack
Soil Type - Kratka
Soil Test - pH 7.7; phosphorus 7 lbs/A; potassium 300 lbs/A

	Tons Hay/Acre and Percent Protein				
	1st Cutting		2nd Cutting		Total
Treatment	hay	protein %	hay	protein %	Tons Hay/A
1	.31	10.5	.16	16.3	.47
2	.35	12.3	.22	14.3	.57
3	.94		.46		1.40
4	.48		.22		.70
5	1.72		.96		2.68
6	1.68	12.9	.96	12.1	2.64
7	.58		.28		.86
8	.69		.38		1.07