Treatment	N	P_2O_5	K_2O
	lbs/acre		
A	Check		
B	0	40	40
C	20	10	10
D	40	20	20
E	60	30	30
F	80	40	40
G	100	50	50
H	120	60	60
I	80	40	40 plus Cu, Mn, Zn

Table 1. Location, soil type and other information concerning the experiments.

Field No.	Location	Soil Type	Species Variety	Age of Stand	Burned
1	Roy Kveen Roseau County	Bearden Sil	Timothy Lorain	1969 Seeding	Post-Harvest
2	Ernest Brandli Roseau County	Glyndon Fsl	Timothy Erecta	1968 Seeding	Spring 1972
3	Leonard Johnson Roseau County	Unnamed SL	K. Bluegrass Primo	1969 Seeding	Post-Harvest

The nutrients for Treatment B were supplied with 0-25-25 grade of fertilizer, while Treatments C to I received various rates of 20-10-10 fertilizer. Fertilizer materials were top-dressed with a Gandy spreader on September 21, 1971. Trace elements Cu, Mn and Zn for Treatment I (50 lbs/acre of Cu-, Mn-, Zn- sulfate) had been applied in spring of 1971.

Plant tissue samples were collected at the beginning of emergence of heads or panicles. Total nitrogen in tissue was determined by the Micro-Kjeldahl Method, and the other elements were determined

in a multi-element emission spectrophotometer. Two square-yard samples were harvested from each plot to measure seed yields.

Seed yields and the chemical composition of tissue are reported in Table 2.

Table 2. Effect of fertilization on the seed yield of timothy and K. bluegrass, 1972.

Treatment N P_2O_5 K_2O	Field 1 Lorain Timothy	Field 2 Erecta Timothy	Field 3 Primo K. Bluegrass
lbs/acre	yield of seed, lbs/acre		
Check	130 a[1]	73 a	182 a
0 + 40 + 40	160 b	59 a	297 b
20 + 10 + 10	162 b	95 b	292 b
40 + 20 + 20	257 c	171 d	374 bc
60 + 30 + 30	278 d	138 c	463 cd
80 + 40 + 40	300 e	193 e	605 e
100 + 50 + 50	403 g	264 f	613 e
120 + 60 + 60	268 cd	187 de	617 e
80 + 40 + 40 + Trace Elements	340 f	205 e	519 de
Significance	**	**	**
C.V.%	23	45	13

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

Lorain timothy seed yields on a Bearden silt loam were increased by the various fertilizer rates. The highest yield of 403 lbs/acre was produced with the 100 + 50 + 50 fertilizer treatment, compared to 130 lbs/acre from the check plots. A yield depression resulted from the 120 + 60 + 60 treatment. The addition of trace elements, Cu, Mn, Zn, to the 80 + 40 + 40 treatment increased the seed yield by 40 pounds per acre.

It should be noted that the highest seed yield on this field in 1971 was also produced with the 100 + 50 + 50 treatment, and Treatment I (80 + 40 + 40 plus trace elements) increased yield by 89 pounds per acre.

Fertilization increased K concentration of grass tissue only slightly (Table 3) but had no effect on the P content. Trace elements, applied in spring of 1971, had no effect on Cu, Mn, Zn contents in tissue.

Erecta timothy on Glyndon fine sandy loam produced lower seed yields than those of Lorain timothy. Check plots yielded only 73 lbs/acre, while the highest yield of 264 lbs/acre was produced with the 100 + 50 + 50 fertilizer rate. Seed yield was depressed by 77 lbs/acre with the 120 + 60 + 60 treatment. The application of trace elements had no effect on seed yield.

Fertilization increased P content in tissue of Erecta timothy but had no effect on K concentration (Table 4). Zinc and Cu contents were increased by applications made in spring of 1971.

Primo Kentucky Bluegrass on a sandy loam showed spectacular yield increases from fertilization. The seed yield was increased from 182 lbs/acre without fertilizer to a maximum yield of 605 lbs/acre with the 80 + 40 + 40 treatment. The higher rates of fertilizer had no effect on seed yields. Trace element applications did not affect the seed yield of Primo K. bluegrass.

Phosphorus content (Table 5) of Primo K. bluegrass tissue from

check plots was only 0.10%. It was raised to 0.23% P by an application of 40 lbs/acre of P_2O_5. The soil tests indicated low P availability. Fertilization also increased K concentration in tissue from 1.29% (check) to 1.72% K with 30 lbs/acre K_2O. A carry-over effect of Zn and Cu was indicated by higher concentrations of these two trace elements in grass tissue.

A fourth fertilization trial of this type had been established with S-50 Timothy on Y. Magnusson farm near Roseau in fall of 1971. A very poor seed set was obtained. Seed yield varied from 16 to 72 pounds per acre. Fertilization did not improve seed yield of this variety.

Table 3. Effect of fertilization on chemical composition of Lorain timothy tissue, Roy Kveen, Roseau County, 1972.

Treatment	P	K	Ca	Mg	B	Cu	Mn	Zn	Al	Fe
	------ percent in dry matter ------				---- parts per million in dry matter ----------					
None	.27	1.95ab	.15	.21b	7	4.0ab	26c	24	13	33
0 + 40 + 40	.28	1.99abc	.15	.21b	7	3.7a	23bc	22	14	42
20 + 10 + 10	.28	1.98abc	.17	.22c	7	4.1ab	24bc	23	18	39
40 + 20 + 20	.26	1.93ab	.17	.20a	7	4.3abc	19a	22	5	27
60 + 30 + 30	.24	1.99abc	.17	.20a	5	3.8ab	18a	20	6	33
80 + 40 + 40	.25	1.83a	.17	.21b	6	4.5abc	18a	21	4	27
100 + 50 + 50	.25	2.05bc	.18	.24d	6	4.6bc	19a	19	6	33
120 + 60 + 60	.28	2.18c	.20	.29e	5	5.1c	21ab	20	10	43
80 + 40 + 40 + Trace Elements	.24	2.04bc	.17	.22c	5	5.0c	20a	22	7	47
Significance	NS	*	NS	**	NS	*	**	NS	NS	NS
C.V.,%	9	6	13	12	19	13	15	11	86	50

Table 4. Effect of fertilization on chemical composition Erecta timothy tissue, Ernest Brandli, Roseau County, 1972.

Treatment	P	K	Ca	Mg	B	Cu	Mn	Zn	Al	Fe
	----- percent in dry matter --------				---------- parts per million in dry matter -----					
None	.25a	2.05	.29abc	.17ab	9bc	5.0a	16a	20a	19	40
0 + 40 + 40	.29b	2.05	.30abcd	.16ab	10c	5.5a	25bc	20a	18	41
20 + 10 + 10	.26a	2.01	.29abc	.15a	10c	4.8a	21ab	20a	20	41
40 + 20 + 20	.29b	2.08	.27a	.17ab	9bc	5.1a	25bc	27ab	15	39
60 + 30 + 30	.31bc	2.17	.29abc	.17ab	8a	5.4a	29cd	20a	21	48
80 + 40 + 40	.30bc	2.15	.33bcd	.17ab	8a	5.0a	32de	21a	17	44
100 + 50 + 50	.31bc	2.21	.34cd	.19bc	9bc	4.9a	34de	25a	18	49
120 + 60 + 60	.32c	2.18	.34cd	.21c	8a	5.5a	36e	23a	20	53
80 + 40 + 40 + Trace Elements	.30bc	2.14	.35d	.18bc	8a	7.3b	34de	32b	24	54
Significance	**	NS	*	**	*	**	**	**	NS	NS
C.V.,%	5	5	11	10	14	15	16	20	37	16

Table 5. Effect of fertilization on chemical composition of Primo Kentucky Bluegrass tissue, Leonard Johnson, Roseau County, 1972.

Treatment	P	K	Ca	Mg	B	Cu	Mn	Zn	Al	Fe
	-----percent in dry matter --------				-------- parts per million in dry matter -------					
None	.10a	1.29a	.19a	.12a	5	4.1a	30	15ab	18	43
0 + 40 + 40	.23e	1.58bc	.24ab	.14abc	5	4.2a	24	14a	22	50
20 + 10 + 10	.14b	1.46b	.21ab	.13ab	5	4.0a	25	16ab	19	42
40 + 20 + 20	.16b	1.54b	.23ab	.13abc	5	4.0a	25	16ab	17	39
60 + 30 + 30	.19c	1.72cd	.28bc	.15bc	4	4.1a	23	16ab	18	40
80 + 40 + 40	.19c	1.74cd	.29bc	.15bc	4	4.0a	26	15ab	24	53
100 + 50 + 50	.20cd	1.83d	.36cd	.18de	5	4.0a	22	18b	23	54
120 + 60 + 60	.22de	1.90d	.38d	.19e	4	4.1a	22	17b	23	55
80 + 40 + 40 + Trace Elements	.20cd	1.76cd	.26ab	.15bc	4	6.3b	22	21c	16	46
Significance	**	**	**	**	NS	**	NS	**	NS	NS
C.V.,%	7	7	19	11	15	14	15	9	32	22

NITROGEN RATE STUDY WITH PARK KENTUCKY BLUEGRASS ON PEAT-1972

John Grava, D. S. Fairchild, B. D. McCaslin and R. S. Farnham

A field experiment was conducted on the Charles Habstritt farm, Roseau County to study the effect of different rates of N on seed yields of Park K. 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 (33-0-0) was used as the N source. The fertilizer treatments were made on Sept. 21, 1971.

Soil test results are given in Table 1.

Fertilization, as shown in Table 2, had no effect on the seed yield of Park K. bluegrass.

Table 1. Soil Test Results.

Depth of Sampling inches	pH	Extractable P pp2m	Exchangeable K pp2m
0-3	6.5	4	35
3-6	6.8	5	15
6-12	6.4	7	10

Table 2. Effect of fertilization on the seed yield of Park K. bluegrass* on peat (Ch. Habstritt, Roseau), 1972.

Treatment N P_2O_5 K_2O lbs/acre	Seed Yield lbs/acre
Check	347
0 + 40 + 40	386
10 + 40 + 40	337
20 + 40 + 40	342
30 + 40 + 40	351
40 + 40 + 40	362
80 + 40 + 40	391
Significance	NS
C.V., %	22

* 1970 seeding.

Table 3. Effect of fertilization on chemical composition of Park Kentucky bluegrass tissue, Ch. Habstritt, Roseau County, 1972.

Treatment	P	K	Ca	Mg	B	Cu	Mn	Zn	Al	Fe
	----- percent in dry matter -------				--------- parts per million in dry matter --------					
None	.16a	1.39a	.16ab	.15ab	3	<0.5	22	20	9ab	38abc
0 + 40 + 40	.23b	1.53b	.15a	.14a	3	<0.5	20	18	7a	31a
10 + 40 + 40	.23b	1.53b	.17abc	.15ab	3	<0.5	19	19	9ab	33ab
20 + 40 + 40	.22b	1.53b	.17abc	.15ab	3	<0.5	19	18	11abc	38abc
30 + 40 + 40	.23b	1.56bc	.19bcd	.16bc	3	<0.5	20	19	12abc	38abc
40 + 40 + 40	.23b	1.67c	.19bcd	.17c	3	<0.5	21	19	15c	42cd
80 + 40 + 40	.23b	1.63bc	.20d	.19d	4	<0.5	20	19	14bc	47d
Significance	**	**	**	**	NS	--	NS	NS	*	**
C.V.%	6	5	11	8	18	--	15	8	40	15

THE EFFECT OF NITROGEN FERTILIZATION ON SEED YIELD AND CHEMICAL COMPOSITION OF GRASSES WHEN APPLIED ALONE OR WITH PHOSPHORUS AND POTASSIUM-1972[1]

John Grava, D. S. Fairchild, B. D. McCaslin and R. S. Farnham

Most grass seed production fields in northwestern Minnesota receive annual applications of commercial fertilizers. Nitrogen, when used at rates of 90 pounds per acre or less, seems to be used up during the growing season and no carry-over effects are evident in the following crop. However, there is some phosphorus and potassium carry-over from topdressed fertilizer as shown by the relatively high P and K soil test levels of the top three inches of soil.

The objective of this study was to find out whether nitrogen alone would insure high seed yields on soils in which P and K levels have been built up by past fertilization.

In 1970 two field experiments were established in Lake of the Woods County. General information on the experimental sites is given in Table 1.

Table 1. Location, soil type, age of stand and other information concerning the experiments.

Location	Soil Type	Species Variety	Age of Stand	Burned
F. Baade L.O.W. County	Ulen VFSL	Timothy Climax	6th Seed Year	Spring 1972
Helmstetter Bros. L.O.W. County	Spooner VFSL	K. Bluegrass, Park	1967 Plow- Back	Post-Har- vest Burn

[1] See "A Report on Field Research in Soils", Soil Series 87, March 1971, pp. 116-119, and Soil Series 88, March 1972, pp. 170-173 for results obtained from similar investigations conducted in 1970 and 1971.

A randomized block design was used with six treatments replicated seven times. Individual plots were 10 feet wide and 20 feet long. Ammonium nitrate (33-0-0) was used as the N source, and P K were supplied with 0-25-25 fertilized. The fertilizer treatments were made with a Gandy spreader on September 20, 1971. Plant tissue samples were collected at the emergence of heads or panicles. Total nitrogen in tissue has not been determined as yet. Other nutrient elements were determined in a multi-element emission spectrophotometer. Two-square yard samples were cut from each plot at harvest time for the measurement of seed yield.

Seed yields and the P and K concentrations in tissue of grasses are reported in Tables 2 and 3.

Climax Timothy (F. Baade)

1970 - The seed yield of timothy was increased significantly by increasing the N rate from 60 to 120 lb/A (spring application). The N content of tissue from 90 lb/A treatment was significantly higher than that in tissue from the 60 lb/A N treatment. While the 0 + 40 + 40 fertilizer treatment did not affect the seed yield, it did increase the P and K concentration in tissue.

1971 - The seed yield was increased by increasing the N rate from 60 to 90 lb/A. Increasing the N rate to 120 lb/A did not result in higher seed yield. The N content of tissue from 120 lb/A treatment was significantly higher than N in tissue from the two lower N rates. The 0 + 40 + 40 fertilizer treatment increased the P and K contents of tissue but had no effect on the seed yield of Climax timothy.

1972 - Sixty pounds of N produced nearly 300 lb/A of seed (Table 2). Increasing the N rate to 90 or 120 lb/A did not result in higher seed yields.

The third year in a row, the only measured effects obtained from the P K treatment were the increased contents of these two elements in

grass tissue (Table 2).

Park Kentucky Bluegrass (Helmstetter Bros.)

1970 - The seed yield, and the N and P contents of bluegrass tissue were increased by increasing the N rate from 60 to 120 lbs/A. The only effect the 0 + 40 + 40 treatment had was an increase in P content of tissue.

1971 - The seed yield, and the N and P contents of bluegrass tissue were increased by increasing the N rate from 60 to 120 lbs/A, same as in 1970. The 0 + 40 + 40 treatment increased the P and K contents of tissue but had no effect on seed yield.

1972 - About 230 pounds of bluegrass seed per acre were produced with 60 lbs/A of N on this field (Table 3). Neither the higher N rates nor the addition of P K fertilizer had any effect on seed yield. There was some lodging observed prior to harvest time on the 90 + 40 + 40 and 20 + 40 + 40 treatment plots. This would indicate that the vegetative growth of bluegrass was somewhat stimulated by the addition of P and K.

Phosphorus and potassium contents of grass tissue were significantly increased by the 0 + 40 + 40 treatment (Table 3). The concentrations of these two nutrient elements in tissue were lowered by the use of higher N rates.

Changes in Soil Test Results

Soil samples were collected from these plots in fall of 1972 to determine to what extent test values have been affected by fertilization. The results are reported in Tables 4 and 5.

Changes in P and K test levels due to +PK and + PK (0 + 40 + 40) treatment occurred mainly in the top 3-inches of soil. Under timothy (Table 4), P availability had been decreased from a high level (24 lb/A) to a low of 6 lb/A by withholding P and K for three years. On the other hand, the high P test level had been maintained in this

soil through annual applications of 0 + 40 + 40. This treatment also increased the exchangeable K content slightly compared to test results obtained three years ago.

Under K. bluegrass, phosphorus availability in top 0-3 and 3-6 inches was very high at the beginning of the experiment (Table 5). The P test level in the top 3 inches was decreased from 72 to 41 pp2m during the three years of seed production with fertilization with N alone. An annual application of 0 + 40 + 40 increased the P soil test to 97 pp2m. Exchangeable K content was maintained at the original level with the application of 0 + 40 + 40, while the -PK treatment resulted in a decreased K test level.

Table 2. The effect of nitrogen fertilization when applied alone or with phosphorus and potassium on seed yield and chemical composition of Climax timothy, F. Baade, L. O. W. County.

Treatment	Yield of Seed	P	K
lbs/acre	lbs/acre	percent in dry matter	
N			
60	294	.28	1.96
90	374	.29	2.02
120	399	.30	2.00
Significance	NS	NS	NS
PK			
None	361	.26 a	1.90 a
0 + 40 + 40	350	.32 b	2.08 b
Significance	NS	**	**

Table 3. The effect of nitrogen fertilization when applied alone or with phosphorus and potassium on seed yield and chemical composition of Park Kentucky bluegrass, Helmstetter Bros., L. O. W. County.

Treatment	Yield of Seed	P	K
lbs/acre	lbs/acre	percent in dry matter	
N			
60	229	.240 b	1.49 b
90	232	.224 ab	1.43 ab
120	230	.219 a	1.36 a
Significance	NS	**	*
PK			
None	217	.210 a	1.20 a
0 + 40 + 40	243	.240 b	1.65 b
Significance	NS	**	**

Table 4. Soil test results (F. Baade).

Depth of Sampling inches	Extractable P pp2m Spring '70	Oct. '72 -PK	Oct. '72 +PK	Exchangeable K pp2m Spring '70	Oct '72 -PK	Oct. '72 +PK
0-3	24	6	27	90	90	150
3-6	6	4	5	60	50	50
6-12	6	3	2	50	30	40

Table 5. Soil test results (Helmstetter Bros.)

Depth of Sampling inches	Extractable P pp2m Spring '70	Oct. '72 -PK	Oct. '72 +PK	Exchangeable K pp2m Spring '70	Oct. '72 -PK	Oct. '72 +PK
0-3	72	41	97	130	60	120
3-6	50	30	37	90	40	50
6-12	10	9	9	70	40	40

CLASSIFICATION OF NATURAL COMMUNITIES

David Grigal

As outlined in last year's report[1], in a cooperative project with personnel on the staff of the North Central Forest Experiment Station, U.S. Forest Service, we have used multivariate techniques including numerical classification, canonical analysis, and discriminant functions to describe and classify forest vegetation in the Boundary Waters Canoe Area (BWCA), northeastern Minnesota. The analysis was based on data collected in 106 natural or "virgin" forest stands and in 68 stands which had been logged 40 to 70 years ago. The data used were frequency-of-occurrence of 53 species common in the area. The major upland plant community-types of the BWCA, identified by the analysis include a lichen type, jack pine-oak type, red pine type, jack pine-black spruce type, jack pine-fir type, black spruce-feather moss type, maple-oak type, aspen-birch type, aspen-birch-white pine type, maple-aspen-birch type, maple-aspen-birch-fir type, and white cedar type. Each of these types is based on a complex of the 53 species, though the name may incorrectly imply one or two dominant overstory species are indicative of the type. A report is currently being prepared in which the composition of each type is described in detail. In addition, the report will contain a series of linear transforms which can be used to ascertain the status, in relation to these types, of a newly sampled forest stand or group of stands from in or near the BWCA. Either or both a discriminant

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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.

function and the position in canonical space can be calculated with these transforms.

The major successional trends in the area, without disturbance, lead to fir-birch and ultimately to the white cedar community-type. White-tailed deer may have had an impact on restricting the occurrence and reproduction of the white-cedar type. The major natural agent of disturbance in the area is fire. Because each fire and its subsequent effects are unique, few generalizations can be made concerning its effect on vegetation. Important factors to be considered are season and severity of burn, seed source, post-fire weather, etc. Logging, too, has a spectrum of effects related to the species logged, logging intensity, and post-logging treatment. In general, however, logging in the BWCA appears to have had little effect on the abundance of the most common forest species, but has increased the prevalence of broadleaf types at the expense of conifer types. Spruce budworm, while affecting a late successional stage, results in only a temporary hiatus in stand successional development.

STUDIES OF SOME EFFECTS OF FOREST FIRES

David Grigal

As noted in last year's report[1] two relatively distinct studies of consequences of the Little Sioux Forest Fire, which burned 15,000 acres in northeastern Minnesota in May 1971, are being conducted by the Department of Soil Science. The study of nutrient cycling following the burn is continuing. Samples were collected again during the summer of 1972. We have recently received a research grant from the National Science Foundation. With this money analyses of the many samples which have been collected has begun. Next year in our report we will be able to quantify the nutrient cycle for the two growing seasons following the fire.

A cooperative study with the North Central Forest Experiment Station of the U.S. Forest Service is continuing. Analyses of the vegetation resprouting on the burn during 1971 has been completed. Vegetation was clipped on ten randomly located plots in each of seven forest stands in the burned area. The material was separated by species, weighed, and analyzed. Table 1 shows the total quantity of nutrients immobilized in those communities by resprouting vegetation. These values are comparable to those recorded in the annual litterfall of southern boreal conifer forests, but much of the nutrients in the present study are returned to the woody stem and roots before leaffall. The three communities with large broadleaf components, the two aspen-birch stands and the fir-birch stand, show larger quantities

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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.

of nutrients immobilized. This is due to the greater biomass present in the resprouting suckers of the tree species. The sampling during the 1972 growing season will probably show this effect even more strongly.

Table 1. Quantity of nutrients immobilized by resprouting vegetation on the Little Sioux Burn, northeastern Minnesota, during the first growing season following the fire.

Plant Community	Nutrient				
	N	P	K	Ca	Mg
	g/m^2				
jack pine-black spruce	0.87	0.14	1.00	0.33	0.14
jack pine (oak)	1.40	0.20	1.66	0.58	0.22
aspen-birch	4.08	0.46	2.82	1.38	0.41
jack pine (fir)	1.40	0.29	1.66	0.70	0.21
white pine	1.60	0.31	2.17	1.26	0.28
fir-birch	2.38	0.38	1.71	1.21	0.29
aspen-birch	2.32	0.37	2.03	1.24	0.31

THE EFFECTS OF FERTILIZER RATES ON EDIBLE BEANS IN RENVILLE COUNTY, 1972

W. E. Fenster, P. J. Maher, D. S. Fairchild

The introduction of different crops to western Minnesota has created a need for new research to determine crop response to applied fertilizer. To fulfill this need, three field experiments on pinto and navy beans were established in Renville County in the spring of 1972. General information on the experimental sites is given in Table 1.

Table 1. Location, crop and soil test levels of edible bean experimental sites.

Location	Crop	Soil Tests			
		pH	P	K	Zn
			lbs/A		ppm
James Zenk	Navy beans	6.5	86	550	3.3
William Roebke	Pinto beans	6.8	47	430	2.7

Navy Beans

A split block design with half of each plot receiving starter fertilizer and the other half receiving no starter fertilizer was used to determine effects of increasing rates of phosphorus and zinc on navy beans. The following rates of phosphorus and zinc were added to the starter-no starter plots:

lbs. P_2O_5/A	+	lbs. Zn/A
0	+	0
0	+	20
40	+	0
40	+	20
80	+	0
80	+	20

Navy bean yields are reported in Table 2 with no significant increases in yields with increasing rates of phosphorus and zinc. Bean yields were 200 lbs./acre higher with starter fertilizer, but the increase was not statistically significant (Table 3).

Table 2. 1972 navy bean yields with varying rates of phosphorus and zinc in Renville County.

Fertilizer Treatment P_2O_5 + Zn	Navy Bean Yields
lbs/A	lbs/A
0 + 0	1680 a*
0 + 20	1711 a
40 + 0	1633 a
40 + 20	1616 a
80 + 0	1905 a
80 + 20	1681 a

* Where letters differ, yields are statistically different at the 5% level.

Table 3. 1972 navy bean yields with starter fertilizer versus no starter fertilizer in Renville County.

Fertilizer Treatment	Navy Bean Yields lbs/A
No starter	1603 a*
Starter	1805 a

* Where letters differ, yields are statistically different at the 5% level.

Plant tissue samples were collected from upper leaves at the early bloom stage. No significant interactions were noted between the applied fertilizer treatments and the elements P, K, Ca, Mg, Al, Fe, Cu, Mn and B. Zinc levels in the plant tissue were increased with 20 pounds of zinc fertilizer per acre.

Pinto Beans (phosphorus-zinc)

A randomized block design was used to determine effects of increasing rates of P and Zn fertilizer on pinto bean yields and plant tissue contents. Fertilizer treatments were applied before tillage. An adequate rate of starter fertilizer was used on all plots. Fertilizer treatments included:

lbs. P_2O_5/A	+	lbs. Zn/A
0	+	0
0	+	20
40	+	0
40	+	20
80	+	0
80	+	20

Table 4 indicates no increase in pinto bean yields with increasing rates of P and Zn. Yields were not as high as expected because of rust damage.

Table 4. 1972 pinto bean yields with varying rates of phosphorus and zinc in Renville County.

Fertilizer Treatment P_2O_5 + Zn	Pinto Bean Yields
lbs/A	lbs/A
0 + 0	697 a*
0 + 20	645 a
40 + 0	641 a
40 + 20	738 a
80 + 0	711 a
80 + 20	708 a

* Where letters differ, yields are statistically different at the 5% level.

No interaction of applied fertilizer with the elements P, K, Ca, Mg, Al, Fe, Cu, Mn and B was noted in the plant tissue contents.

Zinc contents of the plant tissue was significantly increased with 20 pounds of zinc fertilizer per acre.

Pinto Beans (potassium experiment)

Potassium rates of 0, 50 and 100 pounds per acre were used in a series of plots randomized and replicated four times. Potassium treatments were applied before tillage with all plots receiving an adequate rate of starter fertilizer.

No increases in yields are noted in Table 5 with increasing rates of potassium fertilizer.

Table 5. 1972 pinto bean yields with increasing rate of potassium fertilizer in Renville County.

Fertilizer Treatment lbs. K_2O/A	Pinto Bean Yields lbs/A
0	594 a*
50	529 a
100	516 a

* Where letters differ, yields are statistically different at the 5% level.

Plant tissue samples indicated no interaction of the elements P, K, Ca, Mg, Al, Fe, Zn, Cu, Mn and B with increasing potassium rates.

1973 Experiments

Edible bean fertilization will be studied further in 1973. Fertilization with phosphorus, zinc, potassium and starter fertilizers will be continued with increased emphasis on disease control which should facilitate higher yields and possible fertilizer responses. Plant analysis will be used to determine amounts of P, K, Ca, Mg, Al, Fe, Cu, Mn, Zn and B in plant tissue and define the critical levels of these elements for edible bean production.

LIME PLOTS, DAKOTA COUNTY, 1972[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.

Soil samples were collected from all check plots in July (Table 1).

The soybean yield and chemical composition of trifoliate are given in Tables 2 and 3.

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.

Table 1. Soil Test Results

Depth of Sampling, Inches	pH	SMP Buffer Index	Extractable P ppm	Exchangeable K pp2m
0-6	5.7	6.5	61	310
6-12	5.7	6.5	31	220
12-18	5.9	6.7	14	110
18-24	5.9	6.9	12	90
24-30	6.2		13	50
30-36	6.2		12	40

[1] See "A Report on Field Research in Soils," Soil Series 88, March 1972, pp. 196-197 for results obtained during 1971.

Table 2. Yield of Soybeans, Earl Almquist's Farm, Dakota County, 1972.

Rate of Lime Tons/Acre	Yield Bu/Acre
0	52
2.5	50
5.0	50
10.0	52
Significance	NS
CV,%	4

Table 3. Chemical Composition of Soybean Trifoliate, Earl Almquist's Farm, Dakota County, 1972.

Lime Treatment	P	K	Ca	Mg	Zn	Cu	Mn	B	Fe	Al
	-----Percent in Dry Matter------				------Parts Per Million in Dry Matter----------					
0	.45	1.88	.99	.39	47	10.7c	58b	41	112	20
2.5	.46	1.93	.97	.40	44	10.3bc	51ab	39	113	19
5.0	.44	1.86	1.01	.41	43	9.5a	49a	39	110	21
10.0	.45	1.87	1.00	.41	43	9.6ab	49a	38	105	19
Significance	NS	NS	NS	NS	NS	**	*	NS	NS	NS
CV, %	5	7	6	7	6	6	10	6	6	19

PASTURE IMPROVEMENT THROUGH FERTILIZATION

Results of Trials in Minnesota Red River Valley--1972

C. A. Simkins, Oliver Strand, Marlin O. Johnson

Minnesota has more than two million acres of unimproved grassland. Land which is often unsuitable for cultivated crops is left in permanent pastures. To a lesser extent, some land which could be used as cultivated land is also devoted to permanent grass pasture or hay land. In numerous instances, without fertilization and management, this land provides forage for only a short period of the year (6 to 8 weeks). Yields of hay (equivalent) obtained from this pasture management are often less than 1 ton per acre.

Profitable forage production depends on high yields and good quality. Less than 15 percent of the hay and pasture land in Minnesota is fertilized. Few farmers are taking advantage of today's research know-how and our grass lands are neglected acres. While there are many reasons, perhaps one of the most important in northern Minnesota is the fact that farmers do not feel the need for additional forages because they keep only enough livestock to utilize the forages they normally produce. To be profitable, forages must be fed to livestock. Forages are not easily marketed and during years of surplus production, the market price is often low. Minnesota has frequent instances of under utilization of hay and pastures during the growing season. Farmers must have sufficient livestock to utilize additional forages produced as a result of fertilization.

Studies conducted at 11 locations in northern Minnesota (in 1971 and 1972) show clearly that fertilizer use can increase hay yields

on grasses now being used by many farmers.

Table 1 shows yields of grasses in tons per acre of hay obtained from various treatments.

Table 1. Hay yields--fertilizer trials--Red River Basin, Minnesota -- 1971 and 1972.

	Tons/acre*	
	1971	1972
No fertilizer	1.38	1.24
30+15+15	1.80	1.92
100+0+0	2.08	1.67
100+50+50	3.50	3.07

*Mixed grasses--predominantly quack, timothy, orchard, brome, Kentucky bluegrass.

These results illustrate the high potential for dairy, beef, and livestock industries, but as they are used now they are similar to a factory working at less than half capacity.

In growing, harvesting, and feeding forages, especially grasses, nothing is more important than early cutting. Researchers have shown that cows eat only about one-half as much late cut hay as they would comparable early cut hay. Well-managed, well-fertilized forage crops are not only high yielding, but a quality feed that approaches grain in feed value with a bonus in extra protein. Table 2 illustrates the production of T.D.N. and protein from grass pasture compared to corn.

Table 2. Production of T.D.N. and protein from grass pasture--1971

	Tons hay/acre	Pounds TDN/acre	Pounds protein/acre
Grass pasture--no fertilizer	1.38	1,380	151
Grass pasture--plus 30-15-15	1.80	1,800	230
Grass pasture--plus 100-50-50	3.50	3,500	1,000

Fertilizing grasslands increases forage yields and protein content. Early cutting or grazing produces high quality forage which can reduce feed buying and result in increased profits.

Small Grain Yields in 1972 at Eight Locations in the Red River Valley Basin Following Spring Fertilization with Some Major, Secondary and Micronutrient Elements, and General Conclusions of a Three Year (1970-72) Field Study on 39 Fertilized Fields.

J. M. MacGregor*

Small grain production dominates the cropping area of northwestern Minnesota, since these crops are well adapted to both climate and soils of the region. Precipitation is relatively limited and often is poorly distributed during the short growing season. The comparatively level lake-laid soils have poor internal drainage and contain free lime, with accumulations of the more soluble salts in some areas being troublesome, especially with the more salt sensitive crops such as soybeans, flax and several ornamental plant species.

The present study was initiated in the spring of 1970 to determine the fertilizing value of additional potash, sulfur, zinc, manganese, boron, and copper broadcast with a basic N, P_2O_5, and K_2O treatment at the 40 lb/A rate of each.

A number of fields were selected each spring (1970, 1971, and 1972), the soils were sampled and analyzed, and previous management information obtained. The summer or fall plowed fields were staked as soon as dry in the spring, and five replications of nine fertility treatments were broadcast. All field stakes were then removed and the farm operator prepared the seedbed as usual by disking the plowed field. Most operators applied starter fertilizer of their choice when seeding, and in 1970, the amounts of starter nutrients applied were subtracted from the broadcast basic treatment so the total amounts (starter

and that broadcast) totalled 40+40+40 per acre. This procedure was found to be time consuming and impractical, since the many field weighings limited the number of fields which could be fertilized prior to spring seeding. In 1971 and 1972, the basic 40+40+40 treatment was broadcast irrespective of and in addition to the starter fertilizer applied by the farm operator. Also, since some of the 1970 fields showed a significant yield increase from the basic 40+40+40 treatment, an additional treatment with no potash (40+40+0) was included in 1971 and 1972 to determine if the potash of the basic treatment contributed to this effect. The plots of all fields were restaked with 48" wood lath following the usual June herbicide spraying. Yield samples were cut just prior to swathing, using a 36" sickle type mower for an 8' length (24 sq. ft.) from each plot. The samples were bagged, dried in low temperature ovens, threshed and the grain yields calculated and statistically analyzed.

During the 3 year study, only the 1971 growing season was considered ideal for small grain production, a year of early seeding, good rainfall distribution, and relatively cool temperatures. On the other hand, the 1970 and 1972 seasons had very wet springs which delayed planting, followed by very dry weather late in June and July. The results obtained on the 1970 and 1971 experimental fields have been previously reported (see Soil Series 88, pp. 225-227, March 1972).

A total of nine fields (5 of wheat, 2 of oats, and 2 of barley) were fertilized in 1972. One wheat field was so seriously damaged by a July hailstorm that it was discarded. Pertinent information including locations, soil tests, management, and grain yields are

shown in Table 1.

As already mentioned, the 1972 small grain growing season was relatively unfavorable, with heavy spring rains resulting in working wet soils and late seeding. Relatively dry weather followed, with much of the experimental area receiving less than 3" of rain in the critical two month mid-May through mid-July period. Fertilizer effectiveness for grain production was minimal.

Texture of the eight soils was that of a loam or finer, and all were high in organic matter. Available phosphorus was very low on three fields. Soluble salt content was relatively low, even with the high alkalinity (high pH) of the two barley fields. Cropping and fertilizer practice was typical of the area.

Only two of the eight 1972 fields produced significantly larger grain yields from the broadcast fertilizer treatments, and obviously this resulted from the nitrogen phosphate (40+40+0). Additional potash, sulfur, or any of the micronutrients had no significant yield effect, either alone or combined, results typical of the two preceding years of this field study.

Conclusions of the Three Year Study

The growing seasons of both 1970 and of 1972 were characterized by unfavorable precipitation distribution during these small grain growing seasons-with extremely early springs with very dry midsummers following. The small grain growing season of 1971 was almost ideal for maximum grain production.

In 1970,one (barley) of the 12 small grain fields responded to the basic 40+40+40 treatment only. In 1971, one of nine oat fields, one of five barley fields, and one of three wheat fields responded to the 40+40+0 treatment. There was a possible effect of the sulfur

treatment (20 lbs/A) on the responding oat field, which was located in eastern Becker county near Ponsford and was about 20 miles east of the true Red River area basin. In 1972, one of four wheat fields and one of two oat fields (two of eight totals) produced significantly larger yields with the 40+40+0 fertilization, with no effect for additional potassium, sulfur, or any of the four micronutrient elements, either alone or combined.

It may be reasonably concluded that the soils of Red River Valley basin which were included in this study still contain sufficient available potassium, sulfur, zinc, manganese, boron, and copper for optimum small grain production. Nitrogen and phosphorus availability is limited in some fields, but this can easily be remedied by fertilizing with these two major fertilizer elements either as broadcast, starter or both.

* This study was possible only through the active interest of cooperating county extension personnel, farm operators, and research staff at the Northwest Experiment Station at Crookston. Their substantial contribution is duly acknowledged.

Table 1. County, Location, Farm Operator, Previous Management, and 1972 Soil Tests and Small Grain Yields on Eight Northwestern Minnesota Farm Fields.

1972 Crop	Wheat				Oats		Barley	
County	Polk	Clay	Clay	Wilkin	Clay	Clay	Clay	Wilkin
Town	Crookston	Georgetown	Moorhead	Kent	Felton	Felton	Glyndon	Foxhome
Operator	NW Exp.Sta.	Fossum	R.Olson	Bellmore	Brantner	Wetterlin	Kuehl	Friedricks
Soil texture	SiCl	SiCl	SiCl	Loam	SiCl	SiL	SiL	SiL
Soil pH	8.4	7.3	8.4	6.9	8.1	8.7	8.5	8.7
Soil O.M.	H	H	H	H	H	H	H	H
Soil P.	28	10	33	16	10	2	4	3
Soil K.	380	460	560	270	550	80	140	210
Soil NO_3-N	49	104	111	32	40	119	75	205
Soil Zn	1.7	1.1	2.2	3.2	1.6	1.3	3.3	1.4
Soil S	16	13	20	9	27	40	10	12
Soluble salts	0.7	0.7	0.9	0.5	0.7	0.9	0.6	0.8
1970 Crop	barley	alfalfa	fallow	barley	wheat	barley	sugarbeets	barley
1970 fert.	0+115+0	none	none	19+48+0	58+23+0	16+49+16	20+100+20	38+95+25
1971 Crop	sugarbeets	alfalfa	sugarbeets	sunflowers	soybeans	sunflowers	wheat	fallow
1971 fert.	6+42+0	none	20+49+16	none	none	15+37+0	69+29+14	none
1972 variety	Era	1809	wheat	1809	G.C.	Lodi	Larker	Larker
1972 starter fert.	none	23+58+0	36+46+12	23+58+0	44+69+0	24+62+0	69+29+14	none

Table 1. (continued)=

1972 Crop	Wheat				Oats		Barley	
County	Polk	Clay	Clay	Wilkin	Clay	Clay	Clay	Wilkin
Town	Crookston	Georgetown	Moorhead	Kent	Felton	Felton	Glyndon	Foxhome
1972 bct fert. (lbs/A)				1972 Small Grain Yield in bushels per acre.				
none	28.1a	39.8	25.8	26.5	52.7a	83.7	42.1	27.9
40+40+0	44.8b	40.4	23.2	27.2	81.6bc	83.8	45.6	35.6
40+40+40	45.5b	39.5	27.2	33.7	71.9bc	95.0	46.2	36.1
40+40+200	45.1b	38.2	24.5	27.4	75.8bc	87.9	48.3	36.4
40+40+40+10 Zn.	47.4b	40.0	24.5	29.3	78.9bc	85.2	48.0	35.9
40+40+40+10 Mn.	46.6b	41.4	24.0	27.1	73.4bc	77.6	47.6	31.1
40+40+40+2 B.	47.8b	37.9	15.8	27.9	73.0bc	84.9	46.2	34.1
40+40+40+10 Cu.	43.4b	39.1	19.3	34.0	85.2c	91.1	49.9	36.5
40+40+40+20 S.	45.6b	37.0	25.5	25.4	67.2b	89.0	46.6	34.1
40+40+40+10 Zn+ 10 Mn + 2 B + 10 Cu +20 S.	43.0b	41.0	31.3	32.0	79.8bc	81.9	51.2	37.2
		N.S.	N.S.	N.S.		N.S.	N.S.	N.S.

SULFUR RESPONSES IN SOUTHERN MINNESOTA

D. S. Fairchild, W. E. Fenster, O. M. Gunderson, W. W. Nelson*
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.

Sulfur is an essential element to plant growth. Like nitrogen, phosphorus, potassium, calcium and magnesium, sulfur is a macronutrient and must be available in larger amounts than micronutrients for good crop growth.[2]

HISTORY OF SULFUR RESEARCH

To better understand sulfur's role in Minnesota agriculture, we should review the sulfur research in the north central states.

Designating sulfur deficient Minnesota soils, determining sulfur supplying capacity of soils and defining sulfur crop needs are not new to Minnesota agriculture. Alway (1920-30) found the annual fallout of sulfur from rain, snow, and dust to vary from 100 lbs/A in Minneapolis to less than 5 lbs/A in northern areas of the state.[1] Evans and Rost (1940-50) determined the total sulfur, total organic sulfur, and sulfate sulfur of 39 different Minnesota soils.[4] More recently Caldwell and associates (1960) have done considerable research on defining the sulfur supplying capacity of soils and crop needs for fertilizer applied sulfur in north central Minnesota.[7]

SOIL SULFUR

The University of Minnesota soil testing laboratory provides a

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* Efforts of Bobby McCaslin and Robert Schoper on plot work and statistical analysis are greatfully acknowledged.

soil test for sulfur that extracts soluble and adsorbed sulfates. It is quite reliable for areas in Minnesota where soil organic matter and fallout concentrations of sulfur are insufficient. The chief limitation of the sulfur soil test is that it does not measure two other major forms of sulfur: organic and atmosphere sulfur. Organic sulfur reacts similar to organic nitrogen in that about 2 percent is released each year in the process of organic matter decomposition. Recent work by Bremner in Iowa with a number of soil types common to southern Minnesota have indicated that organic sulfur can account for 95-98 percent of the total sulfur in soils.[8]

PLANT SULFUR

The sulfur requirement of a plant is the minimum amount of sulfur required for adequate nutrition, or the amount of sulfur that is just sufficient to maintain the plant in a healthy, normal condition and provide maximum yield.[5]

Table 1 indicates that crops differ in their requirements for sulfur.

Table 1. Sulfur content of some crops(2)

	Yield/Acre	Sulfur, Lbs./Acre
Alfalfa	6 tons	30
Corn	200 bu.	44
Wheat	80 bu.	22

Research indicates that alfalfa containing less than 0.20 percent sulfur likely will respond to sulfur fertilization. Corn containing less than 0.15-0.20 percent sulfur in the ear leaf likely will respond to sulfur fertilization.[5] Also, nitrogen to sulfur ratios greater than 11:1 indicate a possible sulfur deficiency.[3]

SULFUR NEEDS IN SOUTHERN MINNESOTA

What about sulfur needs for southern and western Minnesota corn farmers? To try and answer this question research was conducted in 1970, 1971, and 1972 with rates, forms, and starter sulfur fertilizers. The following is a summary of this research.

RATE OF SULFUR STUDY (1970-1971)

In the spring of 1970, a project was initiated to determine if corn will respond to additions of sulfur. The experiment was located at the Southwest Experiment Station at Lamberton on a Webster clay loam soil. General soil test information is given in Table 2.

Table 2. Soil test levels of experimental site.

Soil Depth	P	K	S	Zn	pH	O.M.
	lbs/A		ppm			
0-3"	28	240	11	2.7	5.9	H
3-6"	27	235	12	2.8	6.0	H
6-12"	11	195	13	1.7	6.2	H

Elemental sulfur rates of 0, 20, and 100 lbs/A of actual S were broadcast in early spring of 1970 before tillage. No additional sulfur was applied in 1971 as the experimental site was being used for a sulfur residual study. No significant yield responses resulted from the addition or increased rates of sulfur (Table 3).

Table 3. Sulfur treatments and corresponding 1970 and 1971 corn yields at Lamberton.

Fertilizer Treatment	1970	1971
lbs. El. S/A	Yield (Bu/A)	(15.5%)
0	155	113
20	157	114
100	154	109
Significance	N.S.	N.S.

As evidenced from Table 4, there was no significant difference in plant tissue sulfur contents in 1970. Significant increases in plant tissue sulfur contents, however, are indicated in 1971 This would indicate that in 1970 the applied elemental sulfur was not oxidized to an available form to plants. Tissue samples were collected when corn was 10 inches tall and at silking stage of growth.

Table 4. Sulfur content of corn tissue under variable sulfur treatments, Lamberton 1970 and 1971.

Fertilizer Treatment	1970		1971	
	10"	Ear Leaf	10"	Ear Leaf
lbs. S/A	% S in dry matter			
0	0.29 a*	0.28 a	0.23 a	0.22 a
20	0.28 a	0.27 a	0.23 a	0.21 a
100	0.29 a	0.27 a	0.26 b	0.24 b

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

INVESTIGATIONS ON FORMS AND RATES OF SULFUR (1971 and 1972)

Ten field experiments were established in 1971 to study the effects of sulfur rates and forms with corn, soybeans, and alfalfa. Five locations representing common soil types in southern and western Minnesota will be presented here. General information on the experimental sites is given in Table 5 and 6.

Table 5. Location and soil type of experimental sites.

County	Cooperator	Soil Type	Crop
Wabasha	J. Welti	Port Byron silt loam	Corn
Houston	J. McCormick	Fayette silt loam	Corn
Steele	G. VanRuden	Kenyon loam	Alfalfa
Chippewa	C. Phillips	Nicollet loam	Corn-Soybeans
Pope	Weispfinnig	Esterville sandy loam	Corn

Table 6. Soil test levels of experimental sites.

County	P	K	S	pH	O.M.
	lbs/A		ppm		
Wabasha	68	390	16	6.8	L
Houston	65	190	16	6.6	L
Steele	28	240	10	6.1	M
Chippewa	52	500	19	7.9	H
Pope	41	280	15	6.4	M

The following forms and rates of sulfur were applied in the spring of 1971 before tillage.

Forms of Sulfur	Corn Sites	Alfalfa Sites
	S (lbs/A)	
--	0	0
K_2SO_4	25	50
Elemental-S	25	50
K_2SO_4	50	100
Elemental-S	50	100

All cooperators used optimum rates of N, P, and K with good weed and insect control.

Plant tissue samples were collected at the following stages of growth:

1. Corn - whole plants at 10-inch height and 6th leaf at silking,
2. Alfalfa - top one-third of plant at harvest,
3. Soybeans - upper fully developed trifoliate at bloom stage.

No significant yield increases resulted with the addition of sulfur to corn, soybeans, and alfalfa (Table 7, 8, 9).

Table 7. 1971 and 1972 corn yields on sulfur fertilization trials.

Treatments	Wabasha		Houston		Chippewa	Pope	
	1971	1972	1971	1972	1971	1971	1972
lbs. S/A	Yield (Bu/A)						
0	145	145	193	164	90	98	86
25 (K_2SO_4)	144	138	190	159	89	101	86
25 (Elemental S)	157	147	192	166	90	102	86
50 (K_2SO_4)	157	142	196	163	90	98	90
50 (Elemental S)	151	144	184	159	100	101	85
Significance	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.

Table 8. 1972 soybean yields on sulfur fertilization trials.

Treatment lbs. S/A	Chippewa Yield (Bu/A)
0	38
25 (K_2SO_4)	37
25 (Elemental S)	38
50 (K_2SO_4)	38
50 (Elemental S)	36
Significance	N.S.

Table 9. 1971 and 1972 alfalfa yields on sulfur fertilization trial, Steele Co.

Treatments lbs. S/A	1971 Yield (Tons/A	1972
0	4.2	4.9
50 (K_2SO_4)	4.1	5.2
50 (Elemental S)	4.2	5.1
100 (K_2SO_4)	4.0	5.1
100 (Elemental S)	4.1	5.1
Significance	N.S.	N.S.

STARTER SULFUR

In the spring of 1972, a study was initiated to determine whether or not the addition of sulfur to starter fertilizers would affect early plant growth 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:

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

As shown in Table 10, no significant increases in small plant weights or yield resulted from varying sulfur treatments.

Table 10. Sulfur treatments and corresponding small plant weights and yields at Waseca.

Fertilizer Treatment Lbs. S/A*	Small Plant Weights gms.	Yield Bu/A (15.5%)
0	105	156
5 (starter)	106	161
15 (starter)	104	155
15 (broadcast)	96	166
Significance	N.S.	N.S.

*Used K_2SO_4

However, sulfur applications resulted in significant increase in sulfur content of young plants (Table 11). No significant increase was noted in the ear leaf sulfur contents.

Table 11. Sulfur content of corn tissue under variable sulfur treatments, Waseca 1972.

Fertilizer Treatment lbs. S/A	Small Plants	Ear Leaf
	% S in dry matter	
0	.27 a*	.19 a
5 (starter)	.28 ab	.20 a
15 (starter)	.29 b	.20 a
15 (broadcast)	.30 c	.21 a

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

CONCLUSIONS

1. In 1970 and 1971, the elemental sulfur was apparently not oxidized to an available form for plants, but was equal to potassium sulfate the second year after application.
2. Three years of research showed no yield increases with varying rates and forms of sulfur applied either as a starter or as a broadcast.
3. No economic yield gains were realized with additional sulfur applications to corn, alfalfa and soybeans on soil types common to southern Minnesota.
4. In all cases, the sulfur content of various plant tissues appeared above the critical level and were adequate for maximum yields.
5. It is presently recommended to apply sulfur only on a trial basis in southern Minnesota when sulfur soil tests are low (less than 7.0 ppm).

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SOIL TESTING

John Grava

Currently the University of Minnesota Soil Testing Laboratory processes over twenty eight thousand samples annually. The following data show the number of various types of samples analyzed in 1972.

Regular Farm, Garden and Lawn Samples		20,248
Florist (Greenhouse) Samples		1,932
Specials:	Nitrate	1,223
	Sulfur	1,044
	Zinc	446
	Soluble salts	631
	pH	220
Limestone		18
Departmental Research Samples		2,563
	TOTAL	28,325

The monthly distribution of regular soil samples received by the laboratory is shown in Table 1.

Table 1. Monthly Distribution of Soil Samples received by the University of Minnesota Soil Testing Laboratory During 1972.

MONTH	NUMBER OF SAMPLES
January	480
February	337
March	932
April	3,975
May	3,365
June	1,008
July	851
August	1,399
September	2,354
October	3,162
November	1,666
December	749

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