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 Because these are largely one year results they should not be considered as conclusive and the results are not for publication.

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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
Cats	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 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.

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.

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, .1 or 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 ($^{o}F.$) at Four Minnesota Stations, March 29 - October 3, 1961.

Fairmont* (Radio station KSUM; Clarion-Nicollet-Webster undergrass; 0% slope; Hg in glass thermometer; Ave. of 6 P.M. observation).

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
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).

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
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).

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
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).

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
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.

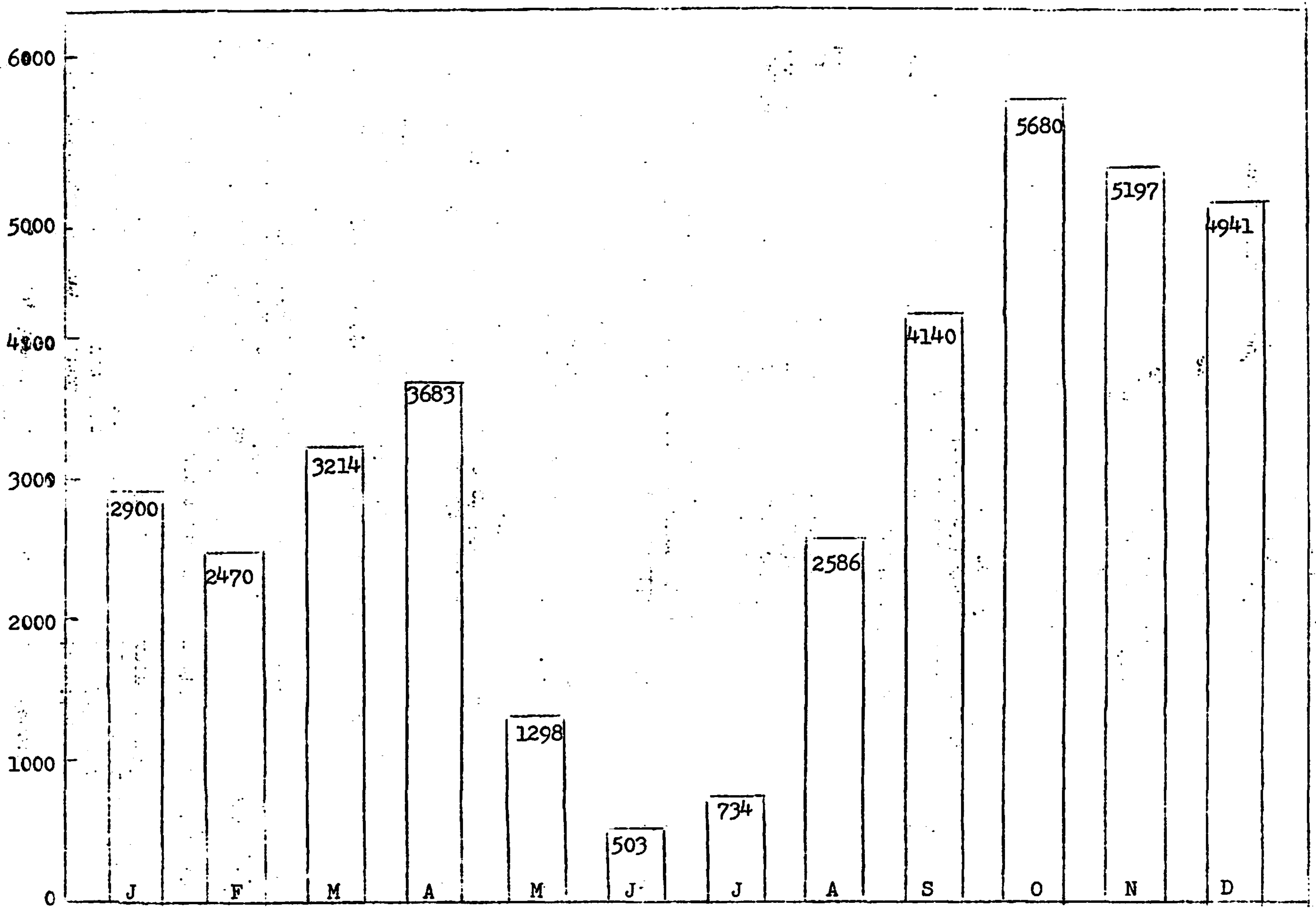

Figure 1. Monthly Distribution of Soil Samples Received by the University of Minnesota Soil Testing Laboratory During 1961 (Total = 37,353).

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 side-dressing 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 lesses 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	Percentage uptake of fertilizer nitrogen 1961	Percentage uptake of fertilizer nitrogen 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	Percentage uptake of fertilizer nitrogen 1961	Percentage uptake of fertilizer nitrogen 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 conditinns until mid-July at Crookston, the fertilized wheat germinated and tillered very thinly and erratically, and this experiment was discontinued for this reason. Drowth conditinns 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 Crookston
(Hegne clay loam)

N applied lbs/A[a]	Ear Corn bu/A	Ear Corn % N	Ear Corn % protein	Ear Corn lbs.N/A	Fodder T/A	Fodder % N	Fodder lbs. N/A	% Fertilizer N uptake
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	39,382	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 tht 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 errror =				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	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 applicatinn 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: Special Fertilizers (lbs/A)	Starter (lbs/A)	S.D.N. (lbs/A)	Replication 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

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
----------------	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.

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
----------------	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

Corn leaves on the different treatments failed to exhibit any marked symptoms of boron deficiency at any observed time during the growing season, and there was no observable effect on the ear shape, kernel production, or in the percentage of barren stalks or nubbin development. Since the growing season of 1961 was relatively favorable for corn production, relatively high corn yields were obtained except on the lower lying and untiled McLeod county field.

The experiment will be continued in 1962 for the purpose of obtaining additional results on the possible boron need for maximum corn production in Minnesota.

Table 3. Effects of Different Fertilizer Treatments to Anoka loamy fine sand on the 1961 Yield of Ear Corn Medium and Heavy Plant Populations. (Isanti County-Laurence Collin farm--Isanti.)

A. 15,000-15,500 stalks per acre.

Fertilizer Treatments: Special Fertilizer (lbs/A)	Starter (lbs/A)	S.D. (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#4-12-36	------------	85	103	98	42	101	96	67	----
----------------	"	155#N, 120#K_2O	98	103	110	108	102	117	106	Check
1 Boron (broadcast)	"	"	100	113	112	100	116	102	107	1
2 " "	"	"	99	108	103	102	98	102	102	-4
1 " (row)	"	"	100	108	110	96	109	98	104	-2
2 " "	"	"	106	116	102	96	99	104	104	-2
6 Solubor (foliar)	"	"	105	114	99	91	98	90	100	-6
15 FTE (broadcast)	"	"	91	106	101	103	113	118	105	-1

B. 21,500-22,000 stalks per acre.

Special Fertilizer (lbs/A)	Starter (lbs/A)	S.D. (lbs/A)	I	II	III	IV	V	VI	Average of 6 reps	Increases over check
----------------	110#4-12-36	------------	104	93	112	93	97	113	102	----
----------------	"	155#N, 120#K_2O	127	106	117	84	120	92	108	Check
1 Boron (broadcast)	"	"	121	111	119	113	105	114	114	6
2 " "	"	"	128	108	114	109	114	110	114	6
1 " (row)	"	"	106	112	121	110	109	115	112	4
2 " "	"	"	121	102	121	99	108	120	112	4
6 Solubor (foliar)	"	"	114	93	114	105	112	104	107	-1
15 FTE (broadcast)	"	"	112	116	120	107	116	81	109	1

1961 Field Experiments Using Iron and Magnesium Ammonium Phosphates on Corn and on Chlorotic Soybeans Growing on Calcareous Webster Clay Loam Near Springfield -- Brown County and to Falx on Hegne Clay Loam Near Fisher -- Polk County

J. M. MacGregor & R. G. Hanson

Two newly developed experimental fertilizer materials were applied at four different rates of application to chlorotic soybeans and to slowly growing corn on a "high lime" Webster clay loam on the Matt Holles farm four miles west and one-half mile south of Springfield in western Brown county. These materials were:

1. Ferrous ammonium phosphate (7-35-0) containing 7% nitrogen, 35% available P_2O_5, and 26% ferrous iron.

2. Magnesium ammonium phosphate (8-40-0) containing 8% nitrogen, 40% available P_2O_5, and 24% magnesium oxide.

The two materials were available in either granular or in powder form. Only the granular form was used at Springfield on the soybeans and on the corn (Tables 1and 2) -- both forms were used on the chlorotic flax experiment near Fisher in Polk County (Table 3).

An area of chlorotic Lindarin soybeans and slowly growing field corn was reported on a limited "high lime" area of Webster silty clay loam on the Matt Holles farm west of Springfield in late June. On July 7th, a randomized block experiment was set up for both crops, using four rates of both of the two metal ammonium phosphates previously mentioned to supply 5, 10, 20 and 50 pounds of iron per acre, and the 8-40-0 at rates which would supply the same amounts of nitrogen and phosphorus as with the 7-35-0. One additional basic treatment consisted of APCA-Fe (Chel 138-Fe) to supply chelated iron at the rate of five pounds per acre since this was a known effective treatment. An untreated row was also included to make a total of ten treatment rows in each of the four replications. All materials were applied two inches to one side of each soybean row and two inches below the soil surface by hoeing out a trench and placing the granulated metal ammonium phosphates and the powdered iron chelate in the trench and then filling it in. The corn treatments were made directly alongside each hill, approximately one to two inches beneath the surface of the soil.

During the following three week period, scattered rains totaled only 1.10" and on July 20th, it was visually evident that the Chel 138-Fe was effective in alleviating the soybean chlorosis, but the 7-35-0 and 8-40-0 treatments were not. None of the three material treatments produced any visual improvement in corn growth.

Precipitation increased during August and was relatively ample both in August and in September, with the chelated Fe treatment apparently producing the only beneficial effect on soybean color and plant development.

The soybeans and the corn were harvested on October 7th, and the granular 7-35-0 and 8-40-0 applied in early July still remained in the soil in granules apparently similar to those applied, and this limited solubility was probably a major reason for the relative ineffectiveness of these two materials in these calcareous soils in 1961. Increased solubility of these two materials might have produced a beneficial growth effect. The yields obtained are shown in Tables 1 and 2.

Table 1. 1961 yields of soybeans growing on calcareous Webster clay loam and fertilized with Ferrous Ammonium Phosphate (7-35-0), Magnesium Ammonium Phosphate (8-40-0), and Iron Chelate 138 (6% Fe). Matt Holles Farm, Springfield.

(Average of 4 replications)

Yield Rank	Treatments: Fertilizer Applied	lbs./A Applied	lbs./A Mg	lbs./A Fe	Yield of Soybeans in bu./A
1	Chelate 138	83	0	5	24.5**
2	7-35-0	200	0	50	17.7
3	Check	0	0	0	17.3
4	8-40-0	35	8.4	0	17.0
5	8-40-0	70	16.8	0	15.1
6	8-40-0	18	4.2	0	14.5
7	7-35-0	80	0	20	14.0
8	7-35-0	40	0	10	13.1
9	7-35-0	20	0	5	12.7
10	8-40-0	175	42.0	0	10.1**

Student-Newman-Kuels Range = 0.05
** Significantly different from check at the 1% level

8-40-0 = 24% Mg
8% N
40% P_2O_5

7-35-0 = 25% Fe
7% N
35% P_2O_5

Table 2. 1961 yields of corn growing on calcareous Webster clay loam and fertilized with Ferrous Ammonium Phosphate (7-35-0), Magnesium Ammonium Phosphate (8-40-0), and Iron Chelate 138 (6% Fe). Matt Holles Farm, Springfield. (Average of 4 replications -- at 15% moisture)

Yield Rank	Treatments: Fertilizer Applied	lbs./A Applied	lbs./A Mg	lbs./A Fe	Yield of corn at bu./A
1	7-35-0	80	0	20	42.3*
2	8-40-0	17.5	42	0	40.7*
3	7-35-0	200	0	530	39.4
4	Chelate 138	83	0	5	39.0
5	8-40-0	17.5	4.2	0	38.4
6	8-40-0	70	16.8	0	37.8
7	7-35-0	20	0	5	37.4
8	Check	0	0	0	36.9
9	8-40-0	35	8.4	0	36.7
10	7-35-0	40	0	10	35.9

Student-Newman-Kuels Range = 0.05
* Significantly different from check above the 5% level

8-40-0 = 24% Mg
8% N
40% P_2O_5

7-35-0 = 25% Fe
7% N
35% P_2O_5

It is evident that the chelated iron was effective for improving soybean yields, but had no appreciable effect on improving corn growth. The metal ammonium phosphates were ineffective at the four rates of application used.

A smaller, two replicate experiment was placed on the Hegne clay loam of the Sam Berland farm near Fisher, in Polk County to try and remedy a chlorotic condition in flax. Both the 7-35-0 and the 8-40-0 were applied in powder and in a granular forms to the soil surface as a broadcast application. No chelated iron was applied to this field.

There was no visible effect of improvement of the chlorotic condition from the different treatments used. The resulting flax yields are shown in Table 3. All treatments were made at the rate of 50 pounds of material per acre.

Table 3. The effect of 7-35-0 and of 8-40-0 when applied to chlorotic flax in late June on Hegne clay loam near Fisher (Sam Berland farm).

	Flax Yield in bu./A.		
Treatment & Form	Replicate 1	Replicate 2	Average
None	9.3	10.1	9.7
7-35-0 - Granular (25% Fe)	8.4	7.3	7.9
8-40-0 - Granular (24% MgO)	7.1	8.1	7.6
7-35-0 - Powdered	8.1	7.4	7.8
8-40-0 - Powdered	9.0	9.3	9.2

It is evident that applications of either of the two materials to the surface of the soil at the rate of 50 pounds per acre failed to increase flax growth or to increase flax yields.

Fertilizer Rotation Studies at the Waseca Morris and Crookston Branch Experiment Stations (1961 Results)

A. C. Caldwell, J. R. Kline, Roy Thompson, John Thompson, and Henry Kramer

Introduction

The permanent fertilizer rotation plots which are established at the Waseca, Morris, and Crookston Branch Experiment Stations have now been in existence for 6 years. These plots were designed to evaluate the effects of the nutrients, nitrogen, phosphorus, and potash, on soil properties and crop response when crops are grown in typical rotations for an area. While all crops receive the three nutrients alone and in all combinations with one another the rates of application are selected appropriately for the specific crops. All fertilizers are applied as a broadcast application in the spring with the exception of a small portion for corn which is applied as a starter at planting.

The crops at Morris and Waseca are in a five year rotation. Continuous corn is also grown at both stations. The rotations at the Waseca and Morris stations are as follows:

Waseca	Morris
corn	corn
corn	corn
soybeans	soybeans
oats	flax
alfalfa	alfalfa
continuous corn*	continuous corn*

The Crookston experiment consists of two rotations, a three and a four year rotation. The three year rotatinn consists of a sequence of sugar beets, wheat and sweet clover fallow. The four year rotation is a sequence of corn, soybeans, wheat and alfalfa.

Besides the regular fertilizer treatments an extra plot has been added to each experiment which receives a very heavy treatment of N, P, and K. These plots, which are known as NPK+ treatments are not analyzed statistically with the rest of the experiment but are used to make qualitative comparisons.

Waseca Yields

Corn

Corn yields were higher in 1961 than they have been since the first year of the experiment. They ranged from 130 to about 160 bushels per acre with unfertilized plots for the three corn strips averaging about 140 bushels per acre. No yield response to any fertilizer treatment was observed on either the continuous corn or the first year corn. Yield increases amounting to about 11 bushels per acre were obtained with the application of potassium on second year corn.

The reported yields have been corrected to a stand of 20,000 plants per acre although this stand was not actually obtained on a few plots due to pheasant infestion. As has been the usual practice, soil insects were controlled by the use of alderin and weeds were controlled by the use of a band spray application of Randox T.

Oats

Fertilizer treatments resulted in reduced grain yields with respect to the untreated plots although the results were not statistically significant. The yields ranged from 60 to about 78 bushels per acre in spite of the fact that the plots were uniformly lodged. The degree of lodging was severe on all plots.

Significant increases in yield of oats forage were found due to the application of N, P, and K. N and K applications resulted in about 1 ton increases while P applications resulted in a 2 ton per acre increase.

Soybeans

Soybean yields ranged from 31 to 37 bushels per acre but no treatment effect was found. Observations made in late summer showed that all plots treated with potassium had moderate lodging of bean plants. This had no effect on ultimate yield.

Five years of data from these plots were tabulated and analyzed statistically (table 9). The results show that the fertility program as practiced in this experiment has produced no significant increase in the long term yield of soybeans.

Alfalfa

Two crops of alfalfa were obtained. Yields of the first crop ranged from 2.4 to 3.5 tons per acre with phosphorus giving a significant increase.

Lower yields were obtained on the second crop and no fertilizer response was found.

Waseca 1961

Table 1. Yield of Continuous Corn

Treatment	Lbs/A $N-P_2O_5-K_2O$	Average Yield bu/A	Difference from untreated	Treatment Effect
None	0 + 0 + 0	139.6	---	
N	160 + 0 + 0	144.4	4.8	
P	0 + 160 + 0	147.4	7.8	
K	0 + 0 + 160	145.7	6.1	
NP	160 + 160 + 0	136.1	-3.5	
NK	160 + 0 + 160	141.2	1.6	
PK	0 + 160 + 160	144.4	4.8	
NPK	160 + 160 + 160	147.6	8.0	
NPK+	320 + 320 + 320	154.4	14.8	

Table 2. Yield of First Year Corn

Treatment	Lbs/A $N-P_2O_5-K_2O$	Average Yield bu/A	Difference from untreated	Treatment Effect
None	0 + 0 + 0	139.0		
N	40 + 0 + 0	142.0	3	
P	0 + 80 + 0	133.0	-6	
K	0 + 0 + 80	133.3	-5.7	
NP	40 + 80 + 0	136.4	-2.6	
NK	40 + 0 + 80	154.9	15.9	
PK	0 + 80 + 80	152.7	13.7	
NPK	40 + 80 + 80	148.6	9.6	
NPK+	80 + 160 + 160	152.1	13.1	

Waseca 1961

Table 3. Yield of Second Year Corn

Treatment	Lbs./A $N-P_2O_5-K_2O$	Average Yield bu/A	Difference from untreated	Treatment Effect
None	0 + 0 + 0	141.7		
N	80 + 0 + 0	156.8	15.1	
P	0 + 80 + 0	142.7	1.0	
K	0 + 0 + 80	150.3	8.6	10.9*
NP	80 + 80 + 0	132.3	-9.4	
NK	80 + 0 + 80	151.7	10.0	
PK	0 + 80 + 80	152.4	10.7	9.1**
NPK	80 + 80 + 80	162.7	21.0	
NPK+	160 + 160 + 160	161.9	20.2	

* Indicates significance at 95% level

** Indicates significance at 99% level

Table 4. Yield of Oats Grain

Treatment	Lbs/A $N-P_2O_5-K_2O$	Average Yield bu/A	Difference from untreated	Treatment Effect
None	0 + 0 + 0	77.6		
N	80 + 0 + 0	64.8	-12.8	
P	0 + 80 + 0	76.2	- 1.4	
K	0 + 0 + 80	63.3	-14.3	
NP	80 + 80 + 0	72.4	- 5.2	
NK	80 + 0 + 80	60.4	-17.2	
PK	0 + 80 + 80	66.5	-11.1	
NPK	80 + 80 + 80	61.0	-16.6	
NPK+	120 + 160 + 160	74.4	- 3.2	

Waseca 1961

Table 5. Yield of Oats Forage[1]

Treatment	Lbs/A $N-P_2O_5-K_2O$	Average Yield tons/A	Difference from untreated	Treatment Effect
None	0 + 0 + 0	6.66	-	
N	80 + 0 + 0	8.27	1.61	0.96*
P	0 + 80 + 0	8.59	1.93	2.04**
K	0 + 0 + 80	8.57	1.91	1.14*
NP	80 + 80 + 0	10.54	3.88	
NK	80 + 0 + 80	8.76	2.10	
PK	0 + 80 + 80	10.60	3.94	
NPK	80 + 80 + 80	10.70	4.04	
NPK+	120 + 160 + 160	10.46	3.80	

[1] Yields are in tons of Fresh Forage (69.2% moisture).

Table 6. Yields of Soybeans

Treatment	Lbs/A $N-P_2O_5-K_2O$	Average Yield bu/A	Difference from untreated	Treatment Effect
None	0 + 0 + 0	32.6	---	
N	20 + 0 + 0	35.5	2.9	
P	0 + 40 + 0	37.4	4.8	
K	0 + 0 + 40	35.6	3.0	
NP	20 + 40 + 0	31.0	-1.6	
NK	20 + 0 + 40	36.8	4.2	
PK	0 + 40 + 40	34.6	2.0	
NPK	20 + 40 + 40	33.8	1.2	
NPK+	40 + 80 + 80	36.7	4.1	

Waseca 1961

Table 7. Yield of First Crop Alfalfa[1]

Treatment	Lbs/A $N-P_2O_5-K_2O$	Average Yield T/A	Difference from untreated	Treatment Effect
None	0 + 0 + 0	2.75	-	
N	20 + 0 + 0	2.66	--.26	
P	0 + 80 + 0	3.13	1.15	0.75**
K	0 + 0 + 80	2.42	-1.0	
NP	20 + 80 + 0	3.36	1.82	
NK	20 + 0 + 80	2.54	- .62	
PK	0 + 80 + 80	3.53	2.33	0.22*
NPK	20 + 80 + 80	3.38	1.90	
NPK+	20 + 160 + 160	2.54	-0.21	

[1] Yields are corrected to 15% moisture

Table 8. Yield of Second Crop Alfalfa[1]

Treatment	Lbs/A $N-P_2O_5-K_2O$	Average Yield T/A	Difference from untreated	Treatment Effect
None	0 - 0 - 0	1.27	-	
N	20 + 0 + 0	1.18	-0.09	
P	0 + 80 + 0	1.31	0.04	
K	0 + 0 + 80	1.30	0.03	
NP	20 + 80 + 0	1.42	0.15	
NK	20 + 0 + 80	1.36	0.09	
PK	0 + 80 + 80	1.35	0.08	
NPK	20 + 80 + 80	1.45	0.18	
NPK+	20 + 160 + 160	1.55	-0.28	

[1] Yields corrected to 15% moisture.

Waseca 1956-1960

Table 9. Five Year Average Yield of Soybeans

Treatment	Lbs/A $N-P_2O_5-K_2O$	Average Yield bu/A	Difference from untreated	Treatment Effect
None	0 - 0 - 0	31.1	--	
N	20 - 0 - 0	32.5	1.4	
P	0 - 40 - 0	32.7	1.6	
K	0 - 0 - 40	31.0	-0.1	
NP	20 - 40 - 0	32.7	1.6	
NK	20 - 0 - 40	31.9	0.8	
PK	0 - 40 - 40	32.4	1.3	
NPK	20 - 40 - 40	33.2	2.1	
NPK+	40 + 80 + 80	33.3	2.2	

Morris Yields

Corn

Continuous corn yields ranged from 53 to about 84 bushels per acre on a stand of 15,600 stalks per acre of drilled corn. Nitrogen has continued to be an important factor in the production of continuous corn as yields were increased by about 23 bushels per acre by this nutrient.

Yields were decreased significantly by the use of nitrogen on both first and second year corn. The decrease amounted to about 8 bushels per acre on both years of corn. This observation has not been explained.

Soybeans

Soybean yields ranged from 16 to 21 bushels per acre in the experiment proper and to 29.6 bushels per acre on the NPK+ plots. No statistical treatment effect was found.

The five year average yields of soybeans were computed and analyzed statistically (table 16). Average annual yields of beans ranged from 23 to 27 bushels per acre. Forty pounds of P per acre annually was found to give an average annual yield increase of 2.4 bushels per acre. This increase was significant at the 95% level.

Flax

Flax yields were poor in 1961 in ranging from only 8 to 11 bushels per acre. No treatment effect was found.

The average annual yield of flax was calculated for five years and found to range from 17 to 20 bushels per acre (table 17). Nitrogen at the rate of 60 lbs. per acre annually was found to give a small but significant average yield increase. On the other hand 40 lbs. P_2O_5 per acre resulted in a small but significant average yield decrease.

Alfalfa

Only one crop of alfalfa was obtained in 1961 due to the fact that the stand had suffered severe winter killing. The yields ranged from 0.2 to 0.9 tons per acre. Phosphate treatments resulted in a yield increase of over 0.4 tons per acre. Nitrogen treatments on the other hand showed yield decreases amounting to 0.2 tons per acre.

Morris 1961

Table 10. Yield of Continuous Corn

Treatment	Lbs/A $N-P_2O_5-K_2O$	Average Yield bu/A	Difference from untreated	Treatment Effect
None	0 + 0 + 0	61.0	-	
N	160 + 0 + 0	74.1	13.1	22.9**
P	0 + 160 + 0	59.5	- 1.5	
K	0 + 0 + 40	57.1	- 3.9	
NP	160 + 160 + 0	81.7	20.7	
NK	160 + 0 + 40	84.3	23.3	
PK	0 + 160 + 40	53.2	- 7.8	
NPK	160 + 160 + 40	82.4	21.4	
NPK+	320 + 320 + 80	70.2	9.2	

Table 11. Yield of First Year Corn

Treatment	Lbs/A $N-P_2O_5-K_2O$	Average Yield bu/A	Difference from untreated	Treatment Effect
None	0 + 0 + 0	56.0	-	
N	60 + 0 + 0	48.7	- 7.3	-8.2*
P	0 + 40 + 0	66.7	10.7	
K	0 + 0 + 40	59.8	3.8	
NP	60 + 40 + 0	57.4	1.4	
NK	60 + 0 + 40	51.8	- 4.2	
PK	0 + 60 + 40	53.2	- 2.8	-8.2*
NPK	60 + 40 + 40	44.9	-11.1	
NPK+	100 + 120 + 80	58.0	2.0	

Morris 1961

Table 12. Yield of Second Year Corn

Treatment	Lbs/A $N+P_2O_5+K_2O$	Average Yield bu/A	Difference from untreated	Treatment Effect
None	0 + 0 + 0	81.9	-	-7.6 (90%)
N	80 + 0 + 0	78.6	- 3.3	
P	0 + 80 + 0	75.4	- 6.5	
K	0 + 0 + 40	78.9	- 3.0	
NP	80 + 80 + 0	73.9	- 8.0	
NK	80 + 0 + 40	67.8	-14.1	
PK	0 + 80 + 40	85.5	3.6	
NPK	80 + 80 + 40	70.6	-11.3	
NPK+	120 + 120 + 80	74.0	- 7.9	

Table 13. Yield of Soybeans

Treatment	Lbs/A $N+P_2O_5+K_2O$	Average Yield bu/A	Difference from untreated	Treatment Effect
None	0 + 0 + 0	17.8	-	
N	20 + 0 + 0	19.2	1.4	
P	0 + 40 + 0	17.8	0	
K	0 + 0 + 40	17.7	-0.1	
NP	20 + 40 + 0	21.5	3.7	
NK	20 + 0 + 40	18.3	0.5	
PK	0 + 40 + 40	16.2	-1.6	
NPK	20 + 40 + 40	19.7	1.9	
NPK+	40 + 80 + 80	29.6	11.8	

Morris 1961

Table 14. Yield of Flax

Treatment	Lbs/A $N+P_2O_5+K_2O$	Average Yields bu/A	Difference from untreated	Treatment Effect
None	0 + 0 + 0	10.4	-	
N	60 + 0 + 0	10.8	0.4	
P	0 + 40 + 0	9.9	-0.5	
K	0 + 0 + 20	11.1	0.7	
NP	60 + 40 + 0	10.3	-0.1	
NK	60 + 0 + 20	11.4	1.0	
PK	0 + 40 + 20	10.6	0.2	
NPK	60 + 40 + 20	8.7	-1.7	
NPK+	120 + 80 + 40	7.7	-2.7	

Table 15. Yield of Alfalfa

None	0 + 0 + 0	0.25	-	
N	20 + 0 + 0	0.18	-0.07	-0.21**
P	0 + 80 + 0	0.78	0.53	0.42**
K	0 + 0 + 40	0.18	-0.07	
NP	20 + 80 + 0	0.42	0.17	-0.18**
NK	20 + 0 + 40	0.19	-0.06	
PK	0 + 80 + 40	0.88	0.63	
NPK	20 + 80 + 40	0.44	0.19	
NPK+	20 + 160 + 80	0.38	0.13	

Morris 1956-60

Table 16. Five Year Average Yield of Soybeans

Treatment	Lbs/A $N-P_2O_5-K_2O$	Average Yield bu/A	Difference from untreated	Treatment Effect
None	0 + 0 + 0	23.6		
N	20 + 0 + 0	23.8	0.2	
P	0 + 40 + 0	26.6	3.0	2.4*
K	0 + 0 + 40	22.8	-0.8	
NP	20 + 40 + 0	25.8	2.2	
NK	20 + 0 + 40	24.2	0.6	1.3 (90%)
PK	0 + 40 + 40	24.4	0.8	
NPK	20 + 40 + 40	27.4	3.8	
NPK+	40 + 80 + 80	26.2	2.6	

Table 17. Five Year Average Yields of Flax

Treatment	Lbs/A $N-P_2O_5-K_2O$	Average Yield bu/A	Difference from untreated	Treatment Effect
None	0 + 0 + 0	18.4	-	
N	60 + 0 + 0	18.4	0.0	1.1 (90%)
P	0 + 40 + 0	16.6	-2.2	-1.3*
K	0 + 0 + 20	17.3	-1.1	
NP	60 + 40 + 0	17.7	-0.7	
NK	60 + 0 + 20	20.1	1.7	
PK	0 + 40 + 20	17.0	-1.4	
NPK	60 + 40 + 20	17.7	-0.7	
NPK+	120 + 80 + 40	19.5.	1.1	

Crookston Yields

Alfalfa - Soybeans

Yields not obtained in 1961.

Sugar beets

Yields of sugar beets were exceptionably large ranging from 23 to 32 tons per acre. Phosphorus at the rate of 120 pounds per acre resulted in an average yield increase of 4.8 tons.

Wheat (3 and 4 year rotation)

Yields were significantly increased by phosphorus treatments in both rotations.

Corn

Corn yields ranged from 55 to 91 bushels per acre with significant increases to 40 lbs. P_2O_5 per acre.

Crookston 1961

Table 18. Yields of Sugar Beets

Treatment	Lbs/A $N-P_2O_5-K_2O$	Average Yield T/A	Difference from untreated	Treatment Effect
None	0 + 0 + 0	23.2		
N	40 + 0 + 0	25.3	2.1	
P	0 + 120 + 0	32.3	9.1	4.8**
K	0 + 0 + 40	22.9	-0.3	
NP	40 + 120 + 0	25.3	2.1	-2.3*
NK	40 + 0 + 40	23.0	-0.2	
PK	0 + 120 + 40	28.3	5.1	
NPK	40 + 120 + 40	28.2	5.0	
NPK+	80 + 240 + 80	29.3	6.1	

Table 19. Yield of Wheat; Three Year Rotatation

Treatment	Lbs/A $N-P_2O_5-K_2O$	Average Yield bu/A	Difference from untreated	Treatment Effect
None	0 + 0 + 0	17.8		
N	20 + 0 + 0	22.5	4.7	
P	0 + 40 + 0	33.0	15.2	14.9**
K	0 + 0 + 20	20.3	2.5	
NP	20 + 40 + 0	32.4	14.6	
NK	20 + 0 + 20	13.4	-4.4	
PK	0 + 40 + 20	29.0	11.2	
NPK	20 + 40 + 20	39.3	11.5	
NPK+	40 + 80 + 40	31.8	14.0	

Crookston 1961

Table 20. Yield of Wheat; Four Year Rotation

Treatment	Lbs/A $N-P_2O_5-K_2O$	Average Yield bu/A	Difference from untreated	Treatment Effect
None	0 + 0 + 0	28.2		
N	40 + 0 + 0	27.1	-1.1	
P	0 + 40 + 0	33.0	4.8	5.6*
K	0 + 0 + 20	26.0	-2.2	
NP	40 + 20 + 0	35.3	7.1	
NK	40 + 0 + 20	28.8	0.6	
PK	0 + 40 + 20	29.4	1.2	
NPK	40 + 40 + 20	34.8	6.6	
NPK+	40 + 120 + 40	40.1	11.9	

Table 21. Yield of Corn

Treatment	Lbs/A $N-P_2O_5-K_2O$	Average Yield bu/A	Difference from untreated	Treatment Effect
None	0 + 0 + 0	57.0		
N	40 + 0 + 0	59.9	2.9	
P	0 + 40 + 0	82.3	25.3	23.5**
K	0 + 0 + 20	62.3	5.3	
NP	40 + 40 + 0	84.8	27.8	
NK	40 + 0 + 20	55.1	-1.9	
PK	0 + 40 + 20	76.6	19.6	
NPK	40 + 40 + 20	84.8	27.8	
NPK+	80 + 120 + 40	90.7	33.7	

THE NICOLLET COUNTY PLOTS
Soil Fertility and Crop Production Studies on the Webster Soils of Southern Minnesota

W. P. Martin, Fred Wetherill and H. W. Kramer

Yield Results - 1960

Re: 1959 results, "A Report on Soils and Soil Fertility", p. 74. Dept. Soils, Mimeo, April 1960; ibid 1960 results, p. 44, Feb. 1961.

Soils: Webster and closely related Nicollet silty clay loams; level topography, minimum erosion, adequate tile drainage.

Cropping systems: (established 1948) (1) corn-oats, (2) corn-oats with clover green manure, (3) 4-yr. rotation of oats-hay-corn-corn extended to five years in 1958 with soybeans between two corn years, and (4) continuous corn included beginning in 1954.

Fertilizer treatments: Multiple rates and materials including barnyard manure at regular and "extra" heavy levels; see tables for treatments and 1959 report for details on materials, rates and methods of applications. There were four replications.

CONTINUOUS CORN: RATE AND TIME OF APPLICATION

Nitrogen:		Yield results:	
Rate	Time*	Starter only**	+PK broadcast***
None	0-0-0	42 bu.	48 bu.
40 lbs	1-0-0	76	98
80 "	1-1-0	105	115
120 "	1-1-1	101	121
80 "	1-0-1	91	109
80 "	0-1-1	94	114
40 "	0-0-1	74	93
40 "	0-1-0	79	101
80 "	2-0-0	102	125
120 "	3-0-0	107	121

* 0-0-0 refers to time of application, i.e. planting time-first cultivation-second cultivation.
** 175 lbs. 6-24-12 starter in row at planting time.
*** Starter plus 300 lbs. 0-20-20 broadcast.

CORN-OATS, WITH AND WITHOUT LEGUME GREEN MANURE: (three replications)

	Corn:	(with legume)	Oats:	(with legume)
1. Check	52 bu.	61 bu.	41 bu.	46 bu.
2. N on oats	60	68	70	63
3. NP on oats	52	74	92	104
4. NPK on oats	55	71	92	108
5. P plowdown	57	73	49	75
6. NPK in hill	58	86	46	66
7. N plowdown	73*	60*	67*	48*
8. N sidedress	88*	67*	73*	38*
LSD (5%)	13	15	20	8.9

*One replication only

CORN-SOYBEANS-CORN-OATS-HAY (WITH REGULAR AND EXTRA-HEAVY FERTILIZATION LEVELS):(four replications)

Treatments (regular)	Corn (1) Reg.	Extra*	Soybeans Reg.	Extra*	Corn (2) Reg.	Extra*	Oats Reg.	Extra*	Hay Reg.	Extra*
6. Check	70 bu.	108 bu.	35 bu.	46 bu.	68 bu.	113 nu.	59 bu.	101 bu.	4.6 t.	5.1 t.
1. P for oats	86	94	40	46	78	69	64	56	4.8	5.3
2. PK for oats	81	104	39	46	80	72	58	47	5.0	5.8
7. NP for oats	88	107	38	42	82	79	99	85	5.5	5.3
3. NPK for oats	84	123	38	46	75	77	95	74	4.8	5.4
10. P for oats & corn	95	108	41	43	81	115	59	56	5.4	5.0
9. P for corn	84	98	39	43	79	84	50	81	5.5	5.3
4. Manure for corn	115	119	47	48	95	130	57	51	4.7	5.3
8. Manure & P for corn	110	115	49	48	87	120	61	65	4.8	5.4
5. " & NPK for corn	120	127	44	47	94	108	65	56	4.7	5.6
LSD (5%)	13.5	16	6.5	5.5	-	15.7	10.3	13	0.22	0.32

*Refers to extra-heavy fertilization treatments in addition to regular treatments outlined.

Profit Possibility Plots

(NPK rates on corn 1961)

C. J. Overdahl, John Grava, L. D. Hanson, M. V. Halverson and James App

The 1961 demonstration plots on corn were designed to show the economics of fertilizer use. Approximately 65 out of 90 established plots were harvested. Hail and uneven stands reduced the number available for summary to 55.

Fertilizer was packaged and furnished to county agents along with complete instructions on plot establishment.

Emphasis was placed on starter fertilizer with half of the total plot area receiving broadcast potash on plots in the eastern portion of the state, while phosphate was broadcast on half the plot area in western Minnesota. Different rates of N, P and K were used to observe most profitable responses and soil test relationships.

Results in southeast Minnesota (13 fields)

Nitrogen (all starter rows had 15 lbs of nitrogern per acre)

supplemental nitrogen	Increase in bushels/acre
25#	6
65#	8

phosphate (N treatment 80#, K_2O = 30#)

soil test level	low	med	high	very high
number fields	2	1	5	5
	yield increases			
30# P_2O_5 row	0	10	9	-8
60# P_2O_5 row	9	8	9	1

potash (N treatment 80#, P_2O_5 = 30#)

soil test level	low	med	high
number fields	4	4	5
	yield increases		
30# K_2O (row)	23	5	0
60# K_2O (row)	26	16	1
60# K_2O (brcst)	14	4	3
90# K_2O (30#r + 60#br)	20	17	1
120# K_2O (60#r + 60#br)	23	10	1

All broadcast potash was applied on plowed land and incorporated into the soil. Broadcast potash plowed under might have shown better results. Nitrogen was applied on the surface down the middle of paired rows. Rainfall appeared adequate to move nitrogen into the soil but perhaps if applied closer to the row or placed deeper results would have been better. Corn followed a non-legume crop and a larger response to nitrogen would have been expected. Subsoil phosphorus on most of these soils is high which appears to make responses to row applied phosphorus on low tests about equal to that of the high tests. There was no broadcast phosphate on these 13 fields.

Results on coarse textured soils (10 fields in Washington, Chisago, Anoka Mille Lacs and Isanti counties.)

	rate	increase
supplemental nitrogen *	25# S D	14 bu
	65# S D	21 bu
phosphate **	30# row	6 bu
potash	low test	medium test
30# K_2O (row)	9 bu increase	7 bu increase
60# K_2O (bcst)	9 bu increase	-2 bu increase
90# K_2O (30#r + 60#bct)	13 bu increase	8 bu increase

* all starter rows had 15 lbs of N plus adequate P and K corn on most plots appeared to need more than 80 pounds of nitrogen

** all plots had high phosphorus tests and increas s were determined where N and K were adequate.

Results southwest Minnesota (32 fields)

Nitrogen (all starter rows had 10 lbs of N per acre)

supplemental nitrogen	Increase in bu/acre
30#	3
70#	8

Phosphate (N treatment 80#, K_2O = 40#)

soil test level	low	medium	high	very high
number fields	6	14	9	3
	yield increases in bu/acre			
40# P_2O_5 (row)	2	3	1	-4
40# P_2O_5 (brcst)	10	3	4	-1
80# P_2O_5 (40r + 40#bct)	11	4	4	-4

Potash (nitrogen treatment 80#, P_2O_5 = 40# or 80#)

soil test level	low-med	high-med	high
number fields	8	6	18
	yield increases in bu/acre		
40# K_2O (row)	6	5.5	2

Responses to nitrogen and phosphate in 1961 in the western half of the state were lower than in past years, particularly for phosphate. The following are individual treatment effects showing the variation from field to field. Corn followed a non-legume crop on all but four fields. Four followed soybeans.

Yield increases due to 80# N

(Barnes-Aasted and Moody soils)

-11, -1, 1, 8, 4, 28, 6, 3, 5, -1, 2, 19, -3, -6, 1, 15, 1. AVERAGE = 4 bu

(Clarion-Webster soils)
after non-legume

10, 17, 10, 11, 27, 8, 7, 37, 10, 12, 26. AVERAGE = 16 bushels

after soybeans

-2, 1, 8, 2. AVERAGE = 2 bushels

phosphate yield increases

(Barnes-Aasted and Moody soils)

40 lbs P_2O_5 in row

low test	10, 5, 10, 1, -2, -13
high test	-1, -8, -8, -9

80 lbs P_2O_5 (40 row + 40 bcst)

low test	16, 12, 9, 7, 2, 21
high test	0, -7, -7, -19

The yield reductions from phosphate particularly on high testing soils in western Minnesota appears to occur consistently.

A multilithed booklet will be made regarding the profits from these plots. In general on coarse and medium textured soils in the eastern portion of the state profits were very high from starter applications of P and K. In western Minnesota profits appeared to be as good or better from broadcast phosphate. Profits from potash in the row on low and medium tests were extremely high.

Fertilizer materials were supplied by the Minnesota Fertilizer Industry Association and funds for packaging and delivering fertilizer to the counties were supplied by the National Plant Food Institute.

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FIELD FERTILITY STUDIES WITH CORN ON FAYETTE SOILS - 1961

John Grava and Lowell D. Hanson[1]

The Fayette soils of southeastern Minnesota often have puzzled soil fertility men. On one hand, their light color would lead one to suspect that he is dealing with low-producing soils. On the other hand, we often see evidence of unexpectedly high productivity. Harold Jones and others[2], for example, in their demonstration "Corn Yesterday and Today" produced 123 bushels/acre yield under proper management in Goodhue County. Top corn yields are produced almost every year by farmers in southeastern Minnesota who participate in Minnesota's X-tra Yield Corn Contest. Consequently, properly managed Fayette soils are given the highest yield potential ratings of any soil in the state.

Fayette soils originally were included in the Fayette-Tama Soil Association. This association occupies about 2.3 million acres in southeastern Minnesota. All of Houston, Wabasha, and parts of Fillmore, Winona, Olmsted, Goodhue and Dodge Counties are included in it. A large portion of the region has a rugged topography which is more pronounced near the Mississippi River, and its larger tributaries. Recently the Fayette-Tama soil area was split up into two separate associations, namely the Fayette-Dubuque, and the Tama-Downs. The Fayette-Dubuque are light-colored, silty soils developed under forest vegetation and underlain by limestone. Fayette soils are deep and have silty subsoils. Dubuque soils are shallow with clayey subsoils over limestone. Topography ranges from rolling to steep. Erosion is serious. The Fayette-Dubuque soils occupy about 1.5 million acres in Minnesota, and are also extensively distributed in southwestern Wisconsin and northeastern Iowa.

Soil test summaries[3] of 10,522 samples received from southeastern Minnesota (Fayette-Dubuque and Tama-Downs areas cmmbined) indicate the following fertility trends: 92% of all samples had silt loam textures; 64% of all samples tested less than 3.1% in organic matter content; 33% of these samples showed pH values of less than 6.3; 65% of samples showed high and very high phosphorus levels; 80% of samples had low to medium potassium contents.

An NPK-Rate Study was initiated last spring in southeastern Minnesota to solve several problems encountered in our soil testing program. The Fayette soil and the corn crop were chosen for the experiments because of their agricultural importance in the area. The main objectives of this study were:

1. To evaluate the reliability of the present soil testing methods by using leaf analyses and yield measurements.

2. To evaluate corn response to different rates of commercial nitrogen, phosphate and potash.

3. To compare the effectiveness of broadcast and row-placed phosphate.

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1 Assistant Professor of Soils and Soils Extension Specialist, respectively.

2 H.E.Jones, Edwin Jensen and Arnold Wiebusch, Plant Food Review, Vol. 1, No. 3, N.P.F.I. Publication, Washington, 1955.

3 J. Grava and R. J. Poff, Unpublished data.

For this purpose five fields of Fayette soil were selected in Goodhue, Wabasha, Winona and Fillmore counties. None of these fields had received manure, heavy fertilization, or alfalfa plowdown in the previous year. Surface and subsoil samples were collected in April for routine chemical analysis and moisture determination. Each field experiment consisted of 12 treatments, replicated three times, for a total of 36 plots. Individual plots were 50 feet long and 13.3 feet wide. The amounts of nutrients applied and the method of application used are given in treatment description (Table 1).

Pioneer 376 (108-112 day) corn variety was planted at all locations. Atrazine was applied in bands at planting time. Fields were cultivated once to control weeds effectively. Corn was thinned to a uniform population of 18,500 plants per acre. The farmer cooperators were provided with rain gauges and asked to keep rainfall records. Corn leaf samples were collected at tasseling time at three locations, and their N, P, and K contents determined. Finally, corn yields were measured. Because of the extremely uneven corn stand at one location, the results from only four of the experiments are reported.

Soil tests indicate (Table 2) that the soils used are comparatively low in organic matter, medium to high in extractable phosphorus and low to medium in exchangeable potassium.

Relatively high amounts of phosphorus were extracted with Bray's No. 1 extracting solution from Fayette subsoil samples (Tables 3, 4, 5, & 6). Subsoil moisture was sufficient at planting time (Table 7). All locations received about 15 inches of rainfall during June, July, August and September (Table 8).

Good subsoil moisture, adequate and well distributed rainfall, sufficient corn populations and effective weed control obviously contributed to comparatively high corn yields at all locations (Table 9). Check plots yielded on the average 102 bushels/acre.

Although three out of four fields showed yield increases to rates of nitrogen as high as 110 pounds per acre, yields of 100 bushels were measured on plots receiving only 10 pounds of row-placed nitrogen. Obviously the Fayette silt loam soils, under proper management and favorable weather conditions, can release substantial amounts of nitrogen to corn.

The effects of phosphate on corn yields were in the main, negative. On all but the Maus field, yields were reduced from one to 30 bushels. This relationship is not presently understood and requires further study.

Broadcast applicatinn of phosphate (40 lbs. P_2O_5/acre) resulted in lower yields (average of 4 fields 14 bu./A) than the same amount of phosphate applied in a row.

Corn leaves collected from no phosphate plots had an average phosphorus content of 0.28% (Table 11) only slightly less than the safe level of 0.295% P. Corn response and leaf analysis would indicate that Bray's No. 1 method is quite reliable in measuring phosphorus availability in Fayette soils.

Soil tests show that Fayette soils are deficient in potassium. This was also substantiated by leaf analysis and corn yield response. Potassium contents of 0.64, 0.79, and 0.90% (Table 12) in leaves collected from no potassium plots were well below the 1.3% K level which is considered to be safe.

In two of the four locations, the 120 pounds per acre K_2O rate was most economical; in the other two locations, 60 pounds of K_2O per acre was as effective as any higher rate.

Acknowledgments

The authors are indepted to the National Plant Food Institute for financial assistance, and to members of the Minnesota Fertilizer Industry Association for contributions of fertilizer materials. They are also grateful to extension agents: Messrs. Arnold Wiebusch, Mat Metz, Oliver Strand and Milton Hoberg for their assistance, and to Messrs. Dale Flueger, Jerome Mahoney, Ervin Maus and Clair Gossman for their generous cooperation.

Table 1. Treatment Description

Treatment Number	Broadcast[1] Lbs./A.	Row Lbs./A.	Total Nutrients Lbs./A.
1	None	None	None
2	100+0+100	10+0+20[2]	110+0+120
3	100+0+100	10+20+20[3]	110+20+120
4	100+0+100	10+40+20[4]	110+40+120
5	100+40+100	10+0+20	110+40+120
6	100+40+0	10+40+0[5]	110+80+0
7	100+40+0	10+40+20	110+80+20
8	100+40+40	10+40+20	110+80+60
9	100+40+160	10+40+20	110+80+180
10	0+40+100	10+40+20	10+80+120
11	50+40+100	10+40+20	60+80+120
12	100+40+100	10+40+20	110+80+120

Fertilizers used:
1 33-0-0; 0-45-0; 0-0-60
2 33-0-0; 0-0-60 (applied on applicator belt separately)
3 10-20-20
4 6-24-12
5 9-36-0

Table 2. Soil Test Results

Location	pH	Organic Matter %	Extractable Phosphorus Lbs./Acre	Exchangeable Potassium Lbs./Acre	Texture
Flueger, Goodhue County	6.9	2.0	16	93	Silt Loam
Mahoney, Goodhue County	7.5	3.9	23	145	Silt Loam
Freeze, Wabasha County	6.9	2.3	21	97	Silt Loam
Maus, Winona County	7.2	2.9	17	105	Silt Loam

Table 3. Subsoil Fertility
Dale Flueger, Goodhue County

Depth in Inches	pH	O.M. %	P p.p. 2m*	K p.p. 2m*
0-6	6.8	1.8	15	100
11-14	5.9	0.6	23	135
18-24	5.3	0.6	50	120
30-35	5.6	0.4	44	70
42-48	5.8	0.4	40	70
50-56	6.3	0.4	53	55
56-60	8.0	0.4	39	70

* p.p. 2m = parts per 2 million

Table 4. Subsoil Fertility
Jerome Mahoney, Goodhue County

Depth in Inches	pH	O.M. %	P p.p. 2m	K p.p. 2m
6-9	6.4	1.9	18	120
10-13	5.6	1.5	12	110
15-19	5.3	1.1	17	110
20-24	5.2	0.8	37	110
26-30	5.3	0.7	61	110
32-36	5.4	0.4	68	110
38-40	5.4	0.4	71	110
44-48	5.5	0.3	65	90
53-56	5.5	0.4	66	100
56-60	5.5	0.3	66	100

Table 5. Subsoil Fertility
Edwin Freeze, Wabasha County

Depth in Inches	pH	O.M. %	P p.p. 2m	K p.p. 2m
0-7	6.8	2.1	26	120
7-14	6.3	2.1	19	100
14-19	6.3	1.0	28	95
19-24	6.0	0.8	46	110
24-30	5.7	0.6	52	120
30-36	5.5	0.5	54	135
36-42	5.5	0.4	50	140
42-48	5.5	0.5	48	120
48-54	5.4	0.5	45	110
54-60	5.4	0.4	50	125

Table 6. Subsoil Fertility
Ervin Maus, Winona County

Depth in Inches	pH	O.M. %	P p.p. 2m	K p.p. 2m
6-12	7.3	2.3	17	90
16-20	6.2	0.9	33	100
22-26	5.5	0.6	60	130
32-36	5.5	0.6	54	130
38-44	5.4	0.6	50	120
46-50	5.6	0.6	40	110
54-56	5.6	0.5	42	130
56-60	5.6	0.5	41	150

Table 7. Subsoil Moisture

Depth in Feet	Location				Average of 4 locations
	Flueger	Mahoney	Freeze	Maus	
	Moisture in percent				
1	24.8	30.6	25.2	26.3	26.7
2	22.8	26.4	23.4	21.1	23.4
3	21.9	21.0	18.4	20.5	20.5
4	14.9	18.9	19.1	22.5	18.9
5	16.6	19.6	18.0	25.0	19.8

Table 8. Rainfall Data

Month	Location				
	Flueger Goodhue Co.	Freeze Wabasha Co.	Maus Winona Co.	Rochester-Airport Total	Long term ave.
	Rainfall Inches				
June	1.2	3.6	1.8	3.9	4.3
July	5.5	4.1	5.9	5.0	3.5
August	2.2	2.5	7.0	2.5	3.5
September	4.9	4.4	4.9	4.0	4.1
Total (4 months)	13.8	14.6	19.6	15.4	15.4

Table 9. Corn Response to Fertilization.

Treatment Number	Rate of Nutrient Applied Lbs./Acre	Location				Average of 4 Locations
		Flueger Goodhue County	Mahoney Goodhue County	Freeze Wabasha County	Maus Winona County	
		YIELD OF SHELLED CORN (15.5% MOISTURE) BUSHELS/ACRE				
1	Check	117	111	79	101	102
	Nitrogen (N)					
10	10	124	118	97	100	110
11	60	139	120	108	123	122
12	110	145	122	125	133	131
	Phosphate (P_2O_5)					
2	0	144	133	126	117	130
3	20	136	129	115	118	124
4	40 Row	137	132	116	123	127
5	40 Bcst.	119	116	96	120	113
12	80	145	122	125	133	131
	Potash (K_2O)					
6	0	133	108	111	102	113
7	20	132	122	114	120	122
8	60	151	127	100	113	123
12	120	145	122	125	133	131
9	180	156	124	121	123	131

Table 10. Effect of Fertilization on Nitrogen Content in 6th Corn Leaf at Tasseling Time.

N Applied Lbs/Acre	Location: Flueger	Freeze	Maus	Average of 3 Locations
	N % in Corn Leaf*			
10	2.65	2.52	2.48	2.55
60	3.16	3.13	2.69	2.99
110	3.19	3.42	2.89	3.17

* Safe level (according to Tyner) 2.9% N

Table 11. Effect of Fertility on Phosphorus Content in 6th Corn Leaf at Tasseling Time.

P_2O_5 Applied Lbs./Acre	Location: Flueger	Freeze	Maus	Average of 3 Locations
	P % in Corn Leaf			
0	.285	.300	.270	.285
20 Row	.293	.305	.281	.293
40 Row	.299	.293	.293	.295
40 Bcst.	.314	.306	.297	.306
80 (40 Row + 40 Bcst.)	.321	.333	.298	.317

Table 12. Effect of Fertilization on Potassium Content in 6th Corn Leaf at Tasseling Time.

K_2O Applied Lbs./Acre	Location: Flueger	Freeze	Maus	Average of 3 Locations
	K % in Corn Leaf			
0	0.90	0.64	0.79	0.78
20	1.09	0.95	1.29	1.11
60	1.55	1.11	1.24	1.30
120	1.58	1.24	1.31	1.38
180	1.91	1.50	1.45	1.62

Comparison of Fertilizer Materials on a Field Basis at Rosemount

By R. Dennistoun, J. B. Weber, and A. C. Caldwell

An experiment was established at the Rosemount Experiment Station in 1961, to determine the corn yield response from application of several fertilizer sources. Sources used were 30-10-0, 20-52-0, 0-52-0, and 5-20-20. Rates of application were: 100, 200, and 300 pounds per acre of 30-10-0, 100 pounds per acre of 20-52-0 plus 0 and 60 pounds per acre of N, 100 pounds per acre of 0-52-0 plus 0, 60, and 90 pounds per acre of N, and 150 pounds per acre of 5-20-20 plus 0 and 90 pounds per acre of N. All fertilizers were applied as starter except N (urea) which was sidedressed. KCl was applied broadcast to the entire experiment at the rate of 100 pounds per acre K_2O. Pioneer 377A corn was planted at the rate of 3 hills per 24 inches in 40 inch rows. Randox was used to control weeds. The experiment was laid out in two replications with plots 8 rows wide and 990 feet long.

Soil tests indicated the area to be relatively low to medium in both available P and exchangeable K.

Yield Results

Corn yield data was obtained by sampling and also by harvesting the entire plots.

Table 1 shows the average yields for the respective treatments by the two methods of harvesting. Results from the two harvesting methods are comparable and yield similar information. Due to the small number of replications and the lack of randomization the small sample method contains a much larger standard error and thus larger values for the lsd and hsd values. Because of this the entire plot harvest presents a more representative picture of the yields on this particular field and will therefore be used in discussing the significant yield differences.

All fertilizer application, except treatment 7 yielded significant increases in yield above the control (treatment 1), lsd at 5%. N application of 60 and 90 pounds per acre were in every case significantly higher than comparable treatment without N, hsd at 5%. There were no treatments which did not receive P, so it is impossible to tell whether the N treatment or the interaction of N and P had the greatest effect on increasing corn yields. There were no significant yield differences attributable to P applications alone, however.

Higher rates of application 30-10-0, treatments 3 and 4, were not significantly different from the 100 pound per acre application, hsd at 5%. Fertilizers were not applied at similar nutrient rates so comparisons cannot be made between fertilizer materials.

The results indicate the most effective fertilizer applications were treatments 2, 6, 8, 9, and 11. The most economical fertilizer application was treatment 2.

Phosphorus Analyses

Chemical analysis of the leaves showed no significant differences in P content which were attributable to the fertilizer applications, table 1. P content of plants receiving P applications was generally higher than the control plants, however.

Table 1. Effect of various fertilizer sources on the yields of corn and phosphorus content of leaves (Rosemount, 1961).

Treatment Number	Kind of Fertilizer	Rate of appl. lbs./acre	N Treatment lbs. N/A	Corn yields by two harvesting methods: Small Sample bu/A.	Small Sample diff.	Entire Plot bu/A.	Entire Plot Diff.	Phos. Content of Leaves % P
1	0	0	0	68	--	65	--	.266
2	30-10-0	100	0	85	17	94	29	.274
3	30-10-0	200	0	94	26	97	32	.288
4	30-10-0	300	0	96	28	105	40	.292
5	20-52-0	100	0	82	14	86	21	.274
6	20-52-0	100	60	98	30	108	43	.299
7	0-52-0	100	0	73	5	72	7	.262
8	0-52-0	100	60	94	26	105	40	.299
9	0-52-0	100	90	105	37	110	45	.308
10	5-20-20	150	0	70	2	76	11	.252
11	5-20-20	150	90	96	28	101	36	.282
Standardcerror =					5.7		3.1	.013
lst ($F_{.95}$) =					14		8	NS
hsd ($F_{.95}$) =					32		17	NS

Comparison of Fertilizer Materials On A Field Basis at Morris

R. L. Thompson & A. C. Caldwell

In 1961 a series of fertilizer materials, including superphosphate, diammonium phosphate and 30-10-0 were applied on corn at Rosemount, Waseca, and Morris. Yields were obtained by hand and by corn picker. The data for Morris are given below.

Previous Cropping History	Fertilizer
1960 - Corn	100 lbs./A 10-20-0
1959 - Alfalfa & South end in Corn	42 lbs. P_2O_5/A on alfalfa. Nothing on corn.
1958 - Oats seeded down to alfalfa	35 lbs. P_2O_5 per Acre.

1958 Soils test - Three tests were taken; one from the higher areas and two others from the low areas in the field.

1961 Soil Samples taken July 20, 1961. Samples taken from areas divided approximately as in 1958.

	pH	Organic Matter	Available Phosphorus lbs.	Exchangeable Potassium lbs.	Soil texture
1958 - High areas	7.5	5.2% Med	47 High	460 V High	Silty Clay loam
" Low areas	7.7	6.2% Med	7 Low	300 V High	Silty Clay loam
" Low areas	7.7	6.3% Med	10 Low	350 V High	Silty Clay loam
1961 - High areas	7.9	6.4% Med	40 V High	440 V High	Silty Clay loam
" Low areas	7.7	7.1% High	37 V High	490 V High	Silty Clay loam

Minnhybrid 612 corn was planted May 23-24, 1960. The field was fall plowed. Spring soil preparation consisted only of digging with spring tooth cultivators immediately prior to wheel track planting. Randox was band sprayed over the row at a rate of 5 lbs. per acre. The corn was later sprayed with 2,4-D to control Canada thistles. Two cultivations were used to complete the weed control program. Anhydrous ammonia was applied approximately June 16.

Yield Determination

Samples were harvested from 25 feet of row two places in the field. These samples were weighed and some kernels shelled off to make a moisture determination by oven drying the sample. Because of excess heat in the oven, several samples were lost so a moisture content of 31% was used in the yield determination. This was the average moisture content of seven treatments in which at least two samples were available out of the three replicates. The range in moisture in these seven treatments was from a low of 29.09 to a high of 32.67 per cent. All yields were then converted to a 15 per cent moisture basis.

The combine harvested plots were harvested with a John Deere two-row combine with corn head attachment. The center four rows from each plot were harvested by making a single round. The corn was then put into a truck and the moisture sample taken and the corn weighed. The length of the plots varied slightly; yields were based on the actual size of plot which ranged from .526 acre to .699 acre in size. The moistures were determined with a Stienlite moisture meter which had been checked against the Brown Duval oil tester. All yields were then converted to bushels per acre at 15 per cent moisture.

CORN YIELDS IN BUSHELS PER ACRE AT 15 PER CENT MOISTURE

Treatment	Rep I		Rep II		Rep III		Average		
	Combine	Hand Harvest	Combine	Hand Harvest	Combine	Hand Harvest	Combine	Hand Harvest	
1. 100 lbs. 0-52-0 + 54 lbs. N	56.74	70.62	66.96	76.98	64.95	69.41	62.88	72.34	
2. 100 lbs. 0-52-0 + 92 lbs. N	62.96	75.16	67.17	63.95	66.69	67.59	65.61	68.90	
3. 100 lbs. 20-52-0 + 54 lbs. N	63.35	60.00	66.87	62.74	66.42	59.71	65.55	60.82	
4. 100 lbs. 20-52-0	63.25	59.71	67.74	71.53	65.81	63.34	65.61	64.86	
5. Check	60.43	62.42	69.64	62.43	67.23	81.53	65.77	68.79	
6. 200 lbs. 30-10-0	63.93	57.28	68.85	74.56	69.05	61.22	67.28	64.35	
7. 300 lbs. 30-10-0	61.05	56.37	63.25	53.95	68.84	71.53	64.38	60.62	
8. 100 lbs. 30-10-0	64.80	54.85	69.00	63.95	71.74	67.59	68.51	62.13	
Border Between Reps (2nd check)	63.69	61.53	71.40	70.62	69.98	- -	68.36	66.02	(Ave. of 2)
							525.90	522.81	
						Ave.	65.7	65.4	

Continuous Corn - High Fertility Experiment
Rosemount Experiment Station
Soils

W. P. Martin and H. W. Kramer

Yield Results - 1961

Re: 1959 results, page 97, Department of Soils Mimeo, April, 1960; 1960 results, page 82, ibid, February, 1961.

Soil Type: Port Byron silty clay loam

Object: To determine profitable rates of fertilization for continuous corn.

Site: Fairly level with minimum erosion hazard; protected from hill pastures with terrace; tile drained.

Past results: Yields have varied from 45 bu./ac. to 133 bu. as an average of all treatments, 1953-1960. Highest yields were obtained in 1954 and lowest in 1957 (because of excess ppc. and weediness). Yields have consistently reflected fertilizer responses.

	16,000 plants	20,000 plants
1. Check	70 bu.	102
2. H*	80	107
3. HS_1	89	114
4. HS_2	87	116
5. B_1H	77	107
6. B_1HS_1	89	119
7. B_1HS_2	86	118
8. B_2H	80	114
9. B_2HS_1	88	117
10. B_2HS_2	88	115
LSD (5%)	6.3	7.7

*H = 200 lbs. 10-20-20 hill drop
S_1 = 100 lbs. 33-0-0 sidedress
S_2 = 200 lbs. 33-0-0 sidedress
B_1 = 400 lbs. 6-24-12 broadcast
B_2 = 800 lbs. 6-24-12 broadcast

Fertilizer Placement and Corn Stand
Rosemount Agricultural Experiment Station - 1961

Paul M. Burson

Diammonium phosphate is a common ingredient in mixed fertilizers whether they are manufactured by treating superphosphate with ammonia or by adding a previously manufactured ammonium phosphate. It is known that if any considerable amount comes in contact with corn seed, germination is damaged.

In the trials in 1961 the splitboot and band placement fertilizer attachments for the corn planter were used. The fertilizers studies were 18-46-0 and a mixed fertilizer, 5-20-20, at different rates. As an additional placement treatment the inverted V shaped spreader was removed from the splitboot attachment allowing the fertilizer and seed to fall together (with seed) so the fertilizer was known to be in contact with the seed.

Fertilizer rates	Number of plants per acre		
	Splitboot	With Seed	Band
	Ammonium phosphate (18-46-0)		
100 lbs	11,350	8750	16,700
200 lbs	8,700	5850	17,000
400 lbs	10,350	1450	16,600
	Mixed fertilizer (5-20-20)		
200 lbs	13,000	11,100	16,750
400 lbs	11,100	5350	16,350

The data shows that straight diammonium phosphate (18-46-0) either with the spreader (inverted V) in or out seriously damaged germination regardless of the rate used and that when placed in a band to the side and below the seed had little effect. The normal mortality rate regardless of the planter used and the kind of seed can range from 10 to 15 percent of the number of kernels dropped.

The germination damaged with the mixed fertilizer (5-20-20) was less in the splitboot attachment than it was with straight diammonium phosphate (18-46-0) but was still serious enough to suggest that the 200 pound rate was too heavy when a splitboot attachment is used. For this attachment the rate should probably not exceed 150 pounds per acre. There was no damage when the band placement was used. The above table shows how placement injured germination and reduced the final stand.

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.

By J. M. MacGregor

In 1953, a seed-bed preparation experiment was initiated on a 9% slope of the Port Byron silt loam at Rosemount to determine the relative effect of deep tillage seed-bed preparation versus conventional plowing, on losses of soil and water and of corn, oat, and hay yields where a four year rotation of corn, oats, followed by two years of alfalfa was practiced.

Six years of experimental results (1953-1958) indicated that the four year rotation in use was adequately maintaining soil tilth, and with no treatment replication there was no significant difference in soil or water loss with the two methods of soil preparation or in the yields of corn, oats, or of alfalfa hay.

Therefore, in 1959, the four year rotation was changed to a continuous corn sequence on each of the eight plots. After harvest each fall, a stalk cutter was used on all plots, after which four were plowed and the remaining four adjacent plots were deeply cultivated (to approximately an eight inch depth) and then reworked to a slightly shallower depth in the spring. Corn was planted to obtain approximately 16,000 plants per acre, using 5-20-20 as starter fertilizer each year at the rate of 200 pounds per acre. A nitrogen sidedressing of 80 pounds of ammonium nitrate nitrogen per acre was broadcast annually in late June or in early July.

Results

The growing season of 1959 was abnormally wet, followed by two comparatively dry summers of 1960 and 1961. This variation in growing season moisture has produced considerable difference in all of the results obtained, as shown in the following table:

Table 1. The effect of seed-bed preparation by plowing or by deep cultivation on soil and water losses and resulting corn yield on a 9% slope of Port Byron silt loam at Rosemount (1959-61) (Averages of four replicates).

	Year		
	1959	1960	1961
Total precipitation (April-Oct. inc.)	32.5"	21.8"	19.3"
Water runoff on plowed plots	6.3"	0.7"	None
Runoff as % of 7 month pptn.	19	3	None
Runoff on cultivated plots	5.6"	0.3"	None
Runoff as % of 7 month pptn.	17	1	None
Tons of soil eroded/A on plowed plots	2.4	None	None
Tons of soil eroded/A on cultivated plots	1.3	None	None
Yield of ear corn per acre on plowed plots	119	88	99
Yield of ear corn per acre on cultivated plots	122	74	81

Discussion

Precipitation - the total amount, the distribution and the relative intensities of each rain, has a great effect on soil erosion and water runoff - and also materially affects subsequent corn yields on the two different methods of seed-bed preparation. The heavier than normal rainfall of 1959 was more effectively controlled and conserved by deep tillage rather than by the plowing, and this method of soil preparation reduced both soil and water losses and also resulted in a 122 bushel yield of ear corn per acre. The plowed plots (all plots of the experiment are worked on the contour) had a greater runoff and soil loss under the heavy rains of that summer, and yielded 118 bushels of corn per acre.

The growing seasons of 1960 and 1961 were drier than normal, and although there were some rains resulting in runoff water in 1959, no measured soil loss occurred in either of these two latter years. The drier soil conditions apparently lowered corn yields substantially in comparison to those produced in 1959, and the deeply cultivated plots were less productive where the seed-bed was prepared by plowing. A yield difference of either 14 or 18 bushels per acre would be of primary concern to a farmer following such conservation practices. In addition, the corn population on the deeply cultivated plots was generally unsatisfactory, although this effect was largely corrected when the corn yields per acre were calculated.

Conclusion

While nothing definite can be concluded from the results from only three years data, it is evident that there was better control of soil moisture under higher rainfall where deep cultivation was used rather than plowing. This better moisture control may have been improved by increasing the water infiltration into the subsoil by working at deeper levels than by normal plowing. Under dry conditinns, this may have been detrimental in a llowing greater losses of soil moisture to the air under prolonged periods of drier soil conditions. It is possible that cutting the corn stalks in a field chopper rather than with a stalk cutter will allow preparation of a suitable seed-bed by cultivation to a maximum depth of six inches. This may allow a greater retention of subsoil moisture, which is apparently a critical factor in drier growing seasons.

Fertilizer Experiment on Continuous Soybeans
Rosemount, 1961

A. C. Caldwell and J. B. Weber

An experiment was set up in 1957 to study the effects of P, K and barnyard manure on the yields and plant composition of soybeans. Plots were laid out consisting of four replications and fifteen treatments.

In 1958 through 1961 no fertilizer was applied in order to study the residual effects of the 1957 applied fertilizer.

Yield results for 1961 are shown in table 1. Significant increases in yields, above the control, occurred only on the 0-400-400-6T treated plots, lsd at 5%. The increases of about 4 bushels per acre above the control are in agreement with the results of the past several years. Significant decreases in yield resulted on the 0-0-80 and 0-400-0 treated plots and this is also in agreement with results of the past several years. None of the treatments, other than the control, are significantly different from each other, hsd at 5%.

Table 1. Effect of residual fertilizer on yield of continuous soybeans, 1961.

Treatment $N-P_2O_5-K_2O$ lbs/A	Yield bu/A	Diff.
0-0-0	20	-
0-0-20	19	-1
0-0-80	16	-4
0-0-400	23	3
0-20-20	18	-2
0-40-40	21	1
0-60-60	21	1
0-80-80	18	2
0-400-400	23	3
0-400-400 + *6T	24	4
0-20-0	19	-1
0-80-0	18	-2
0-400-0	16	-4
0-20-0 + *6T	19	-1
*6 T	21	1

*6 T refers to 6 tons manure/A.

standard error =	1.4
lsd ($F_{.95}$)	3.5
hsd ($F_{.95}$)	7.3

Fertilizer Effect on Yield & Longevity of Ranger Alfalfa on Port Byron Silt Loam at Rosemount, 1949-61.

By J. M. MacGregor & R. G. Hanson

In the fall of 1949, an experiment was initiated to study the effect of different systems of fertilization on the longevity, yield, and composition of Ranger alfalfa. The alfalfa seeding was made in June of 1950 with the first of three annual cuttings being made a year later. Initially eight replications were included, but the continued excessively high production level of the eighth replicate led to its being discarded at the end of three years.

Systematic fertilization and crop removal has been carried on as outlined in the following table, with a variable deterioration in alfalfa stand and a gradual invasion of grasses and a few broad leaved weed species which was more evident in the unfertilized or more poorly fertilized plots. After ten years of continuous hay removal, it was decided to renovate and reseed the entire area after the first cutting of 1961 (31 cuttings having been harvested).

The following table shows the 31 treatments arranged in descending order of effectiveness in hay production for the entire period, including the 1951 yield, the first cut of 1961, the total 10 year yield and the relative increases above those plots receiving no fertilizer

Conclusions

1. Fertilization is highly effective for increasing both yields and longevity of alfalfa.

2. Potassium in addition to the phosphorus is essential if alfalfa stands and yields are to be satisfactory over a period of many years.

3. The ranking effectiveness of potassium of treatment 5 indicates that an 0-1-2 or even 0-1-3 fertilizer ratio might be much more desirable for alfalfa fertilization in Minnesota than the more commonly used 0-1-1 ratio.

4. Heavy initial fertilization is relatively inefficient - better to use lower initial rates and use the remainder as annual or biennial top dressings.

5. Annual top dressings were considerably more economically productive than biennial fertilizer treatments.

6. Initial fertilization followed by annual topdressing was more effective than annual topdressings alone.

7. The inclusion of nitrogen in the fertilizer was not profitable.

8. Initial fertilization with several trace elements failed to increase alfalfa yield or longevity (No's. 22 and 26).

9. Over the ten year period, initial fertilization at moderate rates with no later additions was ineffective for increasing alfalfa yields.

10. Spring fertilization produced essentially the same results as similar treatments applied in the previous fall.

Total Yield - Rosemount Alfalfa - 1951-61

Average of Seven Replications

11 year yield rank	Treatment	(Tons/acre at 15% moisture) 1951	1961	Eleven year total Yield	Increase
30	Check	3.10	1.09	30.19	----
1	300# 0-20-20 SBS + 200# AS	3.96	1.51	45.53	15.34
2	300# 0-20-20 FBS + 200# AF	3.89	1.55	44.75	14.56
3	300# 5-20-20 SBS + 200# AS	4.03	1.64	44.50	14.31
4	1000# 0-20-20 SBS + 200# AS	4.42	1.47	44.01	13.82
5	1000# 0-20-0 SBS + 100# of KCl AFC	4.26	1.60	43.72	13.53
6	1000# 0-20-20 SBS + 200# 5-20-20 BS	4.34	1.33	43.42	13.23
7	200# 0-20-20 AS	3.25	1.42	43.20	13.01
8	1000# 0-20-0 SBS + 200# 0-20-20 AS	4.14	1.15	42.56	12.37
9	300# 0-20-20 FBS + 200# BF	3.51	1.44	41.23	11.04
10	200# 0-20-20 AF + 200# BS	3.60	1.48	41.23	11.04
11	1000# 0-20-20 SBS + 200# BS	4.30	1.42	39.05	8.86
12	300# 0-20-20 SBS + 200# BS	3.79	1.20	38.50	8.31
13.	1000# 0-20-0 SBS + 200# 0-20-20 BS	3.95	1.51	37.12	6.93
14	300# 0-20-0 SBS + 200# AS	3.77	1.13	36.57	6.38
15	300# 0-20-20 SBS	3.90	1.37	35.64	5.45
16	1000# 0-20-20 SBS	4.09	1.17	35.22	5.03
17	1000# 0-20-0 SBS + 200# AS	4.04	1.27	34.71	4.52
18	200# 0-20-0 AS	3.64	1.25	34.69	4.50
19	200# 0-20-0 AF	3.84	1.16	34.44	4.25
20	300# 0-20-0 FBS + 200# BF	3.68	1.07	33.86	3.67
21	300# 0-20-0 FBS + 200# AF	3.77	1.17	33.67	3.48
22	300# 0-20-20 + Trace Elements SBS	3.88	1.15	33.33	3.14
23	300# 0-20-0 SBS + 200# BS	3.64	1.09	32.64	2.45
24	300# 5-20-20 SBS + 20# Nitrogen AS	3.75	1.09	32.62	2.43
25	300# 0-20-0 FBS	3.61	0.97	32.02	1.95
26	300# 0-20-20 + 20# Boron SBS	3.84	1.01	31.07	0.98
27	1000# 0-20-0 SBS	4.01	0.97	30.68	0.49
28	300# 0-20-20 FBS	3.78	1.03	30.15	-0.04
29	300# 5-20-20 SBS	3.82	0.95	30.13	-0.06
31	300# 0-20-20 SBS	3.59	0.93	29.42	-0.77

SBS - Spring before seeding
FBS - Fall before seeding
AFC - Annual first cutting
AS - Annual spring
BS - Biennial spring
AF - Annual fall
BF - Biennial fall
Trace Elements - $CuSO_4$ 25#/A; $ZnSO_4$ 25#/A; $MnSO_4$ 25#/A; $FeSO_4$ 25#/A; Borax 20#/A.

With the gradual invasion of grasses and weeds and the depletion of the alfalfa stand, the experimental area is being renovated and was seeded with Vernal alfalfa following the removal of the first cutting in 1961. The same fertilization will be continued.

This experiment was designed by Dr. C. O. Rost. The research work has been carried on under the direction of Dr. J. M. MacGregor by W. W. Nelson, J. R. Brownell, R. G. Burau and R. G. Hanson.

TEN YEARS OF PASTURE EXPERIMENTS
FERTILIZATION AND MANAGEMENT

Paul M. Burson, Soils, & A. L. Harvey, Animal Husbandry

1. Pasture forage and livestock production is the best landuse program for land that is too rolling and steep for production of cultivated crops. This combination program of landuse will maintain soil fertility. It may control erosion and can bring economical returns to the farmer.

2. Lime and fertilizer needs were determined by soil tests.

   a. Lime requirement was 3 tons per acre. It was applied in 1951.

   b. In 1951, soil tests showed phosphate to be low to very low and potash to range from medium to low to very low.

   c. In 1951, all slopes were badly eroded, gullied and no topsoil. This resulted in low organic matter and nitrogen.

   d. The soil fertility was generally low.

3. In 1960, soil tests on fertilized pastures showed pH above 6.0, phosphate and potash tests to be generally high with some areas in the pastures as very high.

4. The fertilizer program, depending on soil tests, included a basic treatment of 60 to 100 lbs. of phosphate (P_2O_5) and the same amount of potash (K_2O) per acre at the time the pastures were originally seeded.

   a. The use of 60 lb. per acre each of phosphate and potash as a basic treatment seems to be adequate.

   b. Annual topdressed applications followed of 40 lbs. per acre each of phosphate and potash applied in early spring.

   c. Annual application of 66 lb. of topdressed nitrogen are made at different times of the pasture season.

5. Clipping yields were made comparing nitrogen fertilization as to time of application and split versus one application.

   a. All the nitrogen applied at one time generally is the most satisfactory.

   b. With all nitrogen applied in the 1st week of June, the yields were about equal to that being applied in the last week of April.

   c. June application has been effective because it stimulated growth after early spring growth, has been partially grazed off and while an adequate moisture supply is still available to make the nitrogen response most effective.

   d. If split applications of nitrogen are used, with one-half applied in July, the effectiveness is dependent upon the amount and distribution of the summer rainfall.

   e. The annual application of 60 to 80 lbs. of actual nitrogen applied per acre appeared adequate. Higher amounts per acre should be used on severely eroded and at the time of initial seeding.

6. Nitrogen fertilizer changed pasture composition.

   a. In 1957-58, 60 lb. of nitrogen increased the percent grass from 3 in May to 24 in July.

   b. For the same period, all the nitrogen applied at one time increased the percent range of grass throughout the season from 40 to 80, while the split applicatinn ranged from 40 to 59.

7. Adequate fertilization is most essential on eroded land if uniform composition of the pasturage is to be maintained.

8. The steers showed grazing preference to the fertilized pastures over the unfertilized pastures.

   a. On the unfertilized pastures the steers grazed the grasses before they grazed the legumes.

   b. On the fertilized pastures, the steers grazed both the grasses and legumes, showing no selective preference.

9. Dropping spots were well grazed off on the fertilized pastures while the same spots in the unfertilized pastures generally were not grazed.

10. Manure has been applied annually in the fall since 1957.

   a. It has not retarded grazing when applied in the fall. Steers may do more uniform grazing on manured pastures.

   b. Manure is slower in the release of nitrogen and provides a residue material that tends to conserve moisture in the dryer periods of the grazing season and at the same time reduce excessive runoff during heavy rains.

11. On land subject to erosion, plowing is not recommended for reestablishing pastures. Renovate the old sod with a heavy field cultivator and a disk to prepare the seed bed.

For additional and more detailed information see stations bulletin 452, "Beef from Grassland", and the other sections of the 1961 Beef Cattle-Grassland Field Day report.

12. An average of seven years' results (1953-1959) shows that fertilizing alfalfa-brome pastures increased:

   (1) Carrying capacity 55 steer days (114-169 days) or 8%;
   (2) Beef produced per acre, 85 lb. (206 to 291) or 41%;
   (3) Value of beef produced per acre less fertilizer cost, $10.04 per acre ($47.64-$57.68) or 21%.

When weather conditions were favorable, as in 1958, 461 lb. of beef were produced per acre on the fertilized pastures, which was 159 lb. more than produced per acre on similar unfertilized pastures. The additional beef produced from the fertilized pastures (valued at $28/cwt.) increased the margin, after deducting costs of fertilizing ($15 per acre), $29.52 per acre.

During the summer of 1960, the application of 60 lb. of nitrogen upon a bromegrass pasture increased: (1) carrying capacity, 46 steer days (86-132) or 53%; (2) beef produced per acre, 76 lb. (134-210 lb.) or 57%; (3) value of beef produced per acre less fertilizer costs, 96¢ per acre

($28.14-$29.10) or 3%.

Fertilizing brome-timothy pastures with manure and nitrogen over a 3-year period (1958-1960) did not prove to be a profitable procedure after fertilizer charge and seed costs were deducted.

PASTURE FERTILITY AND BEEF PRODUCTION

P. M. Burson, Soils; A. R. Schmid, Agronomy
A. L. Harvey and O. E. Kolari, Animal Husbandry

On May 23, 1961, steers were lotted and turned onto pasture. One-half of each of the three pastures was fertilized and the other one-half unfertilized. Each pasture received an annual topdressing of 200 lb. per acre of 0-20-20 and 200 lbs. of 33-0-0, ammonium nitrate (66 lbs. of nitrogen). The 0-20-20 was applied in early spring while the nitrogen was applied at different times during the spring and summer as shown in table 2. Pastures A and C are a mixture of alfalfa, brome and some orchard grass, while pastures B and F are brome and orchard grass. Table 1 shows the production of beef for 1961. The total production of beef per acre ranged from 171 lb. on the unfertilized B and F pastures to 385 lb. on the fertilized renovated A and C pastures. It should be noted that the greatest beef production per acre was from the fertilized renovated pastures which also gave the greatest beef return per acre over seed, tillage and fertilizer costs. The carrying capacity as shown by steer-days per acre ranged from 95 on the unfertilized grass to 170 on the fertilized grass to a top of 180 on the fertilized renovated pastures.

As shown in table 2, the application of nitrogen fertilizer on pastures A, B, C, F, and G was made at two different times in the spring. This was compared with a split application with one-half put on in the spring and one-half during mid-summer. The effect of nitrogen fertilizer on the yield of forage produced per acre was determined. The difference in time of application or the use of split applications had no major effect on the amount of forage produced per acre over single applicatinns all applied in early or late spring. In some areas where rainfall is sufficient and well distributed during the summer months, the split application of nitrogen may boost pasture yields during mid-summer. A split application may be important where the soils are eroded to the extent that no topsoil remains. Where no topsoil remains, higher rates of nitrogen should be used at the spring application along with the mid-summer application. The application of nitrogen fertilizer did boost pasture yields from 1.00 ton per acre on the unfertilized G5 pasture to 3.56 tons on the nitrogen fertilized C1 pasture. The percentage of grass in the pasturage was increased by nitrogen fertilizer. However, no difference in the percentage of grass could be noted as to the time of nitrogen application. Sufficient and well distributed moisture throughout the grazing season is very essential for the most efficient response from nitrogen fertilizer.

Table 1. Beef produced with yearling steers on unfertilized and fertilized pastures grazed in rotation. May 23, 1961 to September 6, 1961. (106 days)

	Unfertilized		Fertilized[a]
	Grass B3, B4, F1 5.65 acres	60#N on Grass B1, B2, F1 5.65 acres	Renovated[b] A2, A3, C1 7.50 acres
No. steers at start	6[c]	10[d]	14
Initial weight, lb.	680	680	679
Average wt. 9/6/61 lb.	850	876	913
Total gain, lb.	966	1754	2890
Total steers days	536	960	1352
Daily gain, lb.	1.80	1.83	2.14
Steer days/acre	95	170	180
Beef produced/acre, lb.	171	310	385
Value beef produced/acre @22.00 cwt.	37.62	68.20	84.70
Fertilizer and lime cost/acre	------	15.00	8.00
Tillage and seed cost/acre	------	------	6.00
Value beef produced/acre less seed, tillage and fertilizer cost	37.62	53.20	70.70

a/ 200#/acre 0-20-20 annual
b/ Renovation - three workings with deep tiller and once with disk. Seeded to alfalfa 5#, alsike 1#, Lincoln brome 6#, and orchard grass 2# per acre.
c/ 2 steers removed 7/18/61
d/ 6 steers removed 8/15/61

Table 2. Clipping yields from fertilized pastures A, B, C, F, and G, comparing nitrogen fertilization as to time of applicatinn and split versus one application. P.M. Burson, Soils; A.R. Schmid, Agronomy; A. L. Harvey, Animal Husbandry[a]

Treatments[b] Lb. N/acre	Total tons and average per acre for each pasture at 15% moisture[c] A3	A4	B1	B2	C1	F	G2	G5	Av.
No fertilizer	1.54	1.54	1.38	1.12	----	1.66	1.29	1.00	1.36
1. 66# April	3.13	3.10	1.44	2.08	3.56	3.24	1.98	2.60	2.14
2. 33# April - 33# July	2.87	3.21	2.00	1.57	3.28	2.97	1.72	2.37	2.50
3. 66# June	2.48	2.84	1.86	1.50	3.12	3.51	1.40	1.98	2.34
4. 33# June - 33# July	2.58	1.23	1.93	2.00	2.74	----	1.41	1.81	1.96

a/ Acknowledgement is due Ed Bonnell and Jobst Siefkin who harvested the samples.

b/ Annual application - 200# per acre 0-20-20, April 22, 1960.

c/ All pastures had 3 clippings except C1 which had 4.

BEEF PRODUCTION FROM FERTILIZED GRASS PASTURES

A. R. Schmid, Agronomy; P. M. Burson, Soils;
A. L. Harvey, and O. E. Kolari, Animal Husbandry

Three types of pasture were compared on "G" for the fourth successive year. A fourth type, the renovated, which was compared in previous years was omitted in 1961 because it was being reseeded to alfalfa-grass. The renovation of this pasture consisted of three cultivations with the Glencoe Deep Tiller in the fall of 1960, followed this spring by fertilizer spreading, deep tilling, discing, harrowing and seeding with a cultipacker seeder. The seed mixture used was alfalfa, 6 pounds per acre; Alsike clover, 1; Lincoln brome, 6; and orchardgrass, 2. This was all seeded without a companion crop in the hopes that with some mowing early in the season, the new seeding might make good enough growth to give some grazing in mid-summer. Unfortunately, yellow foxtail, which is unpalatable, predominated in the mixture and so very little grazing was obtained. The use of an oat companion crop still appears to be the best method of establishing a stand on these pastures.

Beef production was measured from the grass pastures. For the manure treatments applications were made each fall. Commercial fertilizer used on the various treatments was applied in the spring. The rates of fertilization, manure and lime are shown in table 1.

Results - The beef produced per acre was 183 lbs., 270 lbs., and 287 lbs. respectively for the unfertilized, manure and nitrogen treatments. In returns per acre above costs, no spectacular differences were obtained. Steers on the pasture treated with manure returned $0.21 less per acre than the unfertilized, the nitrogen $3.53 more per acre. It should be noted that $9.60 per acre is being charged for the manure applied. Thus subtracting the 21 cent loss leaves $9.39 per acre return for the manure applied. After the weight date, September 6, the steers were placed back on these pastures for a few more weeks of grazing. Gains made during this period will register as return above costs.

Table 1. Beef produced from fertilized brome-timothy pastures on "G" (two-pasture rotational grazing system) May 23, 1961 to September 6, 1961. (106 days)

	Unfertilized	Fertilized	
		Manure a/	Nitrogen b/
	G 4 & 6 3.2 acres	G 1 & 7 3.2 acres	G 2 & 5 3.2 acres
No. steers at start	4 c/	6 c/	6 c/
Initial weight, lb.	679	678	680
Final weight, lb.	833	871	843
Total gain	585	864	919
Total steer days	324	536	536
Daily gain per steer/lb	1.81	1.61	1.71
Steer days per acre	101	168	168
Beef produced per acre	183	270	287
Value of beef produced per acre @$22.00 cwt.	$ 40.26	$ 59.40	$ 63.14
Fertilizer, lime and manure cost per acre a/ b/ d/	$ 0.97	$ 20.32	$ 20.32
Value beef produced per acre less lime, manure and fertilizer costs	$ 39.29	$ 39.08	$ 42.82

a/ Manure, 8 tons/acre annually, value $9.60. Also 300 lbs. 0-20-20 in 1957 and 200 lbs. annually since 1957. Annual 0-20-20 cost $9.75.

b/ Nitrogen, 80 lb. N/acre annually, cost $9.60. Also same amount 0-20-20 as on manure.

c/ Two steers removed 7/18/61.

d/ Lime, all pastures @ 3 tons per acre, cost $0.97 per year over 10 year period.

Table 1. The effect of cobalt bullets given steers on various fertilized pastures. May 23 to September 6, 1961. (106 days).

Treatment[a]	Control		Cobalt[b]	
Pasture	Av. daily gain, lb.	Beef prod. per acre, lb.	Av. daily gain, lb.	Beef prod. per acre, lb.
Fertilized leg & grass (A2, 3, C1)	2.07	371	2.22	400
Fertilized grass (B1, 2, F1)	1.77	301	1.89	320
Unfertilized grass (B3, 4, F2)	1.76	167	1.84	175
Manure on grass (G1, 7)	1.62	271	1.60	269
Nitrogen on grass (G2, 5)	1.65	276	1.78	298
Unfertilized grass (G4, 6)	1.67	169	1.94	197
Weighted averaged	1.82	272	1.94	290
Increase due to cobalt				
Average daily gain, lb.			0.12	
Beef produced per acre, lb.			18 (6.6%)	
Value of beef produced/acre @$22.00/cwt.		$59.84		$63.80
Increase in value due to cobalt				$ 3.96

[a] All steers implanted with 24 mg. stilbestrol 5/23/61.
[b] 20 gram cobalt bullets given 5/23/61.

Table 2. The effect of cobalt bullets on steers grazed on unfertilized and fertilized pastures. May 23 to September 6, 1961 (106 days).

	Control			Cobalt Bullets[a]		
Pasture	Unfert. grass (B3,4,F2)	Fert. grass (B1,2,F1)	Fert.leg.& grass (A2,3,C1)	Unfert. grass (B3,4,F2)	Fert. grass (B1.2.F1)	Fert.leg. & grass (A2,3,C1)
Acres	2.825	2.825	3.75	2.825	2.825	3.75
No. steers at start	3[b]	5[b]	7[c]	3[b]	5[b]	7[c]
Av. initial wt., lb.	692	667	671	668	692	688
Av. final wt., lb.	839	881	879	860	872	948
Total gain/pasture, lb.	472	849	1390	494	905	1500
Total steer days	268	480	676	268	480	676
Av. daily gain, lb.	1.76	1.77	2.07	1.84	1.89	2.22
Steer days/acre	95	170	180	95	170	180
Beef produced/acre lb.	167	301	371	175	320	400
Increase/acre due to cobalt, lb.(%)				8(5%)	19(6%)	29(8%)
Value of beef produced /acre @ $22.00/cwt.	$36.74	$66.22	$81.62	$38.50	$70.40	$88.00

a. 20 gram cobalt bullets given 5/23/61. b. 1 steer removed 7/18/61. c. 3 steers removed 8/15/61.

Table 3. Comparison of yearling steers grazed on unfertilized and fertilized pastures. May 23 to September 6, 1961 (106 days).

Comparison	Fert.grass (B1,2,F1) vs. Unfert.grass (B3,4F2)	Fert.leg.& grass (A2,3,C1) vs. Fert. grass (B1,2,F1)	Fert.leg.& grass (A2,3,C1) vs. Unfert.grass (B3,4,C1)
Increase due to:	Fertilization	Pasture Mixture	Fertilization and pasture mixture
Steer days/acre	75	10	85
Beef produced/acre, lb.	140	75	215
Value of beef produced /acre[a]	$ 30.69	$ 16.50	$ 47.19

[a] Estimated value of beef produced - $22.00/cwt.

THE EFFECTS OF COBALT BULLETS AND PASTURE FERTILIZATION ON BEEF PRODUCTION

A. L. Harvey, O. E. Kolari, J. C. Meiske, Animal Husbandry;
P. M. Burson, Soils; Ar. R. Schmid, Agronomy

Cobalt is one of the essential trace mineral elements required by the rumen microorganisms in the synthesis of vitamin B12. A deficiency of cobalt results in a deficiency of vitamin B12. The cobalt requirement of cattle is very small; 0.1 part per million (p.p.m.) in forages is considered sufficient. Certain areas in the United States, including parts of Minnesota, have been reported deficient in cobalt.

Recently 20 gram cobalt bullets composed of 90% cobalt oxide and 10% binding agent have become available for cattle. Since the bullet is heavy, when it is given with a balling gun it goes to the rumen and remains there, dissolving slowly and furnishing the rumen microorganisms with a continuous supply of cobalt. This method of supplying cobalt is particularly well adapted to studying the need for supplemental cobalt of cattle on pasture.

Fertilizing pastures in the Beef-Cattle Grassland project since 1953 (Mimeo B-29c) has resulted in increased: (1) carrying capacity; (2) beef produced per acre; (3) value of beef produced per acre. In only one year was the application of fertilizer unprofitable.

The objective of this experiment was to determine the effect of cobalt bullets on the performance of steers grazing unfertilized and fertilized pastures.

PROCEDURE

"Medium-to-good" grade yearling steers were lotted as uniformly as possible into three groups, each grazed in a three-pasture rotation (repeat of 1960 trial). Group I consisted of 6 steers (reduced to 4 steers after 56 days) on unfertilized brome-grass pastures (B3, B4, F2) totaling 5.65 acres; Group II consisted of 10 steers (reduced to 8 steers after 56 days) on fertilized brome-grass pastures (B1, B2, F1) totaling 5.65 acres; and Group III consisted of 14 steers (reduced to 8 steers after 84 days) on fertilized alfalfa-brome pastures (A2, A3, C1) totaling 7.5 acres.

In a series of trials on brome-timothy pastures totaling 3.2 acres in each group (partial repeat of 1960, B-36b), Group IV consisted of 4 steers (reduced to 2 steers after 56 days) on unfertilized pastures (G4 and G6); Group V consisted of 6 steers (reduced to 4 after 56 days) on pasture (G1 and G7) fertilized with manure; Group VI consisted of 6 steers (reduced to 4 after 56 days) on pastures (G2 and G5) fertilized with nitrogen.

Steers in these pasture trials were purchased at South St. Paul in May, 1961. All were implanted with 24 mg. stilbestrol when turned on to pasture May 23, 1961. One half were given 20 gram cobalt bullets at the same time.

RESULTS AND DISCUSSION

Giving 20 gram cobalt bullets to yearling steers on pasture increased average daily gain per head 0.12 lb. (1.82 to 1.94 lb.), beef produced per acre 18 lb. (272 to 290 lb.) or 6.6%, and value of beef produced per acre \$3.96 (\$59.84 to \$63.80). See table 1.

The results of fertilizing pastures grazed by steers, one half of which were given cobalt bullets, are summarized in tables 2 and 3.

Fertilizing brome grass pastures increased: (1) the number of steer days per acre 75 (95 to 170) days or 79%; (2) the pounds of beef produced per acre 140 lb. (171 to 311 lb.) or 82%; and (3) value of beef per acre $30.69 ($37.62 to $68.31).

Using a legume and grass mixture increased: (1) the number of steer days per acre 10 (170 to 180) days or 6% (2) the pounds of beef produced per acre 75 (311 to 386) lb. or 24%; and (3) value of beef produced per acre $16.50 ($48.31 to $84.81).

Fertilizing a legume and grass mixture increased: (1) the number of steer days per acre by 85 (95 to 180) days or 89%; the pounds of beef produced per acre 215 (171 to 386) lb. or 126%; and (3) value of beef produced per acre $47.19 ($37.62 to $84.81).

Fertilizer Experiments on Park Kentucky Bluegrass Seed Production in Roseau County

P. M. Burson, J. M. MacGregor, & H. W. Kramer

Park Kentucky Bluegrass seed is produced on both organic and on mineral soils of Roseau County. Fertilizer effect on seed productinn on both of these soils has been studied for two years with variable effect.

A. Fertilization on Organic (peat) Soils

Two experimental fields were selected during the summer of 1959 and the first fertilizer treatments were made that autumn and comparable treatments were applied in the spring of 1960. No later treatments were made with the 1961 yields obtained and the residual yield effect was also observed in 1961. The yields for the two years are shown in the following table.

Table 1. The effect of different fertilizer treatments on the 1960 and on the 1961 yields of Park Kentucky Bluegrass on two peat soils of Roseau County.

Fertilizer Treatment (lbs/A) N P_2O_5 K_2O	Charles Habstritt deep peat-1959 seeding (Roseau)				Stanley Roadfeldt shallow-1957 seeding (Badger)			
	Fert. fall '59		Fert. Spring '60		Fert.fall '59		Fert.spring '60	
	1960	1961	1960	1961	1960	1961	1960	1961
	Pounds of harvested grass seed per acre.							
None	54	133	54	113	205	113	205	113
0 + 80 + 0	167	327	237	371	382	192	300	195
0 + 80 + 80	196	255	242	259	349	229	334	229
30 + 80 + 0	164	247	218	272	327	202	387	179
30 + 80 + 80	197	265	146	370	306	140	372	216
60 + 80 + 80	128	268	255	257	377	177	409	173
90 + 80 + 80	250	248	221	247	331	223	365	144
40 + 20 + 80	186	220	179	220	-	-	-	-
33 + 33 + 33(winter)	173	203	173	203	279	-	279	-

The 33 + 33 + 33 (winter) applied was the form operator application of 12 - 12 - 12 at the rate of 275#/A.

Although the first half of 1961 was very dry, it is apparent that the additinn of phosphorus is the most profitable single element for the production of grass seed on these organic soils. Spring fertilization was apparently slightly more effective, probably due to the greater availability of the spring applied phosphorus. Potassium (potash) had the least or no effect.

Table 3. The Residual Fertilizer Response vs Additinal Nitrogen on Seed Yields of a Five Year Stand of Park Bluegrass on Mineral Soil. Halvorson Bros. Farm - Roseau County

Fertilizer Lbs./Acre $N + P_2O_5 + K_2O$	1961 - Yield Pounds per Acre		
	Residual Yield/A	(1) Lbs. N applied Spring 1961	Residual plus N Yield/A
0 + 0 + 0	6	60	15
0 + 80 + 0 F	19	30	40
0 + 80 + 0 S	11	60	28
0 + 80 + 80 F	20	30	30
0 + 80 + 80 S	16	60	26
30 + 80 + 0 F	8	30	11
30 + 80 + 0 S	13	30	10
30 + 80 + 80 F	14	30	15
30 + 80 + 80 S	12	30	14
60 + 80 + 80 F	8	60	9
60 + 80 + 80 S	12	60	19
90 + 80 + 80 F	10	90	9
90 + 80 + 80 S	6	90	10

F - Fertilizer applied in Fall of 1959
S - Fertilizer applied in Spring of 1960
(1) Lbs. of N applied in spring of 1961 on one-half of each plot.

B. Fertilization of Park Kentucky Bluegrass on Mineral Soils

Several bluegrass fields on mineral soils were treated with different fertilizers in different ways or times of application to try and determine more efficient fertilization methods for grass seed production. The results are shown in the following two tables.

Table 2. The effect of fall or of spring fertilization (1959-60) of Park Kentucky Bluegrass on Mineral soil and additional Nitrogen Treatments in 1961 on 1960 and 1961 seed yields.
(Oliver Wold farm - Roseau)

New Seeding in 1959.

1959-60 fert. treat. (lbs/A) N P_2O_5 K_2O	1959-60 fertilization				Plus 1961 N fertilization[1]	
	Fall Fert.		Spring Fert.		Fall Fert.	Spring Fert.
	1960	1961	1960	1961	----- 1961 Yield	
	Pounds harvested grass seed per acre.					
0 + 0 + 0	80	51	80	51	57 (60 N)	51
0 + 80 + 0	117	51	108	48	31 (30 N)	145 (60 N)
0 + 80 + 80	123	44	101	56	102 (30 N)	90 (60 N)
30 + 80 + 0	202	51	235	48	70 (30 N)	115 (30 N)
30 + 80 + 80	183	38	228	54	70 (30 N)	101 (30 N)
60 + 80 + 80	368	43	284	49	70 (60 N)	93 (60 N)
90 + 80 + 80	379	39	371	40	52 (90 N)	48 (90 N)

[1] Bracketed values refer to lbs. of N per acre applied in spring of 1961 on old treatments.

The 1960 seed yield was better with fall fertilization where minerals alone were used, but where nitrogen was included, there was a better effect from spring fertilization, and the addition of nitrogen was markedly effective when applied to these mineral soils - in contrast to its lack of effect when applied to the peat soils.

It was considered that a second nitrogen application in the spring of 1961 might be effective, and ammonium nitrate was broadcast on half of the 1959-60 plot area to supply either 30, 60 or 90 pounds of N per acre. With the drowth of 1961, the additional nitrogen increased seed yields considerably, with the heaviest rate (90 lbs. of N/A) producing the poorest results, and it is evident that additional nitrogen topdressing at high rates of application should be avoided in favor of lower rates.

A second field was a 5-year old stand of Park Bluegrass which is considered by farmers in the area as being "sod-bound". This experiment was also established in the fall of 1959. One series of plots was fertilized in the fall of 1959 and a second series was fertilized in the spring of 1960. In the spring of 1961 one-half of each plot was given an additional topdressing treatment of nitrogen so as to compare the residual response with three rates of nitrogen of 30, 60 and 90 lbs. per acre. The following yields give the residual response and the residual plus the nitrogen response. These yields mean very little because 1961 was a very dry year with a shortage of 5.75 inches of rain from April through August which is the critical period for grass seed production. Where the highest rate of N was used (90#/Acre) the seed yields were reduced.

A summary average of the yields of the three rates of N showed the 30 and 60 lbs. rates each produced 20 lbs. of seed per acre with the 90 lb. rate only 10 lbs. were produced as compared to 6 lbs. per acre on the check. Extreme drought was the greatest limiting factor for 1961.

After studying the effects of the fall of 1959 and spring of 1960 fertilization effect on the 1960 bluegrass seed yields, it was reasoned that possibly lowered rates of mineral fertilization might be more practical. A new experimental area was selected on the Clarence Wold farm near Roseau in the spring of 1961, and the phosphate - potash rates were reduced to 50% of those used in 1959-60. The results are shown in the following table. Since nitrogen had previously shown the greatest effect on mineral soils, it was used on all treatments in this experiment.

Table 4. The effect of spring fertilization (1961) of Park Kentucky bluegrass on Mineral soil on 1961 seed yield.

Fert. Treatment (lbs./A) N P_2O_5 K_2O	1961 Seed Yield lbs./A.
0 + 0 + 0	39
40 + 0 + 0	83
80 + 0 + 0	93
40 + 40 + 0	94
80 + 40 + 0	110
40 + 40 + 40	95
40 + 0 + 40	100
40 + 40 + 20	104
80 + 40 + 40	101
80 + 0 + 40	84

It is evident that nitrogen is the most effective element for increasing seed yield, potash had little or no beneficial effect, and phosphate had a slight effect when applied along with the nitrogen. Although nitrogen doubled yields in all cases, the drowth of 1961 caused a serious yield reduction on all treatments.

C. Winter vs Spring Fertilizer Application on Park Bluegrass Seed Production.

A study was conducted in 1961 on time of application of fertilizer in the production of Park bluegrass seed. A number of farmers in Roseau County think that a winter application of fertilizer is the best. Two fields were selected on which 60 + 0 + 0 and 60 + 80 + 80 were applied in February on top of 2 ft. snow cover. This time of application was compared with an early April application of the same rates of nitrogen, phosphate and potash. These fields were located on the Clarence Wold and J. Magnuson farms. Both fields were on mineral soils and were on established Park bluegrass stands that had been in seed production for 3 of the past years. The question of fertilizer less frmm spring runoff has been raised when winter applications are made.

Table 5. Winter vs Spring Fertilizer Application

1961
Roseau County

Fertilizer Treatment (lbs./Acre)	Pounds of Harvested Seed Per Acre			
	February		April	
$N + P_2O_5 + K_2O$	Wold	Magnuson	Wold	Magnuson
0 + 0 + 0	53	39	53	39
60 + 0 + 0	60	43	115	66
60 + 80 + 80	77	97	113	52

The above data shows that 60 lbs. of N applied on the plots on the Wold field in February produced 60 lbs. of seed per acre as compared to 115 lbs. of seed when the fertilizer was applied in April. This is an increase of 55 lbs. of seed in favor of the spring applicatinn. On the same form where 60 + 80 + 80 fertilizer was applied similar results were obtained. The February application produced 77 lbs. of seed per acre as compared to 113 lbs. when the fertilizer was applied in April. This was an increase of 36 lbs. per acre in favor of the April application.

On the Magnuson field 60 lbs. of nitrogen per acre gave an increase of 23 lbs. of seed per acre in favor of the April application. However, with the 60 + 80 + 80 treatment the winter applicatinn produced 97 lbs. of seed per acre as compared to 52 lbs. from the April application.

It is possible that considerable fertilizer could be lost from spring runoff when fertilizer is applied in the winter on a deep snowfall, as were the conditions here in Roseau County in 1961. If the snowfall is light and field conditions are satisfactory for machine operations and there will be no rapid spring runoff, winter may be a satisfactory time to apply the fertilizer.

The Effect of Fertilizer on Yield of Climax Timothy Seed 1960-61

Paul M. Burson, J. M. MacGregor, & H. W. Kramer

Roseau County is fast becoming a grass seed producing area which includes both Park bluegrass and Climax timothy. This northern area of Minnesota is well adapted for the production of these grass seed crops. Grass such as timothy is a basic part of a permanent agriculture for this area. Timothy fits into a forage program. It is an excellent grass crop in mixtures with alfalfa, medium red clover and alsike clover for hay or for pasture. It has a wide range of soil and fertility adaptation and is very palatable for livestock as either hay or pasture. About 5,000 acres of timothy are now being grown in Roseau County for seed production.

In the Fall of 1959 three fields were selected to study the effect of fertilizer on timothy seed production. The two fields selected in Roseau County were on the Clifford Foss and the B. J. Borgen farms while the third was the Andrew Skaar farm in Pennington County. The fertilizer treatments included 80 lbs. of P_2O_5 alone and in combination with 80 lbs. of K_2O with 30, 60, and 90 lbs. of actual nitrogen per acre. On the Borgen and Skaar fields the treatments were applied in the spring of 1960. On the Foss fields the same treatments were applied in the fall of 1959 and on adjacent plots in the spring of 1960. The purpose here was to determine if there was any difference between fall and spring application.

The following table gives the seed yields from the various fertilizer treatment combinations for the years 1960 and 1961. The year 1961 should not be considered as a representative year because of the severe drought from April to September with the rainfall being 5.75 inches below normal during this period. Timothy is not a productive crop during extreme dry periods, and is better adapted to cool moist conditions typical of the usual growing conditions of northern Minnesota. The yield results for 1960 might be considered as quite representative of what could be expected from the fertilization of timothy for seed production.

In 1960 the seed yields ranged from 159 lbs. on the unfertilized soil to almost 900 lbs. with a 90 + 80 + 80 treatment. Spring fertilizer applications gave the greater increase in seed production with an average yield of 531 lbs. in comparison to 431 pounds when fertilized in the fall.

Timothy is not subject to as much lodging as some other grasses or grain crops. Some lodging did occur on the 90 lbs. rate of nitrogen plots, however.

On the basis of the present information 60 lbs. of N appears to be adequate in seed production with little or no danger of lodging. For phosphate and potash needs, the soil test should be the basis for this determination, the same as for any other crop.

Timothy Seed Yields 1960-61

Fertilizer (lbs/acre)	Lbs. per acre - 1961			Lbs. per acre - 1960	
	Skaar[1]	Foss[2]	Borgen[1]	Skaar[1]	Foss[2]
Check	63	56	76	225	159
0 + 80 + 0	141	102	119	235	177
0 + 80 + 80	111	105	104	226	173
30 + 80 + 0	134	70	139	568	494
30 + 80 + 80	121	68	113	634	505
60 + 80 + 80	100	80	144	815	710
90 + 80 + 80	103	62	145	892	823
Ave. Inc. Fall	---	80	---	---	431
Spring	---	82	---	---	531

1 Fertilized Spring, 1960

2 Fertilized Fall, 1959 and Spring, 1960 (Yields include spring and fall treatments) 1961 very dry.

Lake of the Woods County Potato Fertility Demonstration - 1961

Merle Halverson, John Grava and Otto Lee*

Location: John Knutson farm, Graceton, Minnesota

Soil Test Information: Values given represent the range (lowest and highest of six samples taken from the demonstration area.

Texture: loamy sand
Percent organic matter: 2.8 to 4.8 (medium)
pH: 8.1 to 8.3 (alkaline)
Extractable phosphorus, lb/A: 17-21 (medium)
Exchangeable potassium, lb/A: 35-60 (very low)

1960 crop: Oats (fall plowed). No manure.
1959 crop: Flax.

Variety: Irish Cobbler

Crop Details: Between-row spacing: 40 inches
Planting date: June 3
Harvest date: September 25.
Individual plot size: 13 feet 4 inches (4 rows) x 30 ft. = 0.00918 acres
Area harvested from each plot: 6 feet 8 inches (center 2 rows) x 25 feet.

Rainfall Data: (Baudette), February-August

	Average, 1931-55 inches	1961 inches
February	0.65	0.38
March	0.84	0.20
April	1.34	0.95
May	2.06	0.53
June	3.69	1.01
July	3.34	3.85
August	3.44	1.49
TOTALS	15.36	8.41

Deficit, February-August 1961 6.95 inches

Demonstration:

(a) Nitrogen (as ammonium nitrate) was broadcast before planting and disced in. 4 rates (0, 40, 80 and 120 lbs of actual nitrogen per acre) were used.

(b) Phosphate (as 0-45-0 concentrated superphosphate) was band placed through the planter attashment. One rate (120 lb. actual P_2O_5) was used throughout to assure a uniform and adequate phosphate supply.

(c) Potash (as 0-0-60, muriate of potash) was broadcast before planting and disced in. 5 rates (0, 60, 80, 120 and 240 lbs. K_2O per acre) were used.

Note 1. Each of the 5 potash rates was used in combination with each of the 4 nitrogen rates, resulting in a total of 20 treatments per series. This series was replicated 3 times, making for a total of 60 plots in the complete demonstration.

Note 2. Two 50 foot lengths of double row receiving no fertilizer were harvested and the resulting yield compared with the average yield from 3 plots treated with 120 lb./acre of phosphate only. Because fewer observations were used in estimating this yield increase, it is not as reliable an estimate of true yield as the nitrogen and potash figures, where 15 and 12 observations, respectively, were used to estimate each yield.

Note 3. The following measurements were made:

a. Yield (cwt/A) of No. 1 (more than 2" in diameter) tubers.
b. Yield (cwt/A) of Size B (less than 2" in diameter) tubers.
c. Specific gravity (hydrometer method).

Results:

TABLE 1
Effect of phosphate using no nitrogen or potash

Rate, lb. P_2O_5/acre	Yield of No. 1 tubers, cwt/A	Yield of size B tubers, cwt/A	Specific gravity
0	53.4	16.4	1.087
120	77.2	11.3	1.086

TABLE 2

Effect of nitrogen on yield of No. 1 and Size B tubers, and on specific gravity. (each figure is an average from 15 separately harvested plots receiving the indicated nitrogen rate).

Nitrogen rate lb. N/A	Yield of No. 1 tubers, cwt/A	Yield of size B tubers, cwt/A	Specific gravity
0	98.0	11.2	1.088
40	109.9	11.6	1.089
80	108.8	12.5	1.089
120	108.9	10.0	1.091

TABLE 3

Effect of potash on yield of No. 1 and Size B potatoes and on specific gravity. (Each figure is an average from 12 separately harvested plots receiving the indicated potash rate.)

Potash rate lb. K_2O/A	Yield of No. 1 tubers, cwt/A	Yield of size B tubers, cwt/A	Specific gravity
0	75.3	13.6	1.089
60	100.3	11.8	1.090
80	113.1	10.8	1.090
120	121.1	10.2	1.090
240	122.1	10.1	1.091

TABLE 4

Cost of - and return to - best nitrogen and potash rates

Nutrient	Rate, lb./A	Cost dollars/A	Yield increase Cwt/A of No. 1 tubers
Nitrogen (N)	40	$6.00	11.9
Potash (K_2O)	120	$6.00	45.8
	Totals	$12.00	57.7

Interactions

No significant interaction effects between nitrogen and potash were observed. This means that the effect of potash on yield was about the same regardless of which nitrogen rate was used. Conversely, it says that the influence of nitrogen on yield was much the same at each of the several potash rates.

Remarks:

In evaluating these date, it is well to keep in mind that they are the product of particular combination of soil, season, moisture condition, and variety. It is quite possible that under a different set of conditions, the effect of nitrogen and potash may have been more or less favorable. However, the serious moisture deficit in Lake of the Woods county this season would suggest, if anything, that even greater increases might be expected on this soil in a season more normal with respect to rainfall amount and distribution.

(a) Yield of No. 1 Potatoes

(1) Phosphate effects:

The one phosphate rate used (120 lb. P_2O_5/A) resulted in an apparent yield increase of 23.8 cwt. (39.6 bu) per acre. (see Table 1). As noted previously, this apparent difference is not as reliable as those due to nitrogen and potash, because fewer plots were used in arriving at the yield estimates.

(2) Nitrogen effects: (see Table 2)

The initial 40 lb./A nitrogen application produced an apparent yield increase of 11.9 cwt. (20 bu) per acre. The second and third 40 lb./A nitrogen increments did not result in further yield increases. Accordingly, we would conclude that 40 lb. N per acre was as effective as any higher rate under these conditions of placement, moisture supply, soil, season and variety.

(3) Potash effects:

The first 60 lbs./A of potash gave a yield increase of 25.0 cwt. (41.7 bu) per acre. Increasing the potash rate from 60 to 80 lbs. K_2O/A resulted in an additional yield increase of 12.8 cwt (21.3 bu) per acre. Changing the potash rate from 80 to 120 lbs. K_2O per acre boosted yields still another 8.0 cwt. (13.3 bu) per acre. Further yield increases failed to occur only when the potash rate exceeded 120 lbs. K_2O per acre.

It is obvious that potassium was present in extremely short supply on this soil. The return to 120 lbs. K_2O per acre was 45.8 cwt. (76.3 bu.) per acre. It is significant that our soil test procedures (see page 1) were able to describe in advance of planting this very low soil potassium condition.

(b) Yield of Size B (less than 2" in diameter) potatoes

There was a strong tendency for potash to decrease the yield per acre of size B tubers. A variance analysis of the data shows this effect to be significant at the 90 per cent confidence level. Nitrogen, however, had no particular favorable or unfavorable effects upon the number of small tubers produced.

(c) Specific Gravity

In previous demonstration work on soils more adequately supplied with potassium, small but consistent reductions in specific gravity of the tubers has occurred with increasing rate of potash application. The effect of nitrogen has been variable depending upon the soil and season.

Tables 2 and 3 show that neither the nitrogen or potash fertilizers had any adverse effect upon tuber specific gravity in this work.

There is some evidence in the literature to show that potash fertilizers will not seriously reduce tuber specific gravity when used on soils poorly supplied with potassium. It is also possible that the extremely dry season had something to do with failure of this effect to show up in the present work. It would be well to see data from a season of more nearly normal moisture supply before drawing firm conclusions about these effects as they might apply on low potassium soils.

(d) Cost - return relationships

In Table 4 the most profitable rates of nitrogen and potash are shown, together with their costs and the yield increases they produced. Growers with a knowledge of harvesting and handling costs and current potatoes prices can apply such information to the figures in the table and arrive at estimates of the net return per acre and and per dollar spent due to use of nitrogen and potash on this soil.

The phosphate effects are not listed in Table 5. This is because the yield increase due to phosphate was measured less precisely than the nitrogen and potash effects. There is, however, good reason to suppose that the phosphate rate used was an economical one. Figuring phosphate at $0.10 per pound, the 120 lbs. per acre rate used would cost $12 per acre. With potatoes worth as little as $1 per hundredweight, our apparent yield increase due to phosphate (23.8 cwt/A could be considerably in error and still enable the grower to more than break even on its cost.

The authors are indebted to the John Knutson family for their generous cooperation in providing the land, labor, and equipment necessary to establish and care for the demonstration area. They are also grateful to Dr. O. C. Turnquist, Extension Horticulturist, who provided the data on specific gravity, and to Dr. R. D. Munson, American Potash Institute, for his capable assistance at harvest time.

* Extension Soils Specialist, Agricultural Extension Service; Supervisor, Soil Testing Laboratory, University of Minnesota; and Lake of the Woods County Agricultural Agent, respectively.

Fertility Studies on Organic Soils at Hollandale, 1961

by R. S. Farnham

The fertility studies on organic soils at Hollandale begun in 1960 were continued in 1961. The object of these studies was to compare the effect of several rates and grades of commercial fertilizers on the yield and quality of Cobbler potatoes.

The plot area in 1961 was about 1/2 mile west of the 1960 site on the same type of organic soil. The pH of this soil varies from 7.0 to 7.3 and extractable P (Bray No. 1) by soil test was very high (170-200+ lbs/acre) and extractable K was very high (500-600+ lbs/acre). The plot area was tiled.

The design was a randomized block split plot including four replicates. Three fertilizer grades 0-20-20, 4-12-36, 0-12-36 were applied broadcast in late May prior to seeding at 0, 300, 600 and 900 pounds/acre rates. The plots were harvested October 20th and total yields of tubers and specific gravity data are shown in Table 1.

The highest yields were obtained using the 900 pound rate of all the grades with yield increases as high as 62.4 hundred weight in case of 900 rate of 0-20-20. Responses to both potash and phosphate are indicated - nitrogen doesn't appear to give any increases.

In 1961 the 0-20-20 grade having a 1 to 1 P to K ratio is just as effective as the 4-12-36 grade containing a 1 to 3 P to K ratio.

It is of interest to note that these high yield responses are obtained despite the very high soil test values for both phosphorus and potassium

Specific gravity does not seem to be effected by either rate or grade of fertilizer. The high rates of potassium did not materially decrease the specific gravity this year as in 1960.

In a comparison of extracting solutions for soil test phosphorus it was found that water extractable phosphorus values are about 1/10 the values when Bray's No. 1 extracting solution (NH_4F and NH_4Ac) was used. Since there seems to be a response to phosphorus as well as potassium it is suggested that the Bray No. 1 soil test for phosphorus is not too accurate. Water extractable phosphorus content correlates better with yield responses to added phosphorus than does the Bray No. 1 test. Further work along these lines is planned for next year.

Soil test correlation studies with yield responses on various organic soils are planned for several different areas of the state.

Table 1. Yield and Specific Gravity of Cobbler Potatoes on an Organic Soil at Hollandale, 1961.

Rate lbs/acre	0-20-20 Yield cwt/acre	0-20-20 Sp. Gr.	4-12-36 Yield cwt/acre	4-12-36 Sp. Gr.	0-12-36 Yield cwt/acre	0-12-36 Sp. Gr.
0	312.2	1.062	312.2	1.063	366.6	1.061
300	350.6	1.059	320.1	1.065	332.5	1.059
600	355.7	1.062	336.8	1.066	326.7	1.063
900	374.6	1.064	373.9	1.061	371.7	1.065

Structure Nitrogen Study

G. R. Blake and J. M. MacGregor
O. C. Soine, J. R. Thompson, & L. E. Ahlrichs

A. Crookston. Structure effects are measured only each third year as all rotations are in wheat. In 1961 only fertilizer effects are measured as shown in the table.

	No fertilizer	20+40+20	100+40+20	L.S.D.
	Corn after Wheat			
Bu./A (15.5% moisture)	77.4	89.0	87.1	7.2**
% H_2O in grain	52.9	51.6	51.1	N.S.
Shelling %	71.7	74.2	71.3	N.S.
	Continuous Wheat			
Bu./A	17.3	27.8	31.2	11.1**

B. Morris

Corn Yields, bu./A

Seedbed preparation Handling residues plow fall or spring	0-40-40	40-40-40 fall	40-40-40	80-40-40	240-40-40	Ave.
Minimum - chop - spring	21.1	49.8	45.3	41.6	48.5	41.3
Minimum - Not chop - spring	46.6	47.3	50.6	45.7	42.4	46.5
Minimum - chop - fall	35.0	42.4	49.2	48.7	45.3	45.3
Conv. - chop - fall	32.6	55.3	51.1	42.9	44.9	44.9
Field cultivator - chop - fall and spring	26.1	46.8	41.8	46.2	41.4	41.4
Average	32.3	48.3	47.6	45.0	46.1	----

L.S.D. fertilizer 9.3 (99%); Tillage, Not significant
A residual effect of old experiment (Minn. Ag. Expt. Station Bul. 448, 1958) was shown at 95% level. This is believed to have no meaning because of a bias in the old experiment due to location with respect to slope. It is evident that the application of nitrogen at the rate of 40 pounds per acre was highly effective for increasing corn yields and higher application rates failed to increase corn yields further.

C. Waseca

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	No fertilizer	20+40+20	100+40+20	L.S.D.
	Corn after Wheat			
Bu./A (15.5% moisture)	77.4	89.0	87.1	7.2**
% H_2O in grain	52.9	51.6	51.1	N.S.
Shelling %	71.7	74.2	71.3	N.S.
	Continuous Wheat			
Bu./A	17.3	27.8	31.2	11.1**

B. Morris

Corn Yields, bu./A

Seedbed preparation Handling residues plow fall or spring	0-40-40	40-40-40 fall	40-40-40	80-40-40	240-40-40	Ave.
Minimum - chop - spring	21.1	49.8	45.3	41.6	48.5	41.3
Minimum - Not chop - spring	46.6	47.3	50.6	45.7	42.4	46.5
Minimum - chop - fall	35.0	42.4	49.2	48.7	45.3	45.3
Conv. - chop - fall	32.6	55.3	51.1	42.9	44.9	44.9
Field cultivator - chop - fall and spring	26.1	46.8	41.8	46.2	41.4	41.4
Average	32.3	48.3	47.6	45.0	46.1	-----

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C. Waseca

Subsoil Regeneration Study
Lamberton, 1961

G. R. Blake and W. W. Nelson

Deliberate soil packing in earlier years has been observed to persist indefinitely in horizons not loosened by the plow. An experiment was established in 1960 on Nicollet silty clay loam to study this persistence in a field situation. Variables include

a) Packing 9-24 inches vs no packing
b) Crop: corn vs alfalfa
c) Soil water content during winter: (2 levels).

Packing was done with 4 passes of a tractor-mounted packing wheel weighing 5600 lbs. giving pressures at 9" of the order of 100 to 200 lbs. inch^{-2}. Packed zone extended to about 22 inches below the surface.

Packing in 1960 reduced corn yields 7%, corn forage 10%, and oat-alfalfa forage 29%.

Packed layers persisted in 1961, essentially unchanged from 1960, as shown by bulk density profile samples taken at 4 inch intervals to 40 inches deep. However, treatment differences had no significant effect on yields of corn, corn silage, or alfalfa hay. Corn yields averaged 122 bushels.

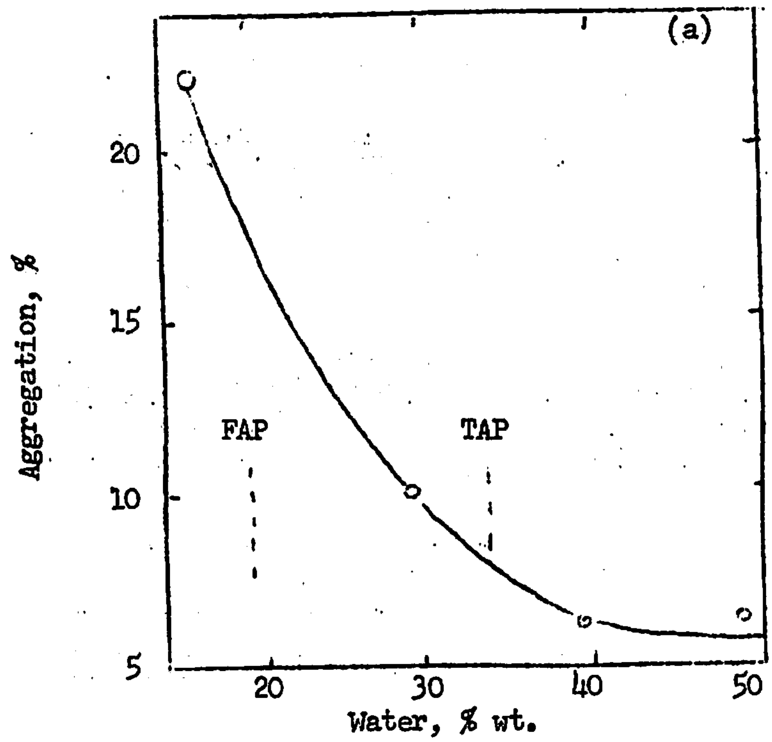
Date Cut	Date Book Reference	Packed		Not Packed	
		Irrigated	Not Irrigated	Irrigated	Not Irrigated
	Alfalfa (lbs./A at 20% moisture)				
June 9	19:19;89-92	2378	2686	3013	3086
July 28	19:94-98	4120	4011	3993	4138
September 6	19:104-113	2385	2258	2513	2461
	Corn fodder (T./A @ 67%; grain Bu./A @ 15.5% moisture)				
Fodder	19:105,110	24.5	21.4	23.9	25.6
Corn	19:106,112	125.8	127.2	115.1	119.0
Corn (% H_2O at harvest)	19:106,118	26.7	24.4	26.9	29.6

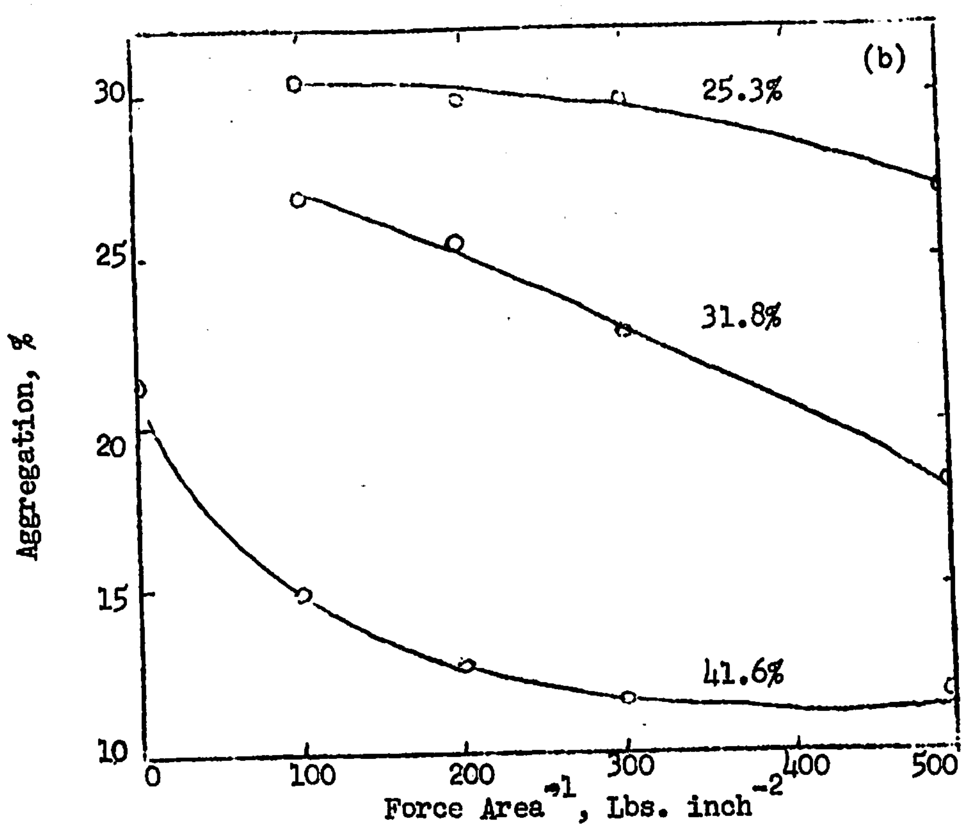
Differences not significant.

D. Seefeldt and G. R. Blake

Aggregate Stability, Webster Silty Clay

(a) Forced through 2.5 mm holes, air dried, wet sieved with 2 and 0.5 mm sieves.
(b) Forced into $\frac{1}{4}$"x$\frac{1}{4}$" cylinders at moisture content shown, air dried, wet sieved.





Soil Compaction and Nutrient Uptake
St. Paul 1961

E. Bonnie-Baffoe & G. R. Blake

Phosphorus and potassium content of above-ground plant parts were determined in 1957 and 1958 on plants grown on packed and unpacked soils. P and K were usually decreased by packing and N was often increased. However, these changes were by no means consistent with crop, soil type, nor year.

As a follow-up, small plots were established in 1961 at 4 bulk density and 2 moisture levels with corn and sorghum. A new technique was used (Stanford, G. and J. D. DeMent, SSSA Proc. 21:612. 1957) in which plants were germinated in sand cultures low in the element to be tested. After plant emergence, the whole culture was transplanted to the test plot and nutrient absorption measured by partial harvesting at approximately 2-week periods.

In the present experiment 30 X 30 inch plots were surface packed to 4 bulk density levels with a hand tamper. Four pots of each crop were placed on each plot. Corn pots contained 10 plants, sorghum 30 plants, initially. Plants from 2 pots were harvested the 9th, 23rd and 37th day after setting on the field plots.

Analysis for P and K are essentially complete but data are not yet analyzed.

Seedbed Preparation for Potatoes
Grand Forks

G. W. French & G. R. Blake

The two chief purposes of seedbed preparation for corn, on northern soils that do nut crust, are hypothesized on the basis of field tests, to be;

(a) to increase soil temperatures by removing residues, and,
(b) to insure seed-soil contact (germination).

Neither of these conditions was necessary for potatoes in 1961 tests on Bearden silty clay loam where potatoes following wheat with no tillage produced as well as with any of 4 other treatments.

Green Manure Evaluation Study
Crookston 1961

G. R. Blake and Q. C. Soine
A. R. Schmid

Green Manure	No Fertilization	0-40-0	Average
Continuous Wheat			
Check	13.6	20.8	17.3
Orchard Grass	14.2	17.3	15.7
Madrid Sweet Clover	16.2	22.4	19.3
Vetch	16.4	28.0	22.2
Vernal Alfalfa	16.4	27.2	21.8
Average	15.3	23.1	
Wheat in Wheat-Fallow Rotation			
Check	39.1	42.9	41.0
Orchard Grass	38.2	45.0	41.6
Madrid Sweet Corn	36.8	43.0	39.9
Vetch	37.3	48.8	48.8
Vernal Alfalfa	44.3	50.9	47.6
Average	39.1	46.1	

L.S.D: Green Manure 4.3 Bu. (0.05)
Rotation 5.7 Bu. (0.01)
Fertilizer 3.3 Bu. (0.01)

Effect of Nitrogen rate and Method of Placement on Yield and Quality of Wheat in the Red River Valley

R. D. Curley, Curtis Klint, Carl Ash, and Marlin Johnson*

Demonstrations were conducted in Norman and Polk counties during 1961 for the primary purpose of showing fertilizer dealers, county agents and farmers (1) comparative effects of various rates of nitrogen application on yield and germination of wheat by broadcast and drill application and (2) correlate stored soil moisture at planting time with yield response from applied nitrogen.

Five sites were selected - 2 in Norman county and 3 in West Polk county. The sites were selected on the basis of soil texture - 3 were silty clay loams and 2 fine sandy loam soils. The approximate location of the plots and the general soil textures are as follows:

Hermandson farm - about 10 miles south of Crookston - silty clay loam
Ness farm - about 2½ miles west of Ada - silty clay loam
Sewill farm - about ½ mile south of Harold - fine sandy loam
Scott farm - 5 miles north and 3 miles east of Ada - fine sandy loam
Vanya Farm - north west corner of W. Polk county - silty clay loam

All plots were planted with a 6 foot grain drill beginning on April 21 at the Ness farm, April 29 at the Scott farm, May 3 at Hermandson and May 4 at the Sewill farm. Each treatment was replicated 3 times in a simple randomized block design using reps as blocks. Treatments consisted of five rates of nitrogen (30, 40, 50, 60 and 80#/acre) applied as (1) broadcast, (2) with the seed, and (3) split drill and broadcast placement methods. TVA ammonium nitrate and granular 54% concentrated superphosphate were used as the nitrogen and phosphorus sources on the broadcast and drill methods of placement plots. In each of these 2 methods, 30# of P_2O_5 were placed with the seed. The split drill and broadcast placement was achieved by applying 10# of N through the drill spout with the seed as diammonium phosphate 16-48-0 grade supplemented with additional broadcast ammonium nitrate after planting to get the desired rate of total nitrogen. Thus with the latter method results are confounded with forms of both N and P. Comparison of this method with the other two should not be made. The fertilizer attachment was calibrated for each treatment prior to planting.

Soil moisture and various chemical determinations were made inthe laboratory by Dr. Ralph Young, North Dakota State University, and by Dr. John Grava, University of Minnesota. Soil samples to a depth of 4 feet were taken from five spots within the over-all site area at each of the 5 locations. The Vanya plots in the northwest corner of West Polk county were not harvested. Extreme drought during June, July and August prevented sufficient plant growth for yield measurements. However, for purposes of providing complete chemical and moisture characterization for future reference the chemical and moisture data are reported for all five locations in series Tables 1 and 2.

Table 3 contains the yield data for all five locations. Tables 4 and 5 contain the yield data and baking quality of the wheat for the Scott and Ness farms, respectively. Tables 6 and 7 contain yield responses only for the Hermandson and Sewill farms, respectively.

Sedimentation tests have not been made on the wheat from the Sewill and Hermandson farms to date. Sedimentation values are a measure of the baking quality of wheat. For detailed information concerning the test contact the Crop Quality Council, Minneapolis or the USDA, ARS. To give the reader some indication of the proposed market value of higher sedimentation scores see table 8. Table 9 shows the relation between % protein and sedimentation values as determined by USDA.

Table 1. - Soil moisture characterization data of the soils at each of five locations in Norman and Polk counties.

Depth (ft.)	Texture	Relative[1] Carbonates Level	Conductivity	Soil moisture characterization: Seeding time	1/3 atmos.	15 atmos.	Avail. water	Maximum water hldg. capacity
				..........percent..........				acre inches
NESS FARM								
0-1	SiCl	3	70	30.79	41.98	21.14	1.36	3.03
1-2	"	3	114	24.70	31.91	16.07	1.29	2.47
2-3	"	3	163	23.64	30.60	12.62	1.75	2.85
3-4	"	3	190	28.14	35.08	14.18	2.47	3.69
							6.87	12.04
HERMANDSON FARM								
0-1	SiCl	2	58	32.14	41.39	20.92	1.59	3.03
1-2	Clay	3	81	24.63	36.37	17.93	1.05	2.86
2-3	Clay	3	154	20.49	34.27	17.24	0.52	2.70
3-4	Clay	3	172	24.46	31.36	14.56	1.22	3.32
							4.38	11.91
SCOTT FARM*								
0-1	FSL	3	33	22.37	19.42	8.32	1.70	2.15
1-2	"	3	24	19.78	15.19	7.59	1.19	1.90
2-3	"	3	20	15.89	6.98	2.60	0.71	2.19
3-4	"	3	23	19.46	5.49	1.82	0.65	3.12
* Values are average of three soil sample borings							4.25	9.36
SEWILL FARM								
0-1[a]	VFSL-SiL	3	41	22.47	25.24	11.27	1.65	2.06
1-2[a]	FSL-C	3	44	21.92	22.77	11.22	1.67	1.81
2-3[a]	SL-C	3	76	18.67	21.56	10.93	1.26	1.70
3-4[b]	SiCl-C	3	147	24.61	30.95	15.81	1.55	2.68
							6.13	8.25
VANYA FARM								
0-1	SiL-Si Cl	2	78	25.07	38.86	18.64	1.31	2.87
1-2	Si Cl	3	85	18.35	33.07	15.36	0.47	2.76
2-3	C	3	103	19.74	34.69	16.16	0.57	2.94
3-4	Si C - C	3	117	25.30	39.24	19.44	1.03	3.50
							3.38	12.07

1/ 0 = None present
1 = Low amounts present
2 = Medium amounts present
3 = High amounts present

a/ values are average of 5 soil sample borings

b/ values are average of 4 soil sample borings

Table 2 - Chemical Characteristics of the Soils at Five Locations

Depth (ft)	Texture 1/	$\#NO_3$ -N per acre		# P/acre NaHCO$_3$	Bray #1	Bray #2	Exchangeable K (#/acre)	O.M. (%)	pH
NESS FARM									
0-1	SiCl	39.6	.... 61.6	26	23	54	540	5.0	7.9
1-2	"	22.0		6	4		310	1.8	8.2
2-3	"	20.8		3	3		320	0.9	8.2
3-4	"	20.0		2	3		370	0.7	8.1
HERMANDSON FARM									
0-1	SiCl	95.6	.... 155.2	11	14	74	600	5.1	7.9
1-2	Clay	59.6		4	5		510	2.3	8.1
2-3	Clay	48.8		3	3		440	1.3	8.1
3-4	SiCl-C	39.6		3	2		400	0.7	8.1
SCOTT FARM									
0-1	FSL	96.4	....133.6	14	6	0	120	3.9	8.2
1-2	"	37.2		3	9		70	1.3	8.6
2-3	"	24.8		2	6		40	0.5	8.7
3-4	"	28.4		1	4		40	0.3	8.8
SEWILL FARM									
0-1	VFSL-SiL	84.4	.... 117.2	15	10	25	290	4.1	8.3
1-2	FSL-C	32.8		5	5		260	1.4	8.6
2-3	SiL-C	30.8		4	4		280	0.9	8.4
3-4	SiCl-C	26.0		3	3		450	0.8	8.1
VANYA FARM									
0-1	SiCl	111.2	.... 192.8	23	31	162	1180	5.4	7.8
1-2	SiCl	81.6		8	6		570	1.8	8.1
2-3	C	60.0		4	3		480	1.2	8.1
3-4	SiC-C	40.0		3	4		490	0.9	8.0

1/ Soil texture abreviations

Si cl	= silty clay loam	Si L	= silt loam
VFSL	= very fine sandy loam	Si C	= silty clay
FSL	= fine sandy loam	C	= clay

Table 3. Effect of rate and method of nitrogen placement on yield of Selkirk wheat at four locations in the Red River Valley (1961)

	NESS			HERMANDSON			SEWILL			SCOTT		
	Method of placement: 2/			Method of placement:			Method of placement:			Method of placement:		
1/ lbsN/acre	#1	#2	#3	#1	#2	#3	#1	#2	#3	#1	#2	#3
	yields bu/A			yields bu/A			yields bu/A			yields bu/A		
30	48.5	50.2	50.3	22.7	20.4	23.5	19.0	15.4	22.9	22.7	20.4	26.9
40	3/	60.0	55.3	22.3	23.9	22.7	19.0	19.1	18.0	22.5	25.3	23.1
50	66.0	58.8	60.6	22.9	24.3	24.7	14.4	17.5	22.5	21.2	20.7	24.1
60	64.2	64.9	58.9	24.9	26.8	26.3	20.9	22.9	18.2	20.6	21.5	24.0
80	60.1	59.5	53.7	22.9	22.5	22.7	16.1	20.8	19.2	16.2	18.1	19.7
CHECK 4/	39.9			21.5			14.8			17.1		
SOIL TEXT.	silty clay loam			silty clay loam			fine sandy loam			fine sandy loam		

2/ #1 - all nitrogen applied with the seed at planting time
#2 - all nitrogen broadcast and harrowed in after drill
#3 - 10 lbs of N with the seed plus broadcast N up to desired level

1/ Source of N and P -
Methods of placement #1 and #2 - ammonium nitrate & concentrated superphos (54
Methods of placement #3 --------- 10+30+0 with seed at planting time as 16-48-0 grade diammonium phosphate plus supplemental BC nitrogen as ammonium nitrate immediately after planting.

3/ Treatment missing due to error in planting

4/ Check plots received 0+0+0 treatment; all plots of methods 1 & 2 received 30# P_2O_5 with the seed.

Table 4. Yield response and sedimentation values as affected by method of placement and rate of nitrogen application at Scott farm. (fine sandy loam soil)

Method of nitrogen placement	Nitrogen rate (#/acre) Check	30	40	50	60	80
	...............yield - bu/acre............					
1	17.1	22.7	22.5	21.2	20.6	16.2
2		20.4	25.3	20.7	21.5	18.1
3		26.9	23.1	24.1	24.0	19.7
Average of 3 methods -		23.6	23.6.	22.0	22.0	18.0
Average of #1 & 2 -		21.6	23.9	21.0	21.0	17.2
	....sedimentation values..........					
All 3 methods combined	48(ck)	62	62	62	63	66

Table 5. Yield response and sedimentation values as effected by method of placement and rate of nitrogen application at Ness farm (silty clay loam soil)

Method of placement	Nitrogen rate (#/acre)					
	Check	30	40	50	60	80
	.... yields - bu/acre...............					
1	39.9	48.5	(-)	66.0	64.2	60.1
2		50.2	60.0	58.8	64.9	59.5
3		50.3	55.3	60.6	58.9	53.7
Average of 3 methods		49.7	57.7	61.8	62.7	57.8
Average of 1 & 2 "		49.4	-	62.4	64.6	59.8
	----------sedimentation values------------					
1	36 (ck)	38	-	44	46	44
2		38	39	43	44	47
3		37	38	39	43	49
Average of 3 methods		38	39	42	44	47
Average of 1 & 2 methods		38	-	44	45	45

Table 6. Yield response to 5 rates of nitrogen as affected by method of nitrogen placement at Hermandson farm (silty clay loam soil)

Method of placement	Nitrogen rate (#/acre)					
	check	30	40	50	60	80
	...........yields - bu/acre.............					
1	21.5	22.7	22.3	22.9	24.9	22.9
2		20.4	23.9	24.3	26.8	22.5
3		23.5	22.7	24.7	26.3	22.7
Average of 3 methods		22.2	23.0	24.0	26.0	22.7
Average of 1 & 2 methods		21.6	23.1	23.6	25.8	22.7

Table 7. Yield response to 5 rates of nitrogen application as affected by method of nitrogen placement at Sewill farm (fine sandy loam)

Method of placement	Nitrogen rate (#/acre)					
	Check	30	40	50	60	80
	..........yields - bu/acre...........					
1	14.8	19.0	19.0	14.4	20.9	16.1
2		15.4	19.1	17.5	22.9	20.8
3		22.9	18.0	22.5	18.2	19.2
Average of 3 methods		19.1	18.7	18.1	20.7	18.7
Average of 1 & 2 methods		17.2	19.1	16.0	21.9	18.5

Table 8. Proposed premium prices for specific wheat sedimentation scores - USDA

Sedimentation value	Premium (cents/bu)
40-44	3
45-49	6
50-54	10
55-59	14
60-64	19
>65	24

Table 9. Relationship of sedimentation values to % protein with several wheat varieties - USDA

% Protein	Selkirk	Thatcher	Conley	Lee
	........sedimentation values..........			
12	40	42	43	38
13	47	48	51	42
14	55	57	58	49
15	64	65	65	58
16	70	69	70	65

The authors wish to express their appreciation to Mr. Henry Kramer for his assistance in harvesting and threshing the plots. They are also grateful to Northland Chemical Co. for providing the financial support without which the project would not have been conducted, and to the Crop Quality Council for their baking quality determinations. We also appreciate Harold Rosendahl's assistance in the soil sampling at the Ness farm.

* TVA Field Representative; Extension Soils Agent, Norman county; West Polk county Agricultural Agent; and Assistant County Agricultural Agent, West Polk county, respectively.