A Report on Field Research in Soils

(A compilation of recent experimental results by personnel of the Department of Soils and Extension Specialists and Agronomists at the Branch Stations at Crookston, Duluth, Grand Rapids, Lamberton, Morris, Rosemount, and Waseca).

Department of Soils
University of Minnesota

February, 1962

Some of the results herein reported are from experiments carried on during 1961 only, and should not be regarded as the results obtained over a number of years. The investigations are those of a more practical nature, and do not include some of the more theoretical problems presently under study in greenhouse and in the laboratory. Because these are largely one year results they should not be considered as conclusive and the results are not for publication.

TABLE OF CONTENTS

		Page
1.	Present Status of the Minnesota Soil Survey - (1962)	1
2.	Aerial Photo Study	2
3.	Soil Productivity Study	5
4.	Minnesota Climate and Soil Moisture in 1961 and Expectations for Spring, 1962	10
	Soil Testing	
5.	Soil Testing in Minnesota During 1961	19
	Nitrogen	
6.	The Effect of Nitrogen Source, Placement and Time of Application on the Yield and Composition of Continuous Corn on Webster clay loam at Lamberton.	21
7.	The Effect of Nitrogen Fertilization On Yield and Composition of Wheat at Crookston in 1960 & 1961.	24
8.	The Effect of Nitrogen Source, Time of Application and Soil Covering	27
9.	The Effect of Anhydrous Ammonia Sidedressing for Corn on Hegne Loam At Crookston and on Port Byron Silt Loam at Rosemount in 1961.	29
10.	Nitrogen Fertilization Studies on Turf Grass - 1961	31
	Phosphorus	
11.	Phosphorus Source Experiment Rosemount, 1961	33
	Secondary and Trace (Micro-or Minor) Elements	
12.	The Effect of Lime and Molybdenum on the Yield of Corn, Soybeans, Oats, and Alfalfa, 1961	35
13.	Boron Investigations on Corn in 1961	37
14.	1961 Field Experiments Using Iron and Magnesium	42
	Rotations	
15.	Fertilizer Rotation Studies at the Waseca, Morris and Crookston Branch Experiment Stations (1961 Results)	46
16.	Soil Fertility and Crop Production Studies on the Webster Soils of Southern Minnesota	61
	Corn	
17.	Profit Possibility Plots (NPK rates on corn 1961)	63
18.	Field Fertility Studies with Corn on Fayette Soils - 1961	66
19.	Comparison of Fertilizer Materials on a Field Basis at Rosemount	75
20.	Comparison of Fertilizer Materials on A Field Basis at Morris	77
21.	Continuous Corn - High Fertility Experiment	79
	Fertilizer Placement	
22.	Fertilizer Placement and Corn Stand	80

Soil Erosion on Continuous Corn - Plowing Vs. Deep Cultivation

23. Comparative Effects of Deep Tillage Versus Plowing on Soil & Water Losses and Corn Yield over Three Years (1959-61) on Port Byron Silt Loam at Rosemount. 81

Legumes

24. Fertilizer Experiment on Continuous Soybeans - Rosemount, 1961 83
25. Fertilizer Effect on Yield & Longevity of Ranger Alfalfa on Port Byron Silt Loam at Rosemount, 1949-61. 84

Pasture Forages

26. Ten Years of Pasture Experiments - Fertilization and Management 86
27. Pasture Fertility and Beef Production 89
28. Beef Production from Fertilized Grass Pastures 92
29. The Effects of Cobalt Bullets and Pasture Fertilization on Beef Production. 96

Grass Seed

30. Fertilizer Experiments on Park Kentucky Bluegrass Seed Production in Roseau County 98
31. The Effect of Fertilizer on Yield of Climax Timothy Seed 1960-61 103

Potatoes

32. Lake of the Woods County Potato Fertility Demonstration - 1961 105

Organic Soils

33. Fertility Studies on Organic Soils at Hollandale, 1961 110

Structure - Fertility Experiments

34. Structure Nitrogen Study 111
35. Subsoil Regeneration Study 112
36. Compaction and Soil Structure 113
37. Soil Compaction and Nutrient Uptake 114

Green Manure Evaluation

38. Green Manure Evaluation Study 115

39. Acknowledgement

PRESENT STATUS OF THE MINNESOTA SOIL SURVEY - (1962)

Counties surveyed:	Year of Survey	
Blue Earth (Detailed survey)	1906	Out of print
Rice (Detailed survey)	1909	"
Goodhue (Detailed survey)	1913	"
Ramsey (Detailed survey)	1914	"
Pennington (Detailed survey)	1914	"
Anoka (Detailed survey)	1916	"
Stevens (Detailed survey)	1919	"
Jackson (Detailed survey)	1923	
Olmsted (Detailed survey)	1923	
Lac qui Parle (Detailed survey)	1924	
Wadena (Detailed survey)	1926	
Lake of the Woods (Reconnaissance survey)	1926	
Mille Lacs (Part detailed, part reconnaissance)	1927	
Hennepin (Detailed survey)	1929	Out of print
Houston (Detailed survey)	1929	
Hubbard (Detailed survey)	1930	
Kanabec (Part detailed, part reconnaissance)	1933	
Red River Valley Counties (Reconnaissance survey)	1933	
Traverse, Clay, Polk, Marshall, Wilkin, Norman, Red Lake, Kittson		
Pine (Part detailed, part reconnaissance)	1935	
Roseau (Detailed survey)	1936	
Winona	1941	Limited supply
Rock	1950	
Brown	1951	
Washington	1952	Limited supply
LeSueur	1954	
McLeod	1955	
Mower	1956	
Faribault	1957	
Fillmore	1958	
Isanti	1958	
Nicollet	1958	
Dakota	1960	
Scott	1959	
Dodge	1961	

Counties being surveyed or maps being published:

Crow Wing, Wabasha, Waseca
Wright, Sherburn

The soil maps and reports are published and distributed by the U. S. Department of Agriculture; the Minnesota Agricultural Experiment Station does not generally supply them, but a limited number of copies are on hand and are available as long as the supply lasts. Requests should be made to Department of Soils, Institute of Agriculture, St. Paul 1, Minnesota. Free copies of the maps and reports also may be obtained from a Minnesota representative in Congress as long as his supply lasts or from the Office of Information, U. S. Department of Agriculture, Washington 25, D. C. After their copies are exhausted, copies may be purchased for a fee from the Superintendent of Documents, Government Printing Office, Washington 25, D. C. Some of the early reports are now out of print but may be consulted in libraries throughout the state.

Aerial Photo Study

R. H. Rust and R. S. Farnham

In order to find more suitable aerial photos for use in soil survey mapping a cooperative project with the Soil Conservation Service was initiated in 1958. This consisted of securing new air photos of selected townships in Watonwan and Wright counties, surveying randomly selected square miles in the areas, and evaluating the accuracy and speed of the soil mapping done.

A part of the procedure was to assign each of 4 surveyors in a county a different kind of photo to be used in mapping a square mile. Each man worked on 8 separate square miles with each of the 4 kinds of photos available (see table 1).

A summary of results is presented in tables 1a and 1b. The statistical significance of all values has not been tested, however, some observations can be made.

1. The surveyors generally rated the new or reflights higher in terms of photo quality than the usual ASC photos which have been used in nearly all previous surveying. The reflights were made in May wereas the ASC photos are usually made in July or August.

2. The accuracy was highest using the normal contact print of the 1:15840 scale photography (4 in. = 1 mile).

3. There is little difference in the average number of acres mapped per hour, 105 for ASC and High flights, 100 for the "dodged" prints, 98 for normal print contact photos.

4. The relative costs of these kinds of photos are not completely established but will affect ultimate recommendations. For example, if the high altitude photos can be obtained at significantly less cost than the usual ASC photos, their use seems justified by this study.

Not for Publication

Table 1a. *Aerial Photo Study - Watonwan County SCD - Minnesota

Mapper	Map No.	Kind of Photo 1/	Acres per Hour	Accuracy Rating	Surveyors Rating of Photos Good	Fair	Poor
A	1	ASC	98	76		X	
D	5		116	73			X
C	9		75	53			X
B	13		97	63		X	
D	17		111	57		X	
A	21		115	75			X
B	25		98	84			X
C	29		81	77			X
Average			99	70		25%	75%
B	2	Hi	100	77			X
A	6		133	83	X		
D	10		120	74		X	
C	14		85	64	X		
C	18		80	70	X		
D	22		107	86	X		
A	26		102	76		X	
B	30		120	87	X		
Average			106	76	50%	37%	13%
C	3	SP	74	78			X
B	7		96	95	X		
A	11		106	85	X		
D	15		108	83		X	
B	19		91	83	X		
C	23		76	80		X	
D	27		125	68		X	
A	31		98	96		X	
Average			97	84	50%	37%	13%
D	4	LE	133	79	X		
C	8		90	56	X		
B	12		95	79	X		
A	16		105	74	X		
A	20		126	76	X		
B	24		92	89	X		
C	28		77	72	X		
D	32		97	77	X		
Average			103	75	50%	50%	

1/ ASC - Agricultural Stabilization and Conservation contract photo (now Commodity Stabilization Service).
HI - Two time ratioed enlargements of 1/31,680 photography
SP - Special 1/.5,840 photography
LE - Logetronically dodged contact prints from SP film

* Tentative data based on incomplete analysis therefore subject to revision

Not for Publication

Table 1b. Aerial Photo Study - Wright County - Minnesota

Mapper	Map No.	Kind of Photo	Acres per Hour	Accuracy Rating	Surveyors Rating of Photos Good	Fair	Poor
A	20		117	19		X	
B	11	ASC	94	79			X
C	31		48	22			X
D	5		157	91	X		
A	22		178	55	X	X	
B	10		128	60			X
C	32		64	54			X
D	1		94	73			X
Average			110	57	19%	19%	62%
A	23		138	18	X		
B	13	Hi	128	93			X
C	25		43	56		X	
D	4		138	26	X		
A	24		107	57			X
B	9		93	68			X
C	26		56	62		X	
D	6		126	50	X		
Average			104	54	37.5%	25%	37.5%
A	19		96	77		X	
B	12		114	22		X	
C	29		66	92	X		
D	7	SP	81	19	X	X	
A	18		122	52	X		
B	14		108	68		X	
C	27		52	72		X	
D	8		143	79		X	
Average			98	60	32%	68%	
A	21		134	89	X		
B	15		94	12		X	
C	30		54	19	X		
D	3	LE	105	83		X	
A	17		114	87		X	
B	16		118	61	X	X	
C	28		51	63		X	
D	2		108	48		X	
Average			97	58	32%	68%	

Soil Productivity Study

R. H. Rust

The soil productivity study which began in 1956 is an attempt to gain reliable estimates of the productivity of major soil types in Minnesota. This productivity is estimated for the major crops under several generally specified soil management programs. The estimates are incorporated in the soil survey reports published for the individual counties by the Soil Conservation Service, USDA, and The Experiment Station, cooperatively.

Since the project began 448 farm cooperators have furnished crop and soil management data on some 92 extensive soil types in the state. Currently 308 cooperators are enrolled in the project. The following kinds of data are recorded: date and rate of seeding; stand estimate; kind and amount of soil amendments used; moisture and temperature conditions during the growing season; weed and insect control measures; yields and losses of yield from harvesting or abnormal conditions; soil tests of pH, available P and K, organic matter.

Since it is planned that productivity estimates be based on multiple regression analysis and since there are a number of factors to be studied, a relatively large number of observations (generally more than 30) of each crop on each soil is necessary in order to establish reliability. In addition, the evaluation of yield variation associated with weather observations (chiefly rainfall and temperature) necessitates collection of data over several years.

In the following table the various soils included in the study are listed together with (1) number of fields, and (2) number of yields. Where 2 or more yields of a crop have been recorded, the crops, number of fields, and the average yields are given. The reader may establish the location of the listed soils by reference to Soils of Minnesota, Ext. Bul. 278, or to the appropriate county soil report.

It should be noted emphatically that the average yields listed do not necessarily reflect the relative productivity of the soils listed. They serve only to indicate the nature of yield levels attained in the last one to five years by farmers who are in general using above average management. Many of the yields also reflect very favorable weather patterns as well as very unfavorable seasons. For those personnel concerned the data may serve to indicate where additional effort is needed.

The results of a multiple regression analysis based on a study of corn yields on groups of somewhat similar soils was presented in the Winter 1961 issue (Vol. XVIII, No. 2) of Farm and Home Science. A five-year summary of data on 1067 yields is currently in progress.

Table 1. Soil series, number of fields, and number of yields included in soil productivity study to date. Average yields of selected crops given where two or more yields received. Yield of corn and grain are in bushels per acre; of hay, in tons; and of pasture, in cow-acre days.

* Number of fields on this series
** Number of yields of all crops

Aastad	(10)*	(28)**
Corn	9	48
Barley	3	49
Flax	2	13
Oats	3	65
S. Wheat	2	32
Other Hay	2	4.6
Alf-Brome pasture	4	186
Afton	(1)	(1)
Anoka	(1)	(1)
Arlington	(1)	(2)
Barnes	(19)	(55)
Corn	17	56
Soybeans	8	21
Barley	2	40
Flax	4	8
Oats	11	63
S. Wheat	2	26
Alfalfa	5	2.0
Alf-Brome	4	4.4
Corn silage	2	5.6
Bearden	(2)	(5)
S. Wheat	2	39
Beltrami	(4)	(6)
Corn	2	66
Blue Earth	(2)	(7)
Corn	4	69
Corn silage	2	9.3
Braham	(1)	(0)
Brainerd	(2)	(5)
Corn	2	52
Buse	(2)	(4)
Alfalfa-Brome	2	1.8
Buse-Barnes	(3)	(5)
Flax	2	9
Central	(3)	(5)
Chilgren	(5)	(15)
Barley	2	55
S. Wheat	2	40
Other Hay	3	2.4
Clarion	(27)	(82)
Corn	29	76
Soybeans	6	30
Flax	2	17
Oats	16	72
S. Wheat	5	30
Alfalfa	8	2.6
Alfalfa-Brome	7	3.1
Mixed Leg-grass	3	5.1
Corn silage	3	11.5
Alf-Brome pasture	2	175
Colvin	(1)	(2)
Corn	2	54
Colvin, cal. var.*	(1)	(2)
Comfrey	(1)	(4)
Corn	2	60
Cormant	(3)	(11)
Oats	2	66
S. Wheat	3	30
Downs	(3)	(8)
Corn	2	131
Alfalfa	3	3.4
Dundas	(4)	(10)
Corn	2	54
Oats	2	70
Alfalfa	2	1.7
Alfalfa-Brome	2	5.2
Enstrom	(2)	(3)
Estelline	(1)	(5)

* cal. var. = a calcareous variant

Estherville	(10)	(32)
Corn	13	59
Oats	8	47
Alfalfa-Brome	6	2.3
Corn silage	4	7.8
Fairhaven	(4)	(10)
Corn	6	62
Oats	3	67
Fargo	(10)	(29)
Soybeans	3	23
Barley	2	31
Flax	2	13
Oats	2	36
S. Wheat	4	32
Alfalfa-Brome	2	1.9
Sw. Cl.-Brome	2	1.9
Fayette	(6)	(25)
Corn	12	99
Oats	3	81
Alfalfa-Brome	4	7.0
Mix. Leg-grass	2	3.6
Flom	(8)	(18)
Corn	5	67
Soybeans	2	24
Flax	2	18
Oats	6	56
Floyd	(4)	(12)
Corn	6	79
Soybeans	3	24
Oats	2	80
Fossum	(1)	(1)
Freer	(2)	(5)
Oats	2	47
Corn silage	2	6.7
Freon	(1)	(3)
Greenbush	(1)	(3)
Other Hay	2	1.5
Grimstad	(4)	(18)
Soybeans	3	15
Barley	3	48
Flax	2	10
Oats	3	75
S. Wheat	2	27
Grygla	(1)	(1)
Hamerly	(1)	(2)
Harpster	(1)	(1)
Hayden	(15)	(52)
Corn	17	92
Oats	10	52
Alfalfa	10	2.6
Alf-Brome	7	3.3
Oats silage	2	7.2
Alf.-Brome Pasture	2	195
Hegne	(3)	(4)
Hubbard	(12)	(35)
Corn	13	66
Soybeans	7	20
Oats	5	47
Alfalfa	5	2.6
Corn silage	2	15.4
Kasson	(2)	(2)
Oats	2	65
Kato. cal. var.	(1)	(3)
Kenyon	(2)	(5)
Corn	2	87
Other hay	2	2.6
Kingston	(3)	(9)
Corn	7	86
Kittson	(2)	(7)
Corn silage	2	5.0
Kranzburg	(5)	(12)
Corn	3	60
Flax	5	12
Alfalfa	2	2.3
Lamoure	(1)	(4)
Corn	3	57
Lamoure sicl. cal. var.	(1)	(2)
Lerdal	(1)	(4)
Corn	2	82
Lester	(9)	(26)
Corn	7	71
Oats	5	53
Alfalfa	7	3.8
Alf-Brome	4	3.1
LeSueur	(6)	(18)
Corn	9	68
Soybeans	4	24
Litchfield	(1)	(4)
Marcus	(1)	(1)

Marna	(4)	(10)
Soybeans	2	33
Corn	8	95
McIntosh	(3)	(8)
S. Wheat	4	35
Menahga	(2)	(7)
Corn silage	2	5.9
Milaca	(2)	(12)
Mix. Leg-grass	4	1.9
Other hay	3	1.7
Corn silage	2	8.2
Moody	(1)	(4)
Corn	3	67
Mora	(2)	(6)
Corn	2	56
Nebish	(6)	(17)
Oats	5	62
Alfalfa	4	1.5
Alf.-Brome	3	2.2
Nicollet	(16)	(54)
Corn	26	74
Soybeans	3	31
Barley	2	94
Oats	9	56
S. Wheat	2	49
Alfalfa	6	3.9
Alf-Brome	2	4.7
Corn silage	2	17.6
Nokay	(1)	(4)
Corn	2	68
Onamia	(2)	(10)
Corn	4	68
Oats	2	69
Alfalfa	2	2.5
Ostrander	(4)	(10)
Corn	3	98
Soybeans	2	26
Oats	2	75
Alfalfa	2	3.3
Parnell	(1)	(5)
Corn	3	44
Peat, Deep	(6)	(12)
Corn	2	79
Soybeans	2	25
Other hay	2	1.6
Corn silage	3	9.6
Peat, Shallow	(2)	(9)
Soybeans	3	24
Barley	3	56
Pierce	(1)	(1)
Redby	(1)	(1)
Rocksbury	(5)	(10)
Flax	2	9
Oats	3	67
S. Cl-Brome	2	1.7
Rockwell	(3)	(5)
Shooks	(2)	(2)
Sioux	(1)	(4)
Oats	2	21
Skyberg	(1)	(4)
Mix. Leg-Grass pasture	2	154
Sletten	(1)	(1)
Storden-Clarion	(1)	(4)
Oats	2	80
Alfalfa	2	2.8
Tama	(7)	(19)
Corn	4	94
Oats	6	62
Alf-Brome	2	4.8
Mix Leg-grass	3	3.1
Alf-Brome pasture	2	175
Todd	(1)	(1)
Truman	(2)	(7)
Corn	4	93
Ulen	(3)	(15)
Corn	5	56
Oats	4	54
Alfalfa	2	2.6
Corn silage	2	15.5
Vallers	(3)	(12)
Corn	4	55
Soybeans	4	20
Oats	2	63
Varco	(1)	(4)
Corn	2	78
Alf-Brome	4	2.8
Vienna	(1)	(1)
Wabash	(1)	(5)
Corn	3	101

Wadena	(4)	(8)
Corn	3	92
Oats	3	80
Waukegan	(5)	(23)
Corn	9	83
Soybeans	2	31
Oats	6	78
Alf-Brome	2	3.5
Waukon	(9)	(23)
Corn	5	66
Barley	2	57
Oats	3	67
Alfalfa	9	2.1
Mix Leg-grass	2	3.2
Webster	(33)	(91)
Corn	38	74
Soybeans	12	21
Oats	16	61
Alfalfa	6	3.2
Alf.-Brome	8	2.9
Mix Leg.-grass	2	3.5
Corn silage	5	9.3
Webster, cal. var.	(8)	(19)
Corn	9	67
Soybeans	4	31
Alfalfa	3	3.2
Wildwood	(1)	(5)
Winger	(4)	(10)
Oats	2	85
Alfalfa	2	1.1
Zimmerman	(2)	(10)
Corn silage	3	11.0
TOTALS	(371)	(1067)

1/15/62

Minnesota Climate and Soil Moisture in 1961 and Expectations for Spring, 1962

Donald G. Baker and Joseph H. Strub, Jr.

Soil Moisture, 1961

Eight different sites, table 1, in the state were sampled in 1961 and the moisture content of the soils were determined gravimetrically. The results from these moisture determinations are shown in table 2. The Crookston

Table 1. Location and description of soil moisture sampling sites.

Nearest Town	County	Soil Type	Percent slope and direction	Maximum available water content*	Crop	Cooperating agency
Butterfield	Watonwan	Nicollet cl.	2 NE	13.8 in.	Corn	S.C.S.
Crookston	Polk	Hegne sic.	0	13.3	Alfalfa	U. of M.
Dodge Center	Dodge	Kasson sil.	1 W	10.7	Alf.-brome	S.C.S.
E. Grand Forks	Polk	Bearden sil.	0	13.7	Sugar beets	Am. Crystal Sugar Co.
Gaylord	Sibley	Nicollet cl.	0-2 NE	11.7	Soybeans	S.C.S.
Kellogg	Wabasha	Fayette sil.	10 S	14.4	Corn	S.C.S.
Lamberton	Redwood	Webster cl.	1 E	13.8	Corn	U. of M.
Milaca	Mille Lacs	Mora sil.	0-1 N	9.8	Alf.-Grass	S.C.S.

* In a 5 foot column of soil.

data are indicative of what happened in portions of the northern one-third of the state. Fortunately rains occurred at the most critical times and prevented a truly serious situation. It should be pointed out that the Crookston data, due to the extremely dry subsoil, sometimes even giving negative available water values, mask the fact that timely July and August rains did provide sufficient moisture in the shallow depths for a tolerable corn crop. However, these rains were not early enough to prevent serious losses in grain production in much of the northern one-third of the state. East-central Minnesota also experienced low soil moisture through part of the season.

Except for some local areas, the remainder of Minnesota was generally well endowed with respect to soil moisture. The south-central part of the state was in very good condition throughout most of the growing season as the Butterfield, Gaylord and Lamberton data show.

Due to problems associated with obtaining soil moisture samples it will be noted that not all of the data are in agreement.

Summary of the 1961 Growing Season Weather

To summarize Minnesota 1961 precipitation to date, January through March was below the long-term mean. April was normal or slightly above,

Table 2. Soil moisture content at eight sites in Minnesota, 1961.

Station	Date	Measured available water present	Percent measured water to maximum possible	Precipitation between sampling periods	Approximate amount of water used*
Butterfield	4/10	8.3 in.	60.1%	---	---
	7/5	9.5	68.8	8.0 in.	6.8 in.
	9/28	4.9	35.5	8.9	13.5
				16.9	20.3
Crookston	4/19	5.2 in.	39.1%	---	---
	5/9	8.0	60.1	1.5 in.	---
	6/8	1.6	12.0	0.4	6.8 in.
	7/3	1.2	9.0	1.4	1.8
	7/31	0.1	0.0	3.0	4.1
	9/1	-0.4**	0.0	1.8	2.5
	10/2	1.8	13.5	4.9	2.7
	11/1	4.1	30.8	2.3	0.0
				15.3	17.9
Dodge Center	5/4	7.5 in.	70.1%	---	---
	9/28	2.7	25.2	19.8*** in.	24.6 in.
				19.8	24.6
E. Grand Forks	5/31	9.1 in.	66.4%	---	---
	7/26	6.8	49.6	3.8 in.	6.1 in.
	9/4	5.6	40.9	1.5	2.7
	10/3	9.6	70.1	3.2	0.0
				8.5	8.8
Gaylord	5/15	11.0 in.	94.0%	---	
	7/5	10.4	88.9	5.3 in.	5.9 in.
	10/25	8.5	72.6	12.1	14.0
				17.4	19.9
Kellogg	5/5	11.4 in.	79.2%	---	
	10/6	7.4	51.4	18.5 in.	22.5 in.
				18.5	22.5
Lamberton	4/17	9.1 in.	65.9%	---	---
	5/1	7.2	52.2	0.6 in.	2.5 in.
	6/28	7.4	53.6	6.9	6.7
	7/28	8.1	58.7	3.9	3.2
	8/30	6.3	45.7	3.4	5.2
	10/2	5.0	36.2	2.7	4.0
	11/21	9.0	65.2	3.6	0.0
				21.1	21.6

Milaca	4/7	6.3 in.	64.3%	---	
	5/13	5.7	58.2	2.5 in.	3.1 in.
	10/2	2.8	28.6	16.8	19.7
				19.3	22.8

* Assuming no runoff or drainage.
** Below wilting point; sum of negative values exceeded positive values, although there was some available water in the first foot of soil; a similar circumstance resulted in the very low values of 7/31 and 10/2.
*** Rochester, Minnesota, precipitation data.

as were the first fourteen days of May. However, from May 14 through June 29 precipitation was much below the long term mean. General rains fell on June 30. Timely July rains fell over the drought stricken counties, as well as the rest of the state. July totals were much above the long term mean with the exception of the Roseau-Warroad area, the Madison-Dawson-Milan area, the Meadowlands area and along the north shore of Lake Superior. Although August rains were below normal, what rain fell was timely and heavy enough to develop field crops. September precipitation was much above normal. In the northern third of the state September totals averaged 3 inches above the long-term mean of 2.50 inches. Precipitation in October was above normal in all of the states except the north-central, northeast and west-central. November was below normal everywhere except the southeast. November precipitation was generally well below the long-term mean except in the southeast.

Temperaturewise the state was 1 to 3 degrees above the long-term mean for the period January through October 27. Actually the temperature cooperated with our lack of precipitation. During May and June when the precipitation deficiency was the greatest, temperatures were below the long-term for May and just slightly above for June. As a result the lack of precipitation was not aggravated by daily hot temperatures. This was one of the reasons the near-drought condition where it existed was not as severe as it was in 1936 and 1934. The monthly mean temperature for the state as a unit was equal to or below the long term mean for January, April, May, July and September. The first occurrence of a temperature of 32°F or colder was reported in the Grand Rapids-Meadowlands-Cloquet area on September 4, many other areas on September 23 and 25. The entire state was blanketed with temperatuers in the 20's on September 28.

Soil Moisture Expectations for 1962

Sufficient precipitation has not yet fallen in the northern one-third of the state to bring soil moisture reserves up to a level where the area could withstand another drouth period without serious effects. As a result this area remains in a precarious soil moisture condition. For adequate plant growth this region requires, as a bare minimum, spring precipitation equal to the long-term mean, and to replenish the subsoil above normal precipitation will be necessary.

Except for localized areas in the central one-third of the state the remainder of Minnesota is entering winter with normal to above normal soil moisture reserves. This part of the state could then expect adequate crop growth with normal to even somewhat below normal precipitation. Above normal spring precipitation would create a surplus problem in certain areas of south-central and southeastern Minnesota.

Table 3 shows the probabilities in percent of receiving below normal, normal and above normal spring precipitation in the nine subdivisions of Minnesota. It is apparent that the probabilities do not favor the build-up of the necessary soil moisture reserves in the northern one-third of Minnesota during the period April 15 - May 31.

Table 3. Probabilities in percent of receiving selected amounts of spring (April 15 - May 31) precipitation in Minnesota.

	NW*	NC	NE	WC	C	EC	SW	SC	SE
½ Normal	84	85	93	84	83	82	83	87	92
Normal	43	43	51	44	40	39	49	40	50
1½ Normal	14	14	18	17	14	13	20	11	15

Table 4. Some temperature and precipitation characteristics of Minnesota.

	NW	NC	NE	WC	C	EC	SW	SC	SE
Ave. Annual Total Precip. (in.)	21.04	24.58	27.26	23.32	25.77	28.41	24.56	28.17	29.23
Ave. % of total received April-June	36.0	35.8	33.2	39.9	39.5	37.6	40.5	37.7	36.5
Ave. Annual Temp. (°F)	38.8	39.2	39.2	43.4	43.3	41.4	45.4	45.8	45.5
Ave. April Temp. (°F)	38.6	39.7	38.9	44.2	44.0	41.9	45.6	46.3	45.9
Ave. May Temp. (°F)	53.8	53.1	50.7	57.1	57.0	54.5	58.3	58.7	58.3
Ave. June Temp. (°F)	63.1	62.9	59.5	66.6	66.7	64.2	67.8	68.7	68.1

Of benefit to the drier parts of the state may be the December snows which fell before frost had penetrated deeply into the soil. As long as the snow cover remains deeper penetration of the frost will be greatly retarded due to the excellent insulating property of snow. As a result, soils may be expected to thaw more quickly in the spring with increased absorption of rain and less runoff.

St. Paul Campus Weather Data

In September, 1960, a weather station was established by the Department of Soils within the experimental plot area of the St. Paul campus. Soil temperatures were the first to be recorded and as funds and equipment became available various other items came to be measured. It was not until December,

1960, for example, that a whole month's data had been recorded for air temperatures. Table 5 is a summary by month of the weather data measured at the station and tables 6 and 7 contain the soil temperature data. While only monthly data are shown it is realized that many may wish more detailed information. Such is available for anyone interested and daily data is on file in Room 335, Soil Science.

Weekly Soil Temperature Averages at Four Stations

Since all too little is known about soil temperatures it is believed that many may find table 8 of interest. Here in table 8 is a compilation of weekly soil and ambient (air) temperatures for the period March 29 through October 3 at the four stations presently taking such data. Only the very shallow depths have been considered since at greater depths the variation decreases greatly.

Table 5. Summary of Atmospheric Conditions at the Experimental Plot, Department of Soils, University of Minnesota, St. Paul, October, 1960 - September, 1961.

	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.
Ambient Temp. °F.												
Ave. Max.	M*	M	27.8	24.2	34.7	42.4	48.8	67.8	80.0	81.0	83.4	71.4
Ave. Min.	M	M	10.9	6.7	16.8	26.9	31.5	43.6	56.9	60.2	61.1	50.1
Ave.	M	M	19.3	15.5	25.8	34.7	40.1	55.7	68.4	70.6	72.3	60.8
Departure[1]	M	M	-0.1	+0.9	+7.6	+3.8	-5.9	-2.8	+0.2	-3.5	+0.8	-1.4
Extreme Max.	M	M	51.7	46.9	49.8	61.0	64.3	85.4	94.0	90.1	93.1	94.0
Extreme Min.	M	M	-7.2	-21.2	-2.7	16.0	15.5	28.3	42.8	29.0	50.1	32.2
Recorder Ave.[2]	M	M	M	M	27.8	33.1	38.4	61.8	71.9	70.1	71.9	59.1
Precipitation												
Total (inches)	M	1.10	0.73	0.10	0.22	1.99	1.42	5.01	2.14	3.19	1.75	3.06
Departure[1] (inches)	M	-0.34	-0.12	-0.70	-0.71	+0.51	-0.59	+1.89	-2.12	+0.52	-1.04	+0.21
Greatest Day (inches)	M	0.90	0.70	0.05	0.17	1.22	0.47	1.15	0.66	0.92	0.60	0.43
No. of Days, .Tor more	M	4	6	6	6	10	10	13	12	16	13	15
Wind[3]												
Total per month (mi.)	M	4383	4326	3941	3389	4687	4866	4389	2774	2197	2471	3609
Ave. per Day (mi.)	M	146	139	127	121	151	162	142	92	71	80	120
Ave. mph Per Day	M	6.1	5.8	5.3	5.0	6.3	6.7	5.9	3.9	2.9	3.3	5.0
Prevailing Direction at 5 p.m.	M	M	M	NW	SSE, NW	NW	NW, NNW	NW	SW	ENE, NW	SSW	NW
% Frequency at 5 p.m.	M	M	M	35	14	26	17	16	13	16	26	20
Relative Humidity[4]												
Ave. Max.	M	M	83	86	92	87	85	78	86	97	94	95
Ave. Min.	M	M	56	53	52	51	43	33	37	44	40	50
Ave.	M	M	70	69	72	69	64	55	61	71	67	73
Ave. Vapor Press. in inches of mercury	M	M	0.069	0.006	0.097	0.139	0.159	0.246	0.427	0.535	0.536	0.392

*M = Missing

[1] Departure from Minneapolis W.B., Long Term Mean, 1931-1955.

[2] Average of 8 hours during day, 0000, 0300, 0600, 0900, 1200, 1500, 1800, 2100 hours.

[3] At 2 feet above ground.

[4] Plot watered July 16 - August 12, 1961.

Table 6. Summary of Soil Temperatures (°F.) at the Experimental Plot, Department of Soils, University of Minnesota, St. Paul, October, 1960 - September, 1961.

	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.[5]	May[6]	June	July	Aug.	Sept.	Ave.
Bare Soil[2]													
1 cm. Depth	50.1	34.9	21.7	17.3	26.3	34.9	39.3	62.4	74.9	77.8	78.5	62.3	48.4
5	50.5	35.6	22.5	17.8	25.7	34.2	38.8	61.1	73.7	77.5	77.8	63.1	48.2
10	50.8	36.3	23.7	18.5	25.5	33.5	38.1	59.9	72.6	76.8	77.2	63.6	48.0
20	51.5	37.6	25.6	19.7	25.4	32.7	37.2	58.4	70.9	75.8	76.3	64.3	47.9
40	52.8	40.0	29.1	22.0	25.2	31.7	35.6	55.0	67.8	73.5	74.7	65.5	47.7
80	55.0	44.7	35.8	27.5	26.5	31.6	34.4	49.6	61.5	68.3	71.2	66.2	47.7
Covered Soil (Sod)[3]													
1 cm. Depth	49.4	36.4	26.0	21.6	26.8	33.9	38.6	57.9	72.9	74.0	74.1	61.8	47.8
5	50.2	37.3	26.9	22.2	26.7	33.2	37.7	57.1	71.0	73.7	73.6	62.2	47.6
10	50.7	38.1	28.0	22.9	26.7	32.7	37.2	56.3	70.3	73.6	73.3	62.6	47.7
20	51.4	39.1	29.3	23.9	26.7	32.2	36.5	54.9	66.4	72.8	72.6	63.1	47.4
40	M	M	M	M	M	M	M	53.2	65.9	71.0	71.6	64.0	M
80	54.9	45.3	37.3	31.3	28.6	31.9	35.0	48.0	60.3	67.0	69.0	64.3	47.7
120[4]	M	M	M	M	M	M	M	46.9	56.0	63.7	66.6	64.0	M
160[4]	M	M	M	M	M	M	M	45.1	53.3	61.3	64.6	63.4	M
320[4]	M	M	M	M	M	M	M	41.7	45.6	51.8	56.5	58.3	M

[1] Copper-constantan thermocouples, auto-recording; averages of 0000, 0300, 0600, 0900, 1200, 1500, 1800, and 2100 hours.
[2] Smoothed and weed-free soil surface; Waukegan silt loam
[3] Oat stubble and volunteer oats October, 1960, until sodded in July, 1961; Waukegan silt loam; plot watered July 16-August 12, 1961.
[4] Installed May 13, 1961.
[5] Nine days missing.
[6] Seven days missing

Table 7. Summary of Standard Deviations of Soil and Ambient Temperatures at the Experimental Plot, Dept. of Soils, University of Minnesota, St. Paul October, 1960 - September, 1961.

	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June.	July	Aug.	Sept.
						Ambient Temp.						
	---	---	---	---	---	---	---	11.4	9.0	4.9	6.0	11.8
						Bare Soil						
1 cm. Depth	9.9	5.5	7.3	9.4	6.6	5.9	7.5	10.4	8.4	6.8	6.3	11.7
5	6.7	4.3	6.6	8.8	6.5	4.5	6.3	9.1	6.5	5.3	5.0	10.6
10	6.0	3.5	5.9	8.2	6.2	3.3	5.2	8.2	5.5	4.4	4.1	9.9
20	5.2	2.9	5.3	7.4	5.9	1.8	4.3	7.4	4.2	3.3	3.2	8.7
40	4.2	2.6	4.5	6.1	5.2	0.5	3.8	6.2	2.9	2.2	1.9	7.1
80	2.8	2.7	3.1	3.8	3.6	0.5	3.3	4.7	2.3	1.2	0.9	4.5
						Covered Soil (Sod)						
1 cm. Depth	6.7	3.9	4.8	5.6	5.5	4.0	6.6	8.1	6.4	4.3	4.4	8.1
5	5.8	3.2	4.4	5.3	5.2	2.5	4.9	7.7	4.9	3.6	3.6	7.7
10	5.4	2.9	4.1	5.0	5.0	1.7	4.4	7.3	4.2	3.1	3.2	7.2
20	4.8	2.8	3.9	4.5	4.7	0.8	3.8	6.6	3.4	2.5	2.6	6.5
40	---	---	---	---	---	---	---	3.7	2.6	1.9	2.0	5.1
80	2.81	2.6	2.4	2.0	1.9	0.5	2.9	4.3	2.6	1.5	1.1	3.3
120	---	---	---	---	---	---	---	1.7	2.7	1.8	0.5	2.2
160	---	---	---	---	---	---	---	1.5	2.9	2.0	0.3	1.6
320	---	---	---	---	---	---	---	0.7	1.7	2.0	0.9	0.5

Table 8. Weekly Ambient and Soil Temperature Averages (°F.) at Four Minnesota Stations, March 29 - October 3, 1961.

Week beginning	3/29	4/5	4/12	4/19	4/26	5/3	5/10	5/17	5/24	5/31	6/7	6/14	6/21	6/28	7/5	7/12	7/19	7/26	8/2	8/9	8/16	8/23	8/30	9/6	9/13	9/20	9/27
Fairmont* (Radio station KSUM; Clarion-Nicollet-Webster undergrass; 0% slope; Hg in glass thermometer; Ave. of 6 P.M. observation).																											
Ambient Temp.	35	37	37	51	43	50	62	54	36	68	74	64	69	77	71	71	72	75	74	73	69	75	71	69	60	56	49
Soil Temp. (3 in.)	35	37	38	49	50	51	58	54	61	66	70	68	69	79	76	75	76	75	76	77	72	76	74	71	61	57	49
Faribault* (Radio station KDHL; Clarion silt loam under grass; 0% slope; Hg in glass thermometer; Ave. of 7 A.M. observation).																											
Ambient Temp.	31	35	34	47	41	49	61	52	59	68	71	62	66	73	68	68	69	75	73	70	68	69	69	68	58	54	45
Soil Temp. (3 in.)	33	32	33	39	39	46	52	54	58	65	69	66	66	68	67	68	70	71	--	--	--	--	72	77	66	61	47
Lamberton* (S.W. Exp. Sta.; Nicollet silty clay loam; bare soil; 0-2% SE slope; Palmer Dial-Type Thermometer; Ave. of Max.-Min. observation).																											
Ambient Temp.	37	37	36	51	43	50	62	53	61	68	74	64	67	74	69	69	69	73	74	71	68	71	71	68	59	57	50
Soil Temp. (2 in.)	33	35	37	47	47	49	57	54	64	71	73	70	71	77	76	72	74	77	76	75	75	75	79	70	60	58	51
St. Paul (Agr. Exp. Sta. Dept. of Soils; Waukegan silt loam under grass; 0% slope; Thermocouples; Ave. of 8 daily observations).																											
Ambient Temp.	33	38	36	49	42	51	60	53	60	68	71	65	64	75	69	69	71	75	73	73	69	71	73	69	59	56	46
Soil Temp. (1 cm.)	35	35	37	56	46	57	61	59	70	80	73	74	73	87	79	77	75	81	81	79	74	75	76	71	61	56	49
Soil Temp. (5 cm.)	35	37	37	47	45	55	61	57	69	73	72	73	72	79	78	77	75	81	80	79	75	75	76	72	61	57	50
Soil Temp. (10 cm.)	34	36	36	45	45	54	61	57	68	71	71	72	71	79	79	76	75	81	79	79	75	74	76	72	61	57	50

* Climatological Data, Minnesota, U.S.W.B., Dept. of Comm., Asheville, N. C. 1961.

Soil Testing in Minnesota During 1961

By John Grava

Currently the University of Minnesota Soil Testing Laboratory tests about 42,000 samples annually. The following data show the number of various types of samples analyzed in 1961:

Regular farm, garden and lawn sampled	37,353
Florist (greenhouse) samples	1,300
Limestone samples	154
Departmental research samples	3,543
Total	42,350

The fall soil sample "round-up" campaign conducted for last several years really paid off in 1961. 23,281 samples, or 62% of the total number were submitted for testing during the last six months of the year. Greatest activity in sample collection during this campaign was in the following counties:

Dakota County	897 samples
Rice County	762 samples
Yellow Medicine County	605 samples
Pennington County	503 samples
Kittson County	464 samples

Figure 1 shows monthly distribution of samples received by the laboratory during 1961.

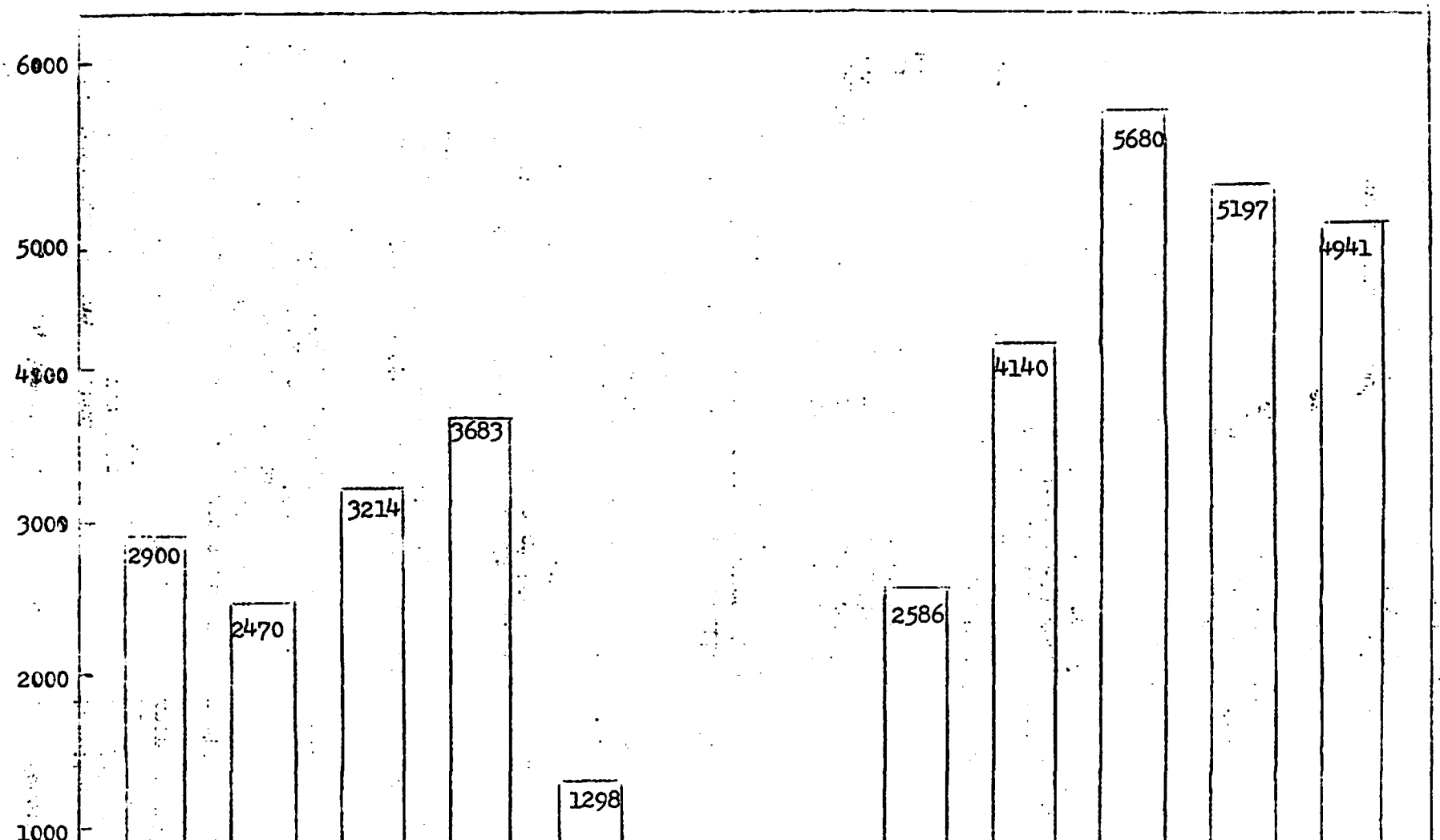

Figure 1. Monthly Distribution of Soil Samples Received by the University of Minnesota Soil Testing Laboratory During 1961 (Total = 37,353).

The Effect of Nitrogen Source, Placement and Time of Application on the Yield and Composition of Continuous Corn on Webster clay loam at Lamberton

J. M. MacGregor, W. W. Nelson, and R. G. Hanson

The long time effect of urea or of ammonium nitrate nitrogen applied at three different rates and times using two placements on the yield and the composition of field corn where grown every year is the object of an investigation commenced on the Southwest Experiment Station at Lamberton early in 1960.

Four replicates of 18 different treatments are established on corn plots six rows in width and 77.5 feet in length. Ample phosphorus and potassium are applied in the starter fertilizer. A plant population of 18,000 stalks per acre is grown and all crop residues are plowed under after harvest in the late fall. The primary objective is to find an answer to four important questions:

1. The relative effectiveness of equal amounts of nitrogen as urea or as ammonium nitrate when applied to this soil at different rates per aare.

2. The relative efficiency of such nitrogen forms when they are applied in the late fall, in the spring at time of planting, or as a sidedressing in late June or in early July.

3. The relative values of fall plowing down two nitrogen sources in comparison to overwintering of the nitrogen fertilizer on the surface of the fall plowed soil.

4. To find if there was any possible fertilizer nitrogen accumulation in the soil, the relative amounts removed by the corn crop and losses sustained through leaching, losses to the air, or losses by soil erosion.

For the first few years, all data is to be obtained by harvesting and chemically analyzing the corn plants, and computing nitrogen removal and relative efficiency based on amounts actually present in the corn plants. Later in the experiment, possible nitrogen accumulations in the soil will be measured directly.

It was not possible to fall plow and fertilize late in 1959, and the area was spring plowed early in 1960 and the first fertilizer treatments were applied at planting time. Fall plowing and fertilizing was carried out both in 1960 and in 1961. The 1961 nitrogen sidedressing with urea or with ammonium nitrate was applied on June 23rd, and the following visual observations were made on July 27th:

1. 40# of applied N/A or less - the corn leaves of all plants were "firing".

2. 80# of applied N/A - fall nitrogen - leaves fired
   spring nitrogen - some firing
   sidedressed - leaves green

3. 160# of N/A - corn leaves of all treatments were a deep green.

4. Nitrogen source, whether from urea or from ammonium nitrate had no visual effect on severity of leaf "firing".

The yield and composition of the 1960 and the 1961 corn grain and fodder are shown in the following table.

The Effect of Nitrogen Source, Rates & Time of Application on the Yield and Nitrogen Content of 1960 & of 1961 Field Corn at Lamberton, and the Percentage N Uptake by the Corn
Webster silty clay loam
(Average of four replicates)

Treatment (lbs. N per acre)[1]	Ear Corn bu./A 1960	Ear Corn bu./A 1961	Ear Corn % N 1960	Ear Corn % N 1961	Fodder Tons/A 1960	Fodder Tons/A 1961	Fodder % N 1960	Fodder % N 1961	Percentage uptake of fertilizer nitrogen 1960	Percentage uptake of fertilizer nitrogen 1961	Percentage uptake of fertilizer nitrogen 2-yr. average
None	49.5	88.2	1.17	1.20	1.82		0.74		--	--	
40 as NH_4NO_3--fall plowed under	42.3	87.5	1.15	1.19	1.79		0.84		8	9	0
40 as urea --- " " "	55.1	78.2	1.09	1.22	1.57		0.61		-28	90	31
40 as NH_4NO_3--left on plowed surface	49.0	96.7	1.26	1.15	1.87		0.84		16	86	51
40 as urea --- " " " "	62.3	101.3	1.20	1.37	1.87		0.76		13	74	44
80 as NH_4NO_3--fall plowed under	67.4	97.9	1.22	1.24	1.85		0.78		5	43	24
80 as urea --- " " "	61.7	76.9	1.25	1.20	1.87		0.88		7	27	17
160 as NH_4NO_3- " " "	69.8	97.9	1.31	1.34	2.23		0.91		17	58	38
160 as urea -- " " "	79.4	112.5	1.22	1.46	2.18		0.85		12	71	42
40 as NH_4NO_3-- at planting	66.2	92.0	1.28	1.21	1.85		0.87		21	67	44
40 as urea --- " "	45.4	91.1	1.22	1.19	2.12		0.85		47	27	37
80 as NH_4NO_3-- " "	59.3	90.0	1.20	1.17	2.07		0.79		12	43	28
80 as urea --- " "	57.7	99.1	1.26	1.32	2.26		0.82		21	40	31
40 as NH_4NO_3-- as late sidedressing	63.6	92.6	1.23	1.19	2.01		0.89		27	80	54
40 as urea --- " " "	57.7	95.6	1.12	1.33	1.90		0.77		9	107	58
80 as NH_4NO_3-- " " "	50.4	98.4	1.22	1.24	1.76		0.89		15	34	25
80 as urea --- " " "	76.9	86.4	1.14	1.37	1.51		0.81		-11	95	42
160 as NH_4NO_3- " " "	40.7	97.4	1.23	1.50	1.65		0.88		0	54	27

[1] The entire area received 0-30-15 at the rate 125#/A as band applied starter + 150#/A broadcast before plowing.

Comments

The yields of corn grain grown on the different nitrogen treatments were variable in both years of the experiment, and it is hoped that these will tend to be more uniform as the experiment is continued. Such variability prevents any meaningful conclusions at present on the relative effectiveness of the two nitrogen sources or as to the most efficient time of applying such forms of nitrogen.

The relative proportions of additional nitrogen taken up by the corn growing on the nitrogen fertilized plots is of interest. So far, fall plowing and the turning under of broadcast fertilizer nitrogen on the cornstalks was not advantageous from considerations of corn yield or efficiency of nitrogen uptake by the corn. Where nitrogen was applied at the low rate of 40 pounds per acre the surface application appeared to produce better results than where the nitrogen fertilizer was plowed under.

Two years of results on this type of experiment are evidently insufficient to draw any definite conclusions on treatment efficiency and only generalizations may be noted. As yet there appears to be little difference in effect of the two nitrogen sources or in the time of nitrogen application or placement on the yield or nitrogen content of corn and relative increases in nitrogen removed where such treatments were made.

The Effect of Nitrogen Fertilization On Yield and Composition of Wheat at Crookston in 1960 & 1961.

J. M. MacGregor, H. W. Kramer, & O. C. Soine

Ammonium nitrate has been the most popular form of solid nitrogen fertilizer in Minnesota for some fifteen years. Urea manufacture and sale has been gradually increasing during the last several years, since it contains 45% N in comparison to the 33% N of the ammonium nitrate, urea manufacturing costs have been reduced, and urea storage (both as to space and possible explosiveness) is simpler than with ammonium nitrate. On being moistened, urea hydrolyzes to ammonium carbonate with the nitrogen being utilized either as the ammonium ion, or after gradual oxidation to the nitrate form. As the urea hydrolyzes, there is a sharp, but localized increase in soil pH - a condition favoring ammonia losses to the atmosphere. Many laboratory and a few field experiments have shown some losses of urea nitrogen as ammonia, but the magnitude of such losses under field conditions and the comparative effectiveness of urea nitrogen to other fertilizer nitrogen sources have not been well established.

The present experiment was designed to study the effect of urea and of ammonium nitrogen on the yield and nitrogen composition of wheat, in order to establish the relative proportions of nitrogen from the two sources actually taken up by wheat. Since laboratory experiments have demonstrated that calcareous soils are subject to greater volatilization of ammonia nitrogen from urea than are acid soils, and immediate covering of the applied urea may reduce such losses, the calcareous Hegne clay loam at Crookston was selected for this trial.

Urea or ammonium nitrate nitrogen was applied in quadruplicate treatments at the rate of 20 or 40 pounds of nitrogen per acre with three basic differences:

1. The nitrogen fertilizers were disked in at time of seeding.

2. The nitrogen fertilizers were broadcast and left on the soil surface immediately following seeding.

3. The nitrogen fertilizers were broadcast when the wheat was in the boot stage and left on the soil surface.

Both wheat grain and straw samples were analyzed for yield and N content, and the additional nitrogen present in the nitrogen-fertilized plants was considered to be due to the addition of nitrogen fertilizer and this was computed as percentage recovery of the applied fertilizer nitrogen. The results are shown in the following table.

The effect of nitrogen source, time and depth of covering of nitrogen fertilizer on the yield and nitrogen content of 1960 and of 1961 wheat on Hegne clay loam at Crookston and percentage uptake of the applied fertilizer nitrogen
(Average of four replicates)

Nitrogen treatment (lbs/A[1]	Grain bu/A 1960	Grain bu/A 1961	Grain % N 1960	Grain % N 1961	Straw tons/A 1960	Straw tons/A 1961	Straw % N 1960	Straw % N 1961	Percentage uptake of fertilizer nitrogen 1960	1961	2 yr. average
None	8.2	12.4	2.08	2.30	0.44	0.72	0.47	0.46	--	--	--
20 as NH_4NO_3-disked in at seeding	11.7	15.5	2.00	2.40	0.82	0.98	0.36	0.42	26	42	34
20 as urea -- " " " "	15.9	20.7*	2.00	2.53	0.78	1.12	0.42	0.39	50	81	66
40 as NH_4NO_3- " " " "	22.7	17.9*	2.11	2.52	0.96	0.90	0.41	0.38	50	21	36
40 as urea -- " " " "	19.6	20.5**	1.47	2.55	0.94	1.15	0.38	0.53	37	49	43
								Average	41	48	45
20 as NH_4NO_3- left on surface at seeding	16.7	15.4	2.05	2.35	1.09	1.04	0.43	0.41	73	25	49
20 as urea--- " " " " "	16.1	17.2	2.05	2.60	0.92	0.96	0.36	0.46	56	53	55
40 as NH_4NO_3- " " " " "	21.3	19.9**	2.10	2.63	1.28	1.17	0.41	0.55	28	47	38
40 as urea--- " " " " "	19.7	21.3**	2.02	2.65	0.86	1.28	0.42	0.45	39	48	44
								Average	49	43	47
20 as NH_4NO_3- broadcast at boot stage	12.6	15.9	2.10	2.59	0.51	0.91	0.56	0.46	33	41	37
20 as urea--- " " " "	6.7	14.6	2.16	2.60	0.36	0.97	0.62	0.46	-4	38	17
40 as NH_4NO_3- " " " "	7.9	16.8*	2.40	2.80	0.58	1.01	0.65	0.50	12	30	21
40 as urea--- " " " "	11.9	12.7	2.19	2.74	0.39	0.78	0.64	0.59	14	24	19
								Average	14	33	24

[1] Entire experimental area A received 0 + 100 + 100 broadcast each spring.

* Significant at the 5% level 5.2 bu.
** Significant at the 1% level 6.9 bu.

Tentative Conclusions (on two years of results)

1. Urea or ammonium nitrate nitrogen broadcast at the time of wheat seeding, and either disked in or left on the surface, was much more effective for increasing wheat yield and nitrogen recovery, than were similar applications made some weeks later when the wheat plants were in the boot stage.

2. Urea was equal in effectiveness to ammonium nitrate nitrogen, both for increasing wheat yields and fertilizer nitrogen recovery.

The Effect of Nitrogen Source, Time of Application and Soil Covering

Yield and Nitrogen Content of 1960 - and 1961 field corn at Crookston on Hegne clay loam

J. M. MacGregor, H. W. Kramer, & O. C. Soine

The relative efficiency of urea and of ammonium nitrate nitrogen on corn production on the Hegne clay loam at Crookston was investigated in 1960 and again in 1961. The entire experimental area (different sites were used each year on the Northwest School and Experiment Station Farm) received broadcast phosphorus-potassium applications equivalent to 0 + 100 + 100. Four replications of thirteen treatments were used. Yields of ear corn and of fodder were determined, and both were analyzed for nitrogen content to estimate the nitrogen removal by the corn grown on the different nitrogen treatments. The results are shown in the following table.

Although the yields were variable, they were generally increased by nitrogen fertilization. The general inconsistencies in the results would allow no distinguishable differences in the relative efficiencies of the two nitrogen sources in either the corn grain or in fodder production. Urea nitrogen appears to be somewhat more effective in the early application of 1961 which was covered by disking.

If the nitrogen content on the non-nitrogen fertilized corn is taken as a measure of the amount of native soil nitrogen removed, and the additional quantity considered to be produced by applying fertilizer nitrogen, it is evident that the average nitrogen recovery is some 30% to 40% of the amount applied in the fertilizer. Where urea nitrogen was applied at time of seeding in May and disked in, fertilizer nitrogen recovery was better from this source than with ammonium nitrate, but when left on the surface, uptake was better from the applied ammonium nitrate. July sidedressing in 1960 with 40 pounds of ammonium nitrate nitrogen per acre was better than where urea was used, but this was not the case in 1961.

Comparative nitrogen efficiency due to differing N sources and application practices will obviously vary with the growing season, soil, and crops grown, and it is evident that results from several additional growing seasons be obtained before any definite conclusions on nitrogen efficiency in corn production on the Hegne clay loam can be made.

The Effect of Nitrogen Source, Time and Depth of Covering of Nitrogen Fertilizer on the Yield and Nitrogen Content of 1960 and of 1961 Field Corn on Hegne clay loam at Crookston, and Percentage Uptake of Applied Fertilizer Nitrogen.

(Average of Four Replicates)

Treatment (lbs N/A)[1]	Ear Corn bu/A 1960	Ear Corn bu/A 1961	Ear Corn % N 1960	Ear Corn % N 1961	Fodder tons/A 1960	Fodder tons/A 1961	Fodder % N 1960	Fodder % N 1961	Percentage uptake of fertilizer nitrogen 1960	1961	2 yr. average
None	52.9	80.8	1.4	1.2	1.18	2.30	0.95	0.50	—	—	—
40 as NH_4NO_3-disked in May.	63.1	71.5	1.4	1.4	1.15	2.25	0.95	0.58	18	15	17
40 as urea — " " "	67.8	93.4*	1.5	1.5	1.15	2.16	0.94	0.66	32	77	55
80 as NH_4NO_3- " " "	67.6	81.8	1.5	1.4	1.70	2.10	0.94	0.52	27	10	19
80 as urea — " " "	67.3	87.2*	1.6	1.5	1.65	2.20	1.01	0.67	34	32	33
								Average	28	34	31
40 as NH_4NO_3-left on surf. - May	66.2	85.5	1.6	1.5	1.58	2.60	1.13	0.64	74	61	68
40 as urea — " " " - "	—	82.7	-	1.4	1.12	2.23	1.12	0.56	—	32	32
80 as NH_4NO_3- " " " - "	66.4	91.4*	1.4	1.5	1.68	1.99	1.01	0.68	27	38	33
80 as urea — " " " - "	60.7	81.4	1.5	1.6	1.25	2.38	1.04	0.68	16	34	25
								Average	39	41	40
40 as NH_4NO_3- sidedressed - July	63.8	75.0	1.5	1.4	1.55	2.25	1.04	0.60	61	25	43
40 as urea — " - "	57.2	79.6	1.3	1.4	1.38	2.29	0.95	0.55	14	26	20
80 as NH_4NO_3- " - "	61.7	93.6*	1.6	1.5	1.38	2.24	1.06	0.74	22	43	33
80 as urea — " - "	60.4	89.6*	1.6	1.4	1.45	2.74	0.97	0.71	21	45	33
								Average	30	34	32

[1] Entire area received 0 + 100 + 100 broadcast in May.

* Significant at the 5% level. 14.8 bu.
** Significant at the 1% level. 19.8 bu.

Corn population approximately 18,000 stalks per acre.

The Effect of Anhydrous Ammonia Sidedressing for Corn on Hegne Clay Loam At Crookston and on Port Byron Silt Loam at Rosemount in 1961.

J. M. MacGregor, P. M. Burson, O. C. Soine,& H. W. Kramer

Anhydrous ammonia is an important source of fertilizer nitrogen in Minnesota and initial 1961 plans included fertilization of both wheat and corn at Crookston, a large corn experiment on Barnes silt loam at Morris, and some sidedressing experiments on corn and grasses at Rosemount. Due to extremely dry soil conditions until mid-July at Crookston, the fertilized wheat germinated and tillered very thinly and erratically, and this experiment was discontinued for this reason. Drowth conditions at Morris resulted in very poor corn seed germination on the starter fertilized experimental area, and in early July this experiment was then abandoned before the contemplated sidedressing with several rates of ammonia nitrogen was carried out. Corn was sidedressed at Rosemount (Port Byron silt loam) early in July, following very dry weather during June when less than one inch of rain fell during the entire month.

The results obtained are shown in the following tables.

Anhydrous ammonia was an effective nitrogen sidedressing at all rates of application, but the more moderate application rates of 40 to 100 pounds per acre produced the better results with the drier soil conditions experienced at both locations during early part of the growing season. Where nitrogen uptake was determined on the corn from Crookston, the 40 and 80 pounds per acre rates nitrogen fertilization were highly efficient for increasing the nitrogen content of plants, and gradually decreased in relative efficiency as the rate of nitrogen fertilization per acre was increased.

The Effect of Nitrogen Sidedressing with Anhydrous Ammonia on the Yield and Composition of 1961 Corn at Crookstan (Hegne clay loam)

N applied lbs/A[a]	Ear Corn				Fodder			% Fertilizer N uptake
	bu/A	% N	% protein	lbs.N/A	T/A	% N	lbs. N/A	
None	80.8	1.18	7.3	56.2	2.30	0.50	79.2	---
40	96.6*	1.57	9.7	89.3	2.51	0.86	132.6	134
80	104.4**	1.64	10.3	101.6	3.04	0.84	152.6	92
120	92.5	1.59	9.9	86.4	3.05	0.91	142.0	52
160	90.4	1.58	9.9	84.4	2.56	0.87	124.8	29

[a] All plots received a broadcast equivalent of 0 + 100 + 100.

* Significance at 5% level -- 14.4 bu.
** Significance at 1% level -- 19.2 bu.

Table 2. The Effect of Nitrogen Sidedressing with Anhydrous Ammonia on the Yield of 1961 Corn at Rosemount. (Port Byron silt loam)

Fertilizer Treatment (lbs/A)	Plant Population	Ear Corn in bu/A
None	15,000	71.4
250 of 6-12-24 as band starter	15,000	81.6
Starter + 60 N	16,000	106.4
Starter + 90 N	16,000	100.8
Starter +120 N	16,000	99.1

Nitrogen Fertilization Studies on Turf Grass - 1961

By R. S. Farnham

Nitrogen fertilization studies on bluegrass turf were continued in 1961 using some of the new coated fertilizers. The objectives of these studies were as follows:

1. To compare the effectiveness of the common lawn fertilizers on yield and quality of Kentucky blue grass turf.

2. To determine the optimum nitrogen rate needed when applied as a single application only and to compare the effectiveness of nitrogen materials from both organic and inorganic sources.

3. To evaluate the effectiveness of several new coated nitrogen materials and slow release chemical products in providing adequate nitrogen during the entire season.

Materials & Methods

Nitrogen fertilizer materials included in the study were ammonium nitrate, mixed fertilizers, 16-8-8, 20-10-5, 12-10-10, both coated and uncoated, ureaform products (uramite and nitroform), urea, calcium, anthraxillate (organic), and several experimental products supplied by Spencer Chemical Company.

Nitrogen was applied at 4 and 8 pounds/1000 sq. ft. rates. Phosphorus and potassium were applied in amounts equivalent to 8 lbs. of P_2O_5 and K_2O per 1000 sq. ft. All materials were applied in May on dry turf and wet thoroughly immediately after application to prevent burning.

Plots were located west of the Farm Shop on the campus and the size of each was 5' x 10'. Color ratings were made at time of each clipping and a total of 10 clippings were made from June 1 to September 15th.

Results & Discussion

Total clipping yields and color ratings are shown in table 1. The data shows that for one application during the season the 8 lbs N/1000 sq. ft. rate of N was superior to the 4 lbs/1000 rate. Some of the coated materials produced by Archer-Daniels-Midland produced the highest yields of clippings and rated highest in color, notably the coated 20-10-5, and 10-10-10 and 30-10-0. The data also shows that a blend of coated 30-10-0 and a slow release chemical product S4238 (Spencer Chemical Co.) yielded the greatestamount of clippings and ranked 3rd in color.

Noticeable in these studies is the good performance of NH_4NO_3 at the highest rate (8 lbs. N/100 sq. ft.) and the poor performance of urea form fertilizers - uramite and nitroform. The latter two are ranked 30th and 27th in yield and 16th and 15th in color which is only slightly better than the check with no nitrogen.

It is suggested that since these studies were made on a medium textured soil where leaching of soluble nitrogen is not too great the slowly soluble forms such as the coated mixed fertilizers, coated ammonium nitrate and Spencer's slow release chemicals would perform even better on very sandy soils. Leaching studies and moist soil burial studies with the coated materials show that the nutrient release rate can in effect be regulated to almost any degree desired by varying the thickness of the film-forming coat on the fertilizer pellets.

Table 1. 1961 Turf plots total clipping yields and color ratings.

Plot No.	Treatment	Rate lbs N/1000 ft^2	Color: Average Color Rating	Color: Rank	Clippings: gms/ 100 ft^2	Clippings: Rank
28	Spencer S4238 ½, 30-10-0 ½ coated	8	6.9	3	59,773	1
9	ADM 20-10-5 (coated)	8	7.4	1	59,351	2
14	NH_4NO_3 (uncoated)	8	7.0	2	58,219	3
7	ADM 10-10-10 (coated)	8	6.5	4	56,388	4
8	10-10-10 (uncoated)	8	6.9	3	55,078	5
27	16-8-8- ½ coated, ½ uncoated	8	6.0	8	52,514	6
4	16-8-8 uncoated	8	6.4	5	51,548	7
3	16-8-8 (coated)	8	6.1	7	51.315	8
5	10-10-10 (coated)	4	5.8	10	51,304	9
24	Spencer coated 30-10-0	8	6.0	8	50,238	10
10	20-10-5 (uncoated)	8	6.1	7	49,750	11
32	20-10-5 ½ coated, ½ uncoated	8	6.1	7	49,672	12
6	10-10-10 (uncoated)	4	5.9	9	49,339	13
11	NH_4NO_3 (coated)	4	6.0	8	49,339	14
22	Spencer S4383	4	5.5	12	48,451	15
29	NH_4NO_3 ½ coated, ½ uncoated	8	6.2	6	48,285	16
17	Belgium calcium anthraxillate	8	6.2	6	47,796	17
25	Spencer 30-10-0 uncoated	8	6.4	5	47,763	18
16	Urea (12% coat)	8	5.8	10	47,663	19
13	NH_4NO_3 (coated)	8	6.0	8	47,330	20
12	NH_4NO_3 (uncoated)	4	5.9	9	46,220	21
15	Urea (8% coat)	8	5.6	11	46,109	22
23	Spencer S4383	8	5.0	14	45,243	23
26	16-8-8 1/3 coat, 1/3 uncoat, 1/3 NH_4NO_3 (C)	8	5.3	13	45,188	24
2	16-8-8 (uncoated)	4	5.6	11	44,189	25
1	16-8-8 (coated)	4	5.5	12	43,545	26
18	Nitroform	8	4.8	15	42,968	27
20	Spencer S4238	4	5.3	13	39,882	28
21	Spencer S4238	8	3.7	18	35,964	29
19	Uramite	8	4.5	16	35,619	30
30 & 31	Check (NO nitrogen)	0	4.0	17	34,065	31

Phosphorus Source Experiment
Rosemount, 1961

A. C. Caldwell and J. B. Weber

A P source experiment was established at Rosemount in 1951. Twelve treatments of various phosphate materials were replicated four times across a regular rotation of corn, wheat, alfalfa, and alfalfa. K fertilizer was supplied according to soil tests.

The crop rotation was changed in 1959 to corn, soybeans, wheat and alfalfa.

Yields of corn, soybeans, and wheat were not significantly affected by the various phosphate sources. Experimental error amounted to a considerable portion of the variation between treatments and hence masked those differences which did exist. A definite overall P response is evident as nearly all of the treatments had a higher yield than their repective controls. Alfalfa yields were significantly (.05) increased by the various phosphate sources. All of the relatively available forms of P, treatments 2, 3, 4, 5, and 6, increased yields above the control to about the same extent. There were no significant differences between the phosphate sources, but the table indicates that the more available forms were somewhat superior to the less available forms.

Table 1. Effect of various phosphate treatments on the yield of corn, soybeans, wheat and alfalfa in a rotation, 1961.

Treatments	P_2O_5/A/yr lbs	Corn[1] bu/A	Corn[1] Diff.	Soybeans bu/A	Soybeans Diff.	Wheat bu/A	Wheat Diff.	Alfalfa[2] Tons/A	Alfalfa[2] Diff.
1. Check	--	120	--	24	-	28	-	3.05	--
2. Ord. Superphos.	40	134	14	25	1	30	2	4.81	1.76
3. Conc. Superphos.	40	133	13	26	2	34	6	4.95	1.90
4. Ca. Metaphos.	40	136	16	29	5	35	7	4.34	1.29
5. H_3PO_4	40	127	7	26	2	34	6	4.37	1.32
6. Fused Tri Ca.	40	132	12	27	3	32	4	4.71	1.66
7. Fla. rock + Ord. Super.	20 + 20	131	11	29	5	36	8	3.19	0.14
8. Fla. rock (lt)	100	137	17	26	2	29	1	4.24	1.19
	lbs. material/A/4 years								
9. Fla. rock (hvy)	1000	134	14	31	7	32	4	4.33	1.28
10. Western rock	1000	136	16	27	3	31	3	3.96	0.91
11. Col. clay rock	1000	127	7	26	2	29	1	3.21	0.16
12. Tunis. rock	1000	128	8	28	4	31	3	4.37	1.32
Standard error =			4.1		1.3		2.5		0.34
lsd (.05) =			N.S.		N.S.		N.S.		0.83
hsd (.05) =									1.74

[1] @ 15% moisture
[2] Dry weight

The Effect of Lime and Molybdenum on the Yield of Corn, Soybeans, Oats, and Alfalfa, 1961

A. C. Caldwell and J. B. Weber

To study the long time effects of lime on the yields of some common crops and on the physical and chemical properties of the soil, a research project with lime was started at the Rosemount station in the fall of 1951. Plots were laid out consisting of four replications of five treatments. Treatments were 0, 3, 6, 12, and 24 tons of lime per acre. A regular rotation of corn, oats, alfalfa, and alfalfa was set up. Each year corn and grain have received 200 pounds of 5-20-20 per acre as a fertilizer treatment. Alfalfa has received phosphorus and potassium fertilizers as needed according to soil test.

In 1959, it was decided to study the effect of lime on soybeans also, so the rotation was changed to corn, soybeans, oats and alfalfa. The soybeans received 100 pounds of 5-20-20 per acre as a starter fertilizer.

In 1960, an application of 8.7 ounces of Mo per acre, as $(NH_4)_2MoO_4$, was made to one of the check plots in each replicate to study the effect of applied Mo on the yields of the various crops.

Yield results from the four crops for 1961 are included in table 1. Corn yields were not significantly affected by the lime or molybdenum treatments. Corn yields on the treated plots are all higher than the control, however. The 6 tons per acre lime treatment appears to be yielding the most corn, as has been the case for several years. Tissue tests taken during the growing season indicated that K may have been limiting, thus resulting in the large variations on similarly treated plots, and a loss of significance in the statistical analysis. Soybean yields were significantly (.05) increased above the control by the 3 and 6 tons of lime per acre treatment. The treatments, other than the control, are not significantly different from each other.

Alfalfa yields were significantly (.05) increased by increasing amounts of lime applied, and also by Mo applications. None of the treatments, other than the control, are significantly different from each other. The results indicate that all of the lime applications yielded about the same amount of alfalfa above the control.

The included soil pH values are following the same trend as in previous years.

Table 1. The effect of lime and molybdenum on soil pH and the yields of corn, soybeans, oats, and alfalfa in a rotation, 1961.

Treatment	Soil pH	Yields: Corn[1] bu/A	Corn[1] Diff.	Soybeans bu/A	Soybeans Diff.	Oats bu/A	Oats Diff.	Alfalfa[2] tons/A	Alfalfa[2] Diff.
0 tons lime/A	6.0	119	--	26.4	---	40	--	2.22	----
3 tons lime/A	6.2	127	8	29.1	2.7	42	2	4.57	2.35
6 tons lime/A	6.8	133	14	28.4	2.0	54	14	4.75	2.53
12 tons lime/A	7.0	121	2	25.2	-1.2	67	27	4.81	2.59
24 tons lime/A	7.4	130	10	26.4	0	59	19	4.86	2.64
8.7 oz. Mo/A	6.0	122	3	27.4	1.0	50	10	3.86	1.58
Standard error =			3.4		0.6		5.3		.26
lsd (.05) =			NS		1.8		15.1		.74
hsd (.05) =			NS		2.8		23.2		1.13

1 @ 15% moisture

2 Dry weight

BORON INVESTIGATIONS ON CORN IN 1961

J. M. MacGregor & J. R. Peterson

In 1960, several alfalfa fields in east central Minnesota were responsive to applications of boron in addition to phosphorus-potassium fertilization, and it was considered possible that field corn might respond to similar boron treatments where ample nitrogen-phosphorus-potassium had been applied and ample plant populations were present.

Three fields to be planted to corn in 1961 were located on three different soil types in cooperation with the county agricultural agent's office as follows:

1. Webster clay loam -- Stewart, McLeod County -- Mike Kasal farm.

2. Fayette silt loam -- Red Wing, Goodhue County -- Herbert & Philip Eckblad farm.

3. Anoka loamy fine sand -- Isanti, Isanti County -- Laurence Collin farm.

It was considered desirable to have six replications having both a medium and a heavy plant population with the farm operator applying a complete starter fertilizer at time of planting. The medium and heavy plant populations were obtained by the farmer using a heavy planting rate on the entire area and then carrying out differential plant thinning on the different replications. Six different treatments or placements were used in addition to the major elements applied, one of which consisted of a foliar Solubor spray applied at three times during the growing season (two pounds of boron applied per acre in each of three spray treatments). A minimum of 80 lbs of nitrogen per acre was applied as a sidedressing. Leaf samples were taken during the later growing season for boron analyses, and at maturity, the corn was harvested and yields were computed. Leaf analysis for boron content is now in progress, but this is not yet complete. The yield results are shown in the three following tables.

Discussion

The yields on Webster clay loam shown in Table 1 are considerably lower than would normally be expected on this soil type, and this is largely due to abnormally heavy rainfall during much of the growing season and resultant severe weed competition arising from the inability of the farm operator to cultivate as frequently as usual. Boron applications failed to increase the corn yield, and there may have been a possible depression in yield where boron was used on the heavier plant population, since the greatest decrease occurred where the soluble form was applied as a foliar spray at four week intervals.

Table 2 presents corn yields from the Tama silt loam, where yields generally exceeded 100 bushels of corn per acre. Apparently there was little obvious need for boron additions in 1961, since none of these treatments produced an appreciably favorable response in corn yield, which need might have been reasonably expected where corn production was at such a high level.

The effect of boron addition to the Anoka loamy fine sand field is shown in Table 3, and there is little evidence of a present need to include boron in the fertilizer treatment on this field, although such a need could be a possibility with the relatively coarse textured soil where high plant populations and liberal NPK application were used.

Table 1. Effects of Different Fertilizer Treatments to Webster clay loam on the 1961 Yield of Ear Corn with Medium and Heavy Plant Populations.

A. 17,000-18,000 stalks per acre (McLeod Co.--Mike Kasal farm--Stewart)

Fertilizer Treatments			Replication							
Special Fertilizers (lbs/A)	Starter (lbs/A)	S.D.N. (lbs/A)	I	II	III	IV	V	VI	Average of 6 reps	Increases over check
			(Bushel of ear corn per acre at 15.5% moisture)							
----------	110#6-24-12	----	68	116	30	90	92	77	79	-----
----------	"	80#N	88	79	76	92	68	97	83	Check
1 boron (broadcast)	"	"	78	80	88	82	87	98	86	3
2 " "	"	"	96	87	86	84	99	76	88	5
1 " (row)	"	"	70	77	65	82	84	103	80	-3
2 " "	"	"	76	86	72	90	82	90	82	-1
6 Solubor (foliar)	"	"	74	80	66	81	78	86	78	-5
15 FTE (broadcast	"	"	75	100	69	90	86	102	90	7

B. 22,000-23,000 stalks per acre

----------	110#6-24-12	----	79	67	68	67	88	89	80	-----
----------	"	80#N	87	78	79	82	87	118	88	Check
1 boron (broadcast)	"	"	91	74	62	77	88	70	77	-11
2 " "	"	"	81	74	88	74	86	97	83	-5
1 " (row)	"	"	72	51	76	78	73	97	75	-13
2 " "	"	"	96	78	69	68	95	89	83	-5
6 Solubor (foliar)	"	"	40	70	36	69	84	102	67	-21
15 FTE (broadcast)	"	"	96	71	73	82	84	89	87	-1

Table 2. Effect of Different Fertilizer Treatments to Fayette silt loam on the 1961 Yield of Ear Corn with Medium and Heavy Plant Population.

A. 16,000-16,500 stalks per acre (Goodhue County ----Herbert and Phillip Eckblad farm--Red Wing)

Fertilizer Treatments			Replication							
Special Fertilizer (lbs/A)	Starter (lbs/A)	S.D.N. (lbs/A)	I	II	III	IV	V	VI	Average of 6 reps	Increase over check
			(Bushel of ear corn per acre at 15.5% moisture)							
----------	150#5-20-20	----	116	106	113	112	111	107	111	-----
----------	"	80#N	137	110	110	116	117	106	116	Check
1 boron (broadcast)	"	"	118	140	107	114	114	114	118	2
2 " "	"	"	117	116	101	113	112	100	110	-6
1 " (row)	"	"	125	111	116	128	107	104	115	-1
2 " "	"	"	132	111	105	132	121	108	118	2
6 Solubor (foliar)	"	"	118	107	112	110	106	107	110	-6
15 FTE (broadcast)	"	"	111	108	117	111	109	109	111	-5

B. 24,000-24,500 stalks per acre.

----------	150#5-20-20	----	109	106	95	103	99	120	105	-----
----------	"	80#N	115	118	102	108	115	114	112	Check
1 boron (broadcast)	"	"	123	114	108	107	112	111	113	1
2 " "	"	"	112	126	119	112	114	113	116	4
1 " (row)	"	"	106	119	108	108	111	108	110	-2
2 " "	"	"	121	113	106	118	113	112	114	2
6 Solubor (foliar)	"	"	122	117	111	113	100	117	113	1
15 FTE (broadcast)	"	"	117	112	105	112	116	126	114	2