Table 1. Annual precipitation and yield of ear corn during fifteen years (1957-71) with different rates of annually applied nitrogen, with N concentrations and removal in the corn grain. (Average of 15 replications.)

Year	Annual Precip.	Annual fertilization rate in lbs/A* 0+40+40 (S)	40+40+40 (F)	40+40+40 (S)	80+40+40 (S)	240+40+40 (S)
		(Bushels of corn per acre @ 15.5% moisture)				
1957 (May -Dec.)	28.06"	65.2	71.0	69.4	72.1	71.3
1958 (12 mo.)	16.92"	73.2	81.5	81.0	82.4	80.3
1959 "	17.99"	36.1	40.9	41.5	39.7	36.8
1960 "	26.14"	53.3	48.2	55.0	53.7	52.5
1961 "	16.98"	32.3	48.3	47.6	45.0	46.1
1962 "	30.42"	38.1	59.0	62.0	65.3	67.1
1963 "	26.29"	62.7	80.9	83.5	77.4	79.5
1964 "	18.89"	33.2	34.1	29.6	29.1	24.7
1965 "	33.48"	50.4	68.3	75.3	80.8	82.8
1966 "	22.20"	49.0	63.7	66.3	75.9	33.1
1967 "	16.79"	66.8	69.2	71.2	69.7	71.3
1968 "	27.68"	64.1	79.6	70.2	78.5	76.0
1969 "	25.47"	76.4	58.0	60.2	59.9	58.7
1970 "	27.33"	59.2	66.9	70.2	78.5	76.0
1971 "	33.16"	64.2	79.9	82.6	83.6	85.4
1972 (Jan.-June 15)	9.91"					
Total	377.71"					
15 Year Average	25.18"	54.3 bu/A	64.0 bu/A	64.8 bu/A	66.1 bu/A	62.8 bu/A

Table 1. continued-

	Annual fertilization rate in lbs/A*				
	0+40+40 (S)	40+40+40 (F)	40+40+40 (S)	80+40+40 (S)	240+40+40 (S)
% N in 1971 corn grain	1.15	1.32	1.47	1.60	1.81
Pounds N/A in 1971 grain	32.8	50.9	60.0	67.0	75.7
N applied in 15 years (lbs/A)	-30	630	630	1230	3630
Approx. N removed grain (lbs/A)	444	599	671	751	807
N balance in soil	-414	+31	-41	+479	+2823

(S) - Fertilizer broadcast in spring

(F) - Fertilizer broadcast in fall

(*) - Commencing in 1969, all phosphate, potash and an additional 10 lbs N/A were applied in the row as starter using 6+24+24 at the rate of 167 lb/A to supply the 10+40+40 treatment.

It is evident that annual applications of nitrogen at the 40 lbs/A rate increased corn yields equivalent to N supplied annually at the higher 80 or the 240 lbs/A rate, although the two latter fertilization rates resulted in higher protein corn and hence a greater N removal per bushel of grain. However, it is evident that over the 15 year period, very large differences in the N balance of the soils have arisen with the different rates of N application. The fate of the excess N applied was examined after nine years in October, 1965, and again in November of 1967, and finally in mid-June of 1972 (after 15 years). The NO_3-N content of these soils found late in 1965 to a depth of 96 inches was reported in Soil Series 80 (February 1966 -- pp. 84-86). After nine years of treatment, the first 48 inches of soil under the annual 40, 80, and 240 lbs/N/A treatments contained 3.3%, 7.1%, and 28.2% as much N as applied, whereas the 48 to 96 inch depths contained 2.3%, 14.7% and 34.3% respectively as much as applied in the fertilizer treatments. Therefore, the first eight feet of soil contained a total of 5.6%, 21.8% and 62.5% as much N as applied previous to that time.

Two years later (November, 1967) three replications of each of the three N treatments (0, 40, and 240 lbs of N annually) were sampled to a depth of 32 feet, and NO_3-N analyses were made of every fourth foot below the 48 inch depth. The results of this study were reported in Soil Series 82 (March, 1968 - pp. 90-92) showing NO_3-N accumulations to greater depths with the 0, 40, and 240 lbs N/A treatments.

Since 1971 the plot area was designated as a future building site, the fertilization experiment was terminated at the end of that year with soil sampling to be done in October or November. However, extremely heavy fall rains made deep soil sampling impossible and this was finally completed amidst the growing corn on June 14 and 15 of 1972

on the same plots as previously sampled. However, soil analyses of one of the 240 lbs N treatment (Plot 35) were much lower in NO_3-N than the same treatments of the other two sampled replications and since it was a depressional area, a similarly treated plot (Plot 35) in the adjoining replicate was sampled and analyzed later in 1972. The results were then averaged with those previously sampled, similarly fertilized plots of the other two main replications. The average NO_3-N content of three profiles of each of the three treatments are shown (in parts per million) in Table 2, and the averages (in pounds per acre) for each depth graphically in Figure 1 (assuming that one acre foot of soil weighs approximately four million pounds).

As might be expected from the calculated soil nitrogen balances reported in Table 1, data of Table 2 and Figure 1 show soil profiles without N fertilization (0+40+40 annually) and those receiving 40 lbs N annually (40+40+40 spring) are consistently low in NO_3-N (the nitrite (NO_2-N) values are also included but these were uniformly less than one part per million).

However, Table 1 shows that soils to which the 240 lbs/A nitrogen (240+40+40 S) treatments were made had little more N removed in the corn grain than either the check or the 40+40+40 treatment, resulting in a positive N balance of 2823 lbs N/A. This accumulation is corroborated by the soil NO_3-N shown in Table 2 and in Figure 1. A large proportion of the N not removed in the grain has now been leached down below the zone of corn root penetration, most occurring as NO_3-N in the 4 to 16 foot soil depth. It is doubtful that any appreciable proportion of this large supply of chemically and biologically available nitrogen can again become available to annual crop plants since roots of these rarely penetrate much below the four foot depth. Deep rooted perennial plants (such as alfalfa) could use at least part of this large NO_3-N supply.

Table 2. Nitrate Nitrogen (in parts per million) present in untiled Barnes loam following fifteen years of corn cropping with different rates of N fertilization. Sampled June 14-15, 1973.

Soil depth (feet)	0+40+40 each of 15 years* Plot Number				40+40+40 each of 15 years* Plot Number				240+40+40 each of 15 years* Plot Number			
	21	46	71	Ave.	10	45	55	Ave.	6	36	62	Ave.
	Nitrate Nitrogen in parts per million											
0.5	4.2	4.2	5.9	4.8	5.6	6.9	9.7	7.4	4.8	2.4	6.2	4.5
0.5-1	6.3	2.6	8.0	5.6	4.4	6.8	4.7	5.3	6.2	11.9	3.8	6.0
1-2	2.4	1.1	5.9	3.1	3.1	3.0	3.7	3.3	5.8	0.9	8.2	4.8
2-3	0.8	0.9	2.8	1.5	3.2	2.8	2.9	3.0	4.8	1.3	8.7	4.9
3-4	0.3	0.9	2.2	1.1	3.2	2.7	3.3	3.1	15.0	2.9	19.1	12.3
4-5	0.2	0.7	1.5	0.8	3.9	2.3	3.1	3.1	54.0	5.6	24.2	27.9
5-6	0.3	1.2	1.1	0.9	4.8	2.8	3.6	3.7	79.0	10.0	38.9	49.3
6-7	0.6	1.3	0.8	0.9	4.5	6.6	3.3	4.8	77.0	22.5	60.9	53.5
7-8	0.7	1.4	0.8	1.0	2.3	6.8	2.1	3.7	63.0	40.5	60.9	54.9
8-9	1.2	0.9	1.2	1.1	1.6	8.1	3.6	4.4	51.0	42.0	55.0	49.3
9-10	1.8	1.0	1.0	1.3	1.6	7.5	2.6	3.9	47.0	56.5	45.5	49.7
10-11	2.2	1.1	1.2	1.5	1.8	7.0	2.2	3.7	43.0	53.5	36.7	44.4
11-12	2.0	1.3	1.6	1.6	2.3	6.9	3.2	4.1	43.0	61.5	33.5	46.0
12-13	2.2	1.1	---	3.3	2.7	9.3	4.3	5.4	41.0	59.0	27.1	42.4
13-14	2.7	1.8	1.3	1.9	2.9	8.7	4.8	5.5	42.0	44.5	27.1	37.9
14-15	2.8	---	1.8	2.3	3.3	9.3	5.9	6.2	37.0	31.0	24.2	30.7
15-16	2.6	---	1.8	2.2	4.0	8.2	5.2	5.8	28.0	19.5	26.4	24.5
16-17	2.5	1.3	1.7	1.8	4.3	10.7	---	7.5	26.0	15.0	18.7	19.9
17-18	2.1	2.0	2.2	2.1	4.7	10.8	4.0	6.5	30.0	12.0	15.9	19.3
18-19	2.5	3.2	3.0	2.9	4.8	8.1	4.1	5.7	29.0	12.0	----	20.5

Table 2. continued--

Soil depth (feet)	0+40+40 each of 15 years*				40+40+40 each of 15 years*				240+40+40 each of 15 years*			
	Plot Number				Plot Number				Plot Number			
	21	46	71	Ave.	10	45	55	Ave.	6	36	62	Ave.
19-20	2.4	4.2	5.2	3.6	5.3	5.2	5.7	4.1	19.2	12.0	----	15.6
20-21	1.8	---	1.9	1.9	4.9	8.8	4.0	5.9	16.9	13.5	19.5	16.6
21-22	1.4	---	4.3	1.9	6.0	---	4.0	5.0	14.0	16.0	10.0	10.0
22-23	1.2	---	4.0	2.6	3.5	---	3.4	3.5	14.1	27.5	7.1	16.2
23-24	1.0	---	---	1.0	4.2	---	2.2	3.2	11.1	28.5	----	19.8
24-25	1.2	---	1.8	1.5	3.4	---	---	3.4	18.8	20.0	----	19.4
25-26	---	---	1.0	1.0	6.3	---	---	6.3	13.5	16.0	----	14.8
26-27	---	---	1.3	1.3	---	---	---	---	10.0	16.0	----	13.0
27-28	---	---	---	---	---	---	---	---	12.3	14.5	----	13.4
28-29	---	---	---	---	---	---	---	---	12.2	12.0	----	12.1
29-30	---	---	---	---	---	---	---	---	7.4	12.5	----	9.9
30-31	---	---	---	---	---	---	---	---	10.2	----	----	10.2
31-32	---	---	---	---	---	---	---	---	10.7	----	----	10.7
32-33	---	---	---	---	---	---	---	---	9.9	----	----	9.9
33-34	---	---	---	---	---	---	---	---	7.8	----	----	7.8

* All plots received an additional 10 lbs N/A in 1969, 1970 and 1971 as starter fertilizer

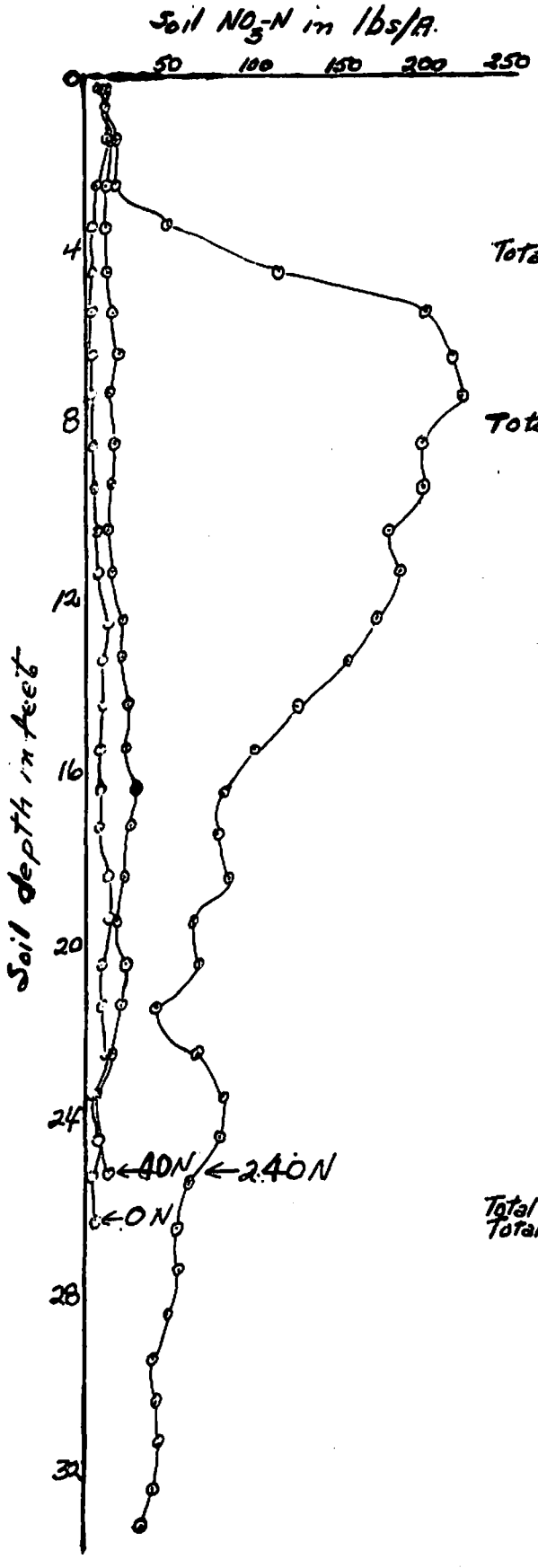
Since increased NO_3-N accumulation is evident to the 34 foot depth, substantial downward movement of N has apparently occurred where heavy rates of N fertilizer were applied for 15 years for corn production under comparatively limited annual precipitation. Such fertilizer practices are quite evidently not justified, either economically, or from their possible contribution of additional NO_3-N to subterranean water supplies.

Ammonium nitrogen (NH_4-N) also occurs in soils, although usually in much lower amounts than occurs as nitrate N (NO_3-N). If soils are water-saturated for a considerable period, much of the N present as NO_3 is then reduced by the lack of free oxygen (O_2) to the NH_4 form, (as in lowland soils on which rice is grown). Soils developed in areas of more limited precipitation such as western Minnesota are usually well aerated, and hence NH_4-N concentrations are comparatively low. Amounts of ammonium N in lbs. per acre foot present at the different soil depths, after 15 years of N fertilization are shown in Figure 2.

It is evident that the continued N fertilization, even at the heaviest rate has not appreciably increased soil NH_4-N to the 34 foot depth.

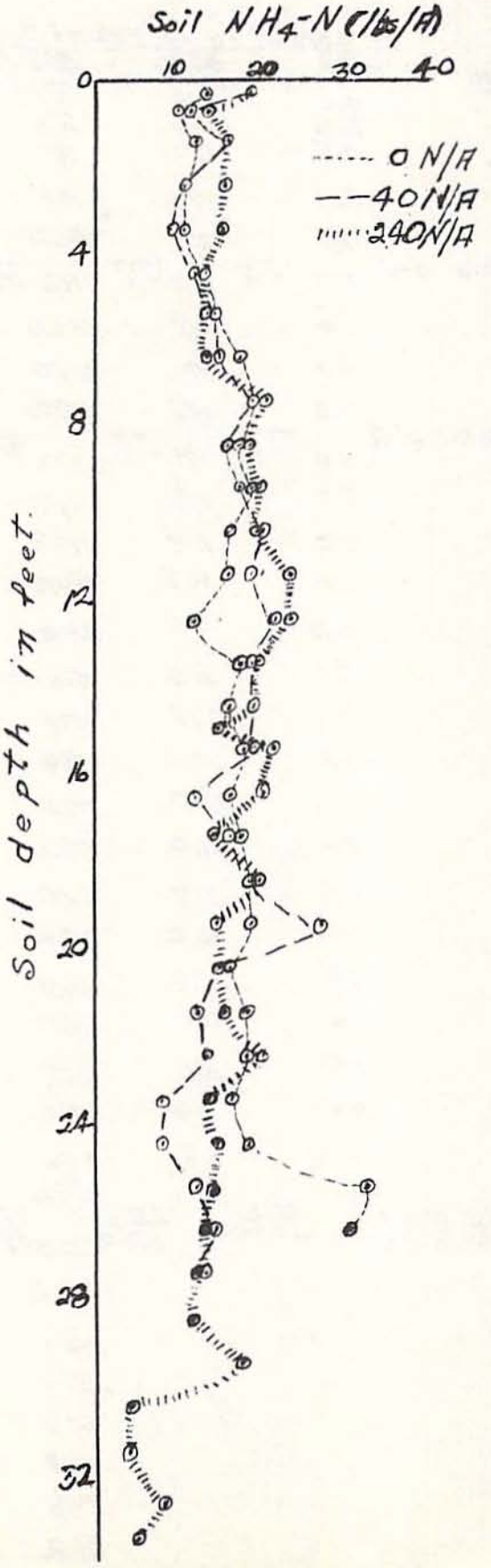
It is evident that 15 years of N fertilization of continuous corn at Morris has resulted in moderate increases in corn yield with moderate fertilization rates. Heavier annual N fertilization rates failed to produce further increases in corn yields and the unused N has largely been leached downward beyond the reach of plant roots and may eventually increase the NO_3-N content of subterranean water supplies.

Figure 1. Nitrate Nitrogen (Pounds per acre) in a Barnes Loam Following Fifteen Years (1957-71) of Annual Corn Cropping with Different Rates of Nitrogen Fertilization. (Sampled June, 1972)



	N applied in 15 years (lbs/A)					
	0		63.8		319.0	
	(Soil NO_3-N in lbs/A)					
	9.6		14.8		9.0	
	11.2		10.6		12.0	
	12.5		13.0		19.2	
	6.0		12.0		19.6	
	4.5		12.4		49.2	
Total 0'-4'	3.2	43.8	12.4	62.8	111.6	109.0
	3.6		14.8		197.2	
	4.0		19.2		214.0	
	4.0		14.8		219.2	
Total 4'-8'	4.4	14.8	17.6	61.2	197.2	742.0
	5.0		15.6		148.8	
	6.0		12.4		177.6	
	6.4		16.4		184.0	
	13.2		21.6		169.6	
	7.6		22.0		151.6	
	9.2		24.8		122.8	
	8.8		23.2		98.4	
	7.2		30.0		79.6	
	8.4		26.0		77.2	
	11.6		22.8		82.0	
	14.4		16.4		62.4	
	7.4		23.6		66.4	
	7.4		20.0		40.0	
	10.4		14.0		64.8	
	4.0		6.4		79.2	
	6.0		6.8		79.6	
	4.0		12.6		59.2	
Total 8'-26'		144.4		372.2		1988.4
Total 0'-26'	5.2	2000		456.2	52.0	2839.4
					53.6	
					48.4	
					39.6	
					40.8	
					42.8	
					39.6	
					31.2	

Figure 2. Exchangeable Ammonium Nitrogen (Pounds per acre) in a Barnes Loam Following Fifteen Years (1957-71) of Annual Corn Cropping with Different Rates of Nitrogen Fertilization. (Sampled June, 1972).



N applied during 15 years (lbs/A)

30	630	3630
(Exchangeable NH_4-N in lbs/A)		
13.4	18.6	18.2
10.0	17.4	13.2
12.0	16.0	16.0
10.8	10.8	15.6
10.8	9.2	15.2
13.2	12.0	13.6
14.8	14.8	13.6
17.2	14.8	13.6
18.8	18.8	20.2
17.2	16.0	18.8
18.8	17.2	19.6
16.0	20.0	19.2
16.0	18.8	23.2
12.0	21.2	23.2
17.2	18.8	19.6
16.0	18.8	18.8
18.0	18.8	14.8
16.0	12.0	21.2
17.2	16.0	20.0
18.8	18.8	14.8
18.8	26.8	19.6
16.0	14.8	14.4
18.0	12.0	15.2
18.0	13.2	20.0
16.0	8.0	13.6
18.0	8.0	14.8
32.0	12.0	14.4
30.0	14.0	13.6
476.0	120	12.4
	437.6	11.6
		17.6
		4.0
		4.0
		8.0
		5.0
		478.0

Small Grain Fertilization

West Central Experiment Station-Morris

S.D. Evans

Field experiments were carried out on Tara silt loam in 1971 and Doland silt loam in 1972 to study the response of wheat, oats, and barley to nitrogen fertilization. Three varieties of each crop were grown at three applied nitrogen levels. The nitrate nitrogen level in the soil was determined by the University of Minnesota Soil Testing Laboratory.

A. Oats

Main plots - Varieties (1) Lodi (2) Otter (3) Diana

Sub-plots- nitrogen levels of 0, 30, 60, and 90 lbs. of actual nitrogen.

Seeding date- April 28, 1972

Nitrate nitrogen soil test- 53 lbs/acre.

A uniform starter application of 100 lbs of 10-20-20 was used.

Table 1. Yield, Oat Fertility Study, Morris, 1972.

Nitrogen Applied lbs/A	Variety			
	Lodi	Otter	Diana+	Average
		---Bu/A---		
0	60.0	53.5	23.5	45.7
30	69.9	71.7	34.0	58.5
60	76.5	77.8	36.3	63.6
90	80.3	76.7	50.8	69.3
Average	71.7	69.9	36.2	

+ There was severe bird damage with variety Diana.

Table 2. Lodging Score (1-9 scale). Oat Fertility Study, Morris 1972.

Nitrogen Applied lbs/A	Variety			
	Lodi	Otter	Diana	Average
		---Lodging---		
0	2.3	2.7	2.0	2.3
30	3.3	2.7	2.3	2.8
60	4.0	2.7	1.7	2.8
90	3.3	4.0	2.7	3.1
Average	3.2	3.0	2.2	

Table 3. Groat Percentages, Oat Fertility Study, Morris 1972.

Nitrogen Applied lb/A	Variety			
	Lodi	Otter	Diana+	Average
		---Groat %---		
0	68	69	58	65
30	66	68	53	63
60	68	68	54	64
90	64	68	64	65
Average	66	68	57	

+ There was severe bird damage in the variety Diana.

The statistical analysis of these variables has not been done.

B. Barley

Main plots- Varieties (1) Dickson (2) Larker (3) 64-76 in 1971 and 65-220 in 1972.

Sub-plots- nitrogen levels of 0, 30, 60, and 90 lbs. of actual nitrogen.

Seeding date- April 7, 1971 and April 28, 1972.

Nitrate nitrogen soil test- 1971-70 lbs/acre
1972-53 lbs/acre

A uniform starter application of 100 lbs. of 10-20-20 was used.

Table 4. Percent protein in grain, Barley Fertility Study, Morris 1971.

Nitrogen Applied lbs/A	Variety			
	Dickson	Larker	64-76	Average
		---% Protein---		
0	11.1	11.3	11.3	11.2
30	10.8	11.9	11.4	11.4
60	11.0	12.1	10.7	11.2
90	12.6	13.1	11.8	12.5
Average	11.4	12.1	11.3	

Table 5. Yield, Barley Fertility Study, Morris 1972.

Nitrogen Applied lbs/A	Variety			
	Dickson	Larker	65-220	Average
		---Bu/A---		
0	27.2	29.9	21.1	26.1
30	34.5	37.0	29.2	33.6
60	46.8	45.4	33.2	41.8
90	40.2	47.1	28.6	38.6
Average	37.2	38.2	28.0	

Table 6. Lodging score (1-9 scale), Barley Fertility Study, 1972.

Nitrogen Applied lbs/A	Variety			
	Dickson	Larker	65-220	Average
		---Lodging---		
0	1.0	1.3	3.7	2.0
30	1.3	1.7	4.0	2.3
60	3.0	2.3	6.7	4.0
90	3.3	3.3	7.0	4.7
Average	2.2	2.2	5.3	

Table 7. Analysis of Variance, Barley Fertility Study, Morris 1971 and 1972.

Source of Variation	1971 % Protein	1972 Bu/A	1972 Lodging
Reps	NS	NS	-not-
Varieties (V)	NS	*	-analyzed-
Nitrogen (N)	*	**	-yet-
V x N	NS	NS	

C. Wheat.

Main plots- Varieties (1) Chris (2) Era (3) Ciano 67

Sub-plots- Nitrogen levels of 0, 40, 80, and 120 lbs of actual nitrogen.

Seeding date- April 7, 1971

Nitrate nitrogen soil test- 1971-70 lbs/acre. A uniform starter application of 100 lbs of 10-20-20 was used.

Table 8. Percent protein in grain, Wheat Fertility Study, Morris, 1971.

Nitrogen Applied lbs/A	Variety			
	Chris	Era	Ciano 67	Average
	----% Protein---			
0	13.8	12.7	14.0	13.5
40	14.6	12.9	14.3	14.0
80	15.5	12.7	13.9	14.0
120	16.7	13.3	14.5	14.8
Average	15.2	12.9	14.2	

The 1972 wheat data was not available at the time of printing.

This work was done in cooperation with the following staff of the Department of Agronomy and Plant Genetics:

Oats - D. D. Stuthman

Barley - D. C. Rasmusson

Wheat - R. E. Heiner

Statistical analysis was done by Dean Fairchild, Department of Soil Science.

SOYBEAN-NITROGEN FERTILIZER SOURCE AND RATE STUDY

G. E. Ham and S. D. Evans

Ammonium nitrate, urea and soybean meal sources of nitrogen at the rate of 100 and 200 pounds of nitrogen per acre were compared at Morris and Rosemount. All fertilizers were applied to the surface and disked in before planting. Non-nodulating and nodulating isolines of Chippewa maturity and Swift soybeans were grown on the plots. The yields for 1972 are shown in Table 1 and 2. Nitrogen fertilizer significantly increased seed yields at Morris but not at Rosemount. The previous crop at Morris was corn and alfalfa at Rosemount which may explain the lack of response to nitrogen at Rosemount. The nodulating plants were well-nodulated at both locations.

Table 1. Effect of nitrogen sources and rates and soybean genotype on soybean seed yield at Morris (1972).

Nitrogen source	Nitrogen rate	Soybean genotype		
		Non-nod	Nod	Swift
	lb/acre	bu/acre		
Check		21 a	33 a	37 ab
Ammonium nitrate	100	27 b	33 a	36 a
Urea	100	27 b	34 a	37 ab
Soybean meal	100	29 bc	34 a	39 bc
Ammonium nitrate	200	33 de	33 a	41 cd
Urea	200	33 de	34 a	39 bc
Soybean meal	200	31 cd	37 b	43 d
Ammonium nitrate	300	34 e	33 a	40 c

Yields under a variety followed by the same letter are not significantly different from each other at the .05 level (Duncan's multiple range test).

Table 2. Effect of nitrogen sources and rates and soybean genotype on soybean seed yield at Rosemount (1972).

Nitrogen source	Nitrogen rate	Soybean genotype		
		Non-nod	Nod	Swift
	lb/acre	bu/acre		
Check		38	44	46
Ammonium nitrate	100	40	42	47
Urea	100	41	44	47
Soybean meal	100	42	43	44
Ammonium nitrate	200	38	43	46
Urea	200	40	46	49
Soybean meal	200	42	43	44
Ammonium nitrate	300	39	41	47

FERTILIZER TRIALS ON IRRIGATED ALFALFA AND RED CLOVER STAPLES, MINNESOTA

C. J. Overdahl, Dean Fairchild and Mel Weins

The plant nutrients phosphorus, potassium, sulfur, boron and copper, under varying rates plus 3 levels of lime, were under study at the Staples Irrigation Farm in 1972.

The first year alfalfa growth was small and yields up to only 3.8 tons per acre were harvested from 3 cuttings. Red clover on this first year was better with yields as high as 5 tons per acre. There was no significant response to any of the nutrients or lime added. This is not easily explained for potassium, since check plot soil tests ranged from 92 to 107, which is quite low.

Phosphorus soil tests were very high, averaging about 90 pounds, sulfur was medium high. The plant analyses on check plots showed 2% potassium, .4% P, which are adequate. All secondary and micro nutrients in the plant analyses were high except copper. Added copper gave no yield increase in 1972. The pH was 6.2 on the surface 6 inches, but averaged 6.5 from 1 to 2 feet and 6.9 from 2 to 3 feet.

Boron readings in alfalfa plant tissue by cutting were: 1st=60 ppm, 2nd=51 ppm, 3rd=45 ppm. Red clover readings were: 1st cut=75 ppm, 2nd cut=35 ppm, 3rd cut=35 ppm. Above 30 ppm is considered sufficient for these crops.

Only limited conclusions can be drawn on one year's data. The 1973 data will probably give more meaningful information.

Efforts of Bob McCaslin, Bob Schoper, Charles Behrens, Fred Bergsrud and others assisting on plots are gratefully acknowledged.

NITROGEN TRIALS ON CHRIS AND ERA WHEAT UNDER IRRIGATION AT STAPLES 1972

A. C. Caldwell, F. G. Bergsrud,
H. J. Miens and D. S. Fairchild

Five rates of N (0, 25, 50, 75, 100 lbs/A) were applied as a broadcast to varieties of Chris and Era wheat on Hubbard sandy loam at Staples. The entire nitrogen rates of 25 and 50 lbs/A were applied before seeding while the 75 lbs of N/A was split into 50 lbs/A at seeding and 25 lbs/A at boot stage, and the 100 lbs rate at 50 lbs/A at seeding and 50 lbs/A at boot stage. A basic starter fertilizer of 8-16-32 + 2 1/2 S was applied at 200 lbs/A.

The nitrate nitrogen level in the 0-24 inch soil zone was at 12 lbs/A. Soil test levels of P and K were very high and medium, respectively.

Table 1 indicates that no significant yield increases were noted in Chris or Era varieties with greater than 50 lbs of N/A.

Table 1. Yields of Era and Chris wheat as affected by nitrogen rates under irrigation, Staples, Minnesota.

Fertilizer Treatments	Variety	
	Era	Chris
(lbs N/A)*	----------Bu/A----------	
0	22 a **	15 a
25	31 bc	19 b
50	37 c	26 c
75	32 bc	26 c
100	29 b	24 c

* N applied as ammonium nitrate

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

The percent nitrogen in the plant tissue from the variety Chris was below the critical level of 2.7% N for treatments receiving 0 and 25 lbs. of N/A. Treatments receiving 50, 75 and 100 lbs. of N/A were not significantly different in % N and above the critical level of 2.7% (Table 2). Nitrogen contents of plant tissue from the variety Era indicated nitrogen deficiencies only in the treatment receiving 0 lbs. of N/A. Significant increases in the nitrogen content of Era's plant tissue were noted with increasing nitrogen fertilizer rates (Table 2).

Table 2. The nitrogen content of plant tissue from Era and Chris wheat as affected by nitrogen rates under irrigation.

Fertilizer Treatment	Variety	
	Era	Chris
(lbs. N/A)	---------% N in dry matter-------	
0	2.5 a*	2.0 a
25	2.8 ab	2.5 b
50	3.0 bc	2.7 bc
75	3.2 cd	2.8 c
100	3.4 d	2.9 c

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

Table 3 indicates the percent nitrogen in Chris and Era wheat grain increased with increasing rates of nitrogen. Significant increases are noted at the 50 and 100 lbs. of N/A rates with the Era grain being slightly lower in nitrogen than the Chris grain.

Table 3. The nitrogen content of grain from Era and Chris wheat as affected by nitrogen rates under irrigation.

Fertilizer Treatments	Variety	
	Era	Chris
(lbs. N/A)	----------%N----------	
0	1.6 a*	1.8 a
25	1.8 a	1.9 a
50	2.0 b	2.1 ab
75	2.1 b	2.4 bc
100	2.4 c	2.6 c

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

Yields of both Chris and Era were not satisfactory and too low to be economical crops under irrigation. This experiment will be repeated in 1973 with greater emphasis on management practices to increase wheat yields and with more extensive soil sampling to monitor the movement of nitrogen on coarse textured soils under irrigation.

THE EFFECTS OF FERTILIZER RATES ON CUCUMBERS UNDER IRRIGATION AT STAPLES, 1972

A. C. Caldwell, F. G. Bergsrud,
H. J. Viens and D. S. Fairchild

The introduction of irrigation and different crops to central Minnesota has created a need for new research to determine crop response to applied fertilizer. To fulfill this need a fertilizer study with cucumbers was initiated at the Staples Irrigation Farm on a Hubbard sandy loam in 1972.

The nitrate nitrogen level in the 0-24 inch soil zone was 54 lbs/A. Soil test levels of phosphorus and potassium were very high and medium, respectively.

A randomized complete block design was used with eight treatments replicated five times. The fertilizer treatments were as follows:

Treatment Code	Treatments	$N+P_2O_5+K_2O+S+B$ --lbs/acre----
A	$N_1 + P_1 + K_1 + S_1 + B$	100 + 75 + 200 + 20 + 3
B	$N_2 + P_1 + K_1 + S_1 + B$	50 + 75 + 200 + 20 + 3
C	$N_3 + P_1 + K_1 + S_1 + B$	100 + 75 + 200 + 20 + 3
D	$N_4 + P_1 + K_1 + S_1 + B$	150 + 75 + 200 + 20 + 3
E	$N_1 + P_2 + K_1 + S_1 + B$	100 + 150 + 200 + 20 + 3
F	$N_1 + P_1 + K_2 + S_1 + B$	100 + 75 + 400 + 20 + 3
G	$N_1 + P_1 + K_1 + S_2 + B$	100 + 75 + 200 + 40 + 3
H	Check	0 + 0 + 0 + 0 + 0

All fertilizer treatments, except the nitrogen rates, were top-dressed and tilled in on June 21, 1972. Nitrogen rates were split into the following amounts and times of application:

1. N_1 - 50 lbs/acre at planting + 50 lbs/acre two weeks after plant appearance,
2. N_2 - 50 lbs/acre at planting,
3. N_3 - 100 lbs/acre at planting, and
4. N_4 - 50 lbs/acre at planting + 50 lbs/acre two weeks after plant appearance + 50 lbs/acre four weeks after plant appearance.

Cucumbers were planted in 22 inch rows on June 27, 1972, at 80-100,000 plants/acre.

Total saleable cucumber yields are reported in Table 1. Highest yields are noted with 100 lbs. of nitrogen/acre either as a split application or as one application at planting. Yield increases are also indicated with the higher fertilizer rates of phosphorus, potassium and sulfur though the increases are not always significant. Six fold increases in yield of fertilized over unfertilized cucumbers are tremendous and it is very apparent that based on one year's results and on this soil, fertilization is a must for satisfactory cucumber yields.

Table 1. 1972 Cucumber yields with variable fertilizer rates under irrigation at Staples.

Fertilizer Treatment Code	Total	Saleable
	-----Yield lbs/acre----------	
A	6192 cd*	5477 de
B	3408 b	2483 b
C	6697 d	4298 cd
D	4585 bc	4109 c

Table 1. (continued) --

Fertilizer Treatment Code	Total	Saleable
	------Yield lbs/acre----------	
E	7875 d *	6017 e
F	6219 cd	5236 cde
G	1348 a	1043 a

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

Plant tissue samples were collected on August 8, 1972, from the fully developed upper leaves at the early bloom stage in growth. Significant increases in nitrogen, potassium, magnesium, sulfur and manganese in the plant tissue are noted in Table 2.

This experiment will be repeated in 1973.

Table 2. Plant analyses of upper leaves from cucumbers with variable fertilizer rates under irrigation at Staples in 1972.

Fertilizer Treatment Code	%						P.P.M.					
	N	P	K	Ca	Mg	S	AL	Fe	Zn	Cu	Mn	B
A	3.98 c*	.82	2.84 b	2.11	.49 a	.64 abc	561	556	67.8	6.4	134 bc	41.5
B	3.21 a	.84	2.74 ab	1.97	.46 a	.69 c	588	576	64.0	6.1	130 b	42.7
C	3.57 b	.82	2.81 b	2.11	.47 a	.68 bc	635	608	71.2	5.9	149 e	39.5
D	4.48 d	.80	2.82 b	2.43	.50 a	.60 a	660	658	70.2	5.6	150 e	42.8
E	4.21 cd	.87	2.79 b	2.20	.49 a	.62 ab	716	678	68.9	6.2	146 de	38.2
F	4.17 cd	.83	2.89 b	2.06	.43 a	.63 abc	621	622	68.6	6.3	143 d	39.4
G	4.08 c	.79	2.74 ab	2.25	.50 a	.69 c	554	545	69.0	5.9	138 c	41.7
H	3.60 b	.89	2.55 a	2.08	.60 b	.69 c	722	650	72.2	8.7	104 a	31.8

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

INFLUENCE OF PHOSPHORUS AND POTASSIUM FERTILIZATION ON ALFALFA YIELDS, WASECA, 1969-1972.

W. E. Lueschen and G. W. Randall

An experiment was established in 1969 at the Southern Experiment Station to evaluate phosphorus and potassium fertilization of alfalfa for south-central Minnesota. The experiment was located on a Webster clay loam soil with a pH of 5.7, P test of 40 and a K test of 240. Prior to seeding the trial a uniform application of 7 tons per acre of limestome was applied. Annual applications of fertilizer were as follows: 30 or 150 pounds per acre of P_2O_5 in combinations with 0, 60 or 300 pounds per acre of K_2O. The initial application of fertilizers was made prior to spring plowing on May 5, 1969; subsequent applications were top-dressed each spring. The trial was seeded on May 14, 1969 with three varieties: Vernal, Saranac and Minn. Syn N. Six replications were established without a companion crop using Eptam and 2, 4-DB for weed control gave excellent initial stands of alfalfa. All plots were harvested to simulate removal as hay with 2, 4, 3 and 3 cuttings removed in 1969, 1970, 1971 and 1972, respectively.

Yield levels were relatively low, as is typical for the Waseca area (tables 1 and 2). The higher yields in 1970 were a result of excellent growing conditions which permitted harvesting 4 cuttings by early September. Lower first and third cutting yields in 1971 reduced that season's total

yield considerably. Removing 4 cuttings in 1970 may have weakened the plants enough to reduce yields for the first cutting in 1971. Inadequate rainfall in July and August of 1971 were mainly responsible for very low third cutting yields.

Saranac tended to be the highest yielding variety in 1969, 1970 and 1971. The response of all three varieties was very similar for all fertilization treatments.

Table 2 gives the effects of the P and K treatments averaged over the three varieties. Although significant yield increases were obtained for phosphorus in 1969 and 1970, the increases were very small; .10 T/A, which would not pay for fertilizer costs. The soil P levels in the upper 6 inches were very high (40 lbs./A) when the trial was initiated in 1969 and remained at very high levels (30 lbs./A) throughout the trial even where only 30 pounds P_2O_5/A were applied annually. Soil tests for phosphorus were increased to 50-60 where an annual application of 150 pounds per acre of P_2O_5 was made. These results explain the lack of large responses to phosphorus. Table 4 gives the percentage phosphorus in plant tissue of the third cutting in 1972. These values were adequate for good alfalfa production even at the low rate of phosphorus fertilization ($<$ 0.20% deficient).

With the exception of 1969, alfalfa yields tended to increase slightly with potassium fertilization. Additions of 60 pounds per acre of K_2O had no effect on yields in 1969 and 1970 but significant increases (0.20 T/A) were observed in 1971 and 1972. As with phosphorus, these increases would not pay for the fertilizer costs using $20/T for the alfalfa and

$.05/lb. of K_2O. Additional yield increases (0.20 T/A) for 300 pounds K_2O/A were observed in 1970 and 1972.

Lack of response in 1969 to potassium fertilization can be explained on the basis of high initial K soil test values (240 lbs./A). Soil tests in the fall of 1972 (table 3) were in the medium range for the 0 and 60 pounds per acre treatment and the high range for the 300 pound rate. With relatively low forage yields in 1972, soil supplied potassium was nearly sufficient to meet plant nutrient needs.

Plant tissue tests for third cutting in 1972 indicate less than adequate K tissue levels ($<$ 1.75% difficient) for the 0 and 60 pound K_2O rate and adequate levels for the 300 pound rate. However, only slight differences in total yield were observed among the treatments in 1972 with no response to K fertilization in the third cutting.

Phytophthora root rot was present in the trial and may have contributed to the poor yields and lack of response to fertilization. New trials are planned with Phytophthora resistant varieties to determine if alfalfa yields can be improved with fertilization of resistant varieties. When severe infestation of this disease exists, extensive damage is done to the root system and this may limit the ability of the plants to extract nutrients from the soil.

Table 1. Influence of phosphorus and potassium fertilization on alfalfa yields, Waseca, 1969-1972.

Variety	P_2O_5 lbs/A	K_2O lbs/A	Hay Yield (T/A @ 12% H_2O) 1969	1970	1971	1972
Vernal	30	0	1.72	5.04	3.31	4.08
"	150	0	1.95	5.25	3.26	4.14
"	30	60	1.72	5.27	3.46	4.13
"	150	60	1.91	5.26	3.41	4.33
"	30	300	1.81	5.43	3.59	4.34
"	150	300	1.80	5.32	3.52	4.18
Variety Average			1.82	5.26	3.43	4.20
Saranac	30	0	1.80	5.50	3.45	4.08
"	150	0	1.95	5.75	3.25	4.02
"	30	60	1.97	5.42	3.70	4.20
"	150	60	2.10	5.61	3.63	4.18
"	30	300	1.92	5.90	3.68	4.07
"	150	300	2.11	5.86	3.72	4.34
Variety Average			1.98	5.67	3.57	4.15
Minn. Syn N	30	0	1.69	5.09	3.01	4.03
"	150	0	1.70	5.08	3.09	3.93
"	30	60	1.75	4.99	3.06	3.87
"	150	60	1.73	5.03	3.19	4.11
"	30	300	1.63	5.19	3.12	4.23
"	150	300	1.77	5.43	3.34	4.37
Variety Average			1.71	5.14	3.14	4.09

Table 2. Influence of phosphorus and potassium fertilization on alfalfa yields (T/A @ 12% H_2O), Waseca, 1969-1972. (Average of 3 varieties)*

Annual K_2O (lbs./A)	Annual P_2O_5 Applications Per Acre 1969 30	1969 150	1970 30	1970 150	1971 30	1971 150	1972 30	1972 150
0	1.74	1.87	5.21	5.36	3.26	3.20	4.07	4.03
60	1.81	1.91	5.23	5.30	3.41	3.41	4.07	4.21
300	1.79	1.89	5.51	5.54	3.46	3.53	4.21	4.28
BLSD (.05) P	.07		.11		ns		ns	
K	ns		.11		.10		.13	

* 2, 4, 3 and 3 cuttings removed in 1969, 1970, 1971 and 1972, respectively.

Table 3. Influence of phosphorus and potassium fertilization on soil tests (Waseca, fall 1970 and 1972).*

Treatments P_2O_5 lbs./A	Treatments K_2O lbs./A	0-6 Inch Depth pH 1970	0-6 Inch Depth pH 1972	0-6 Inch Depth P lbs./A 1970	0-6 Inch Depth P lbs./A 1972	0-6 Inch Depth K lbs./A 1970	0-6 Inch Depth K lbs./A 1972	7-18 Inch Depth pH 1970	7-18 Inch Depth pH 1972	7-18 Inch Depth P lbs./A 1970	7-18 Inch Depth P lbs./A 1972	7-18 Inch Depth K lbs./A 1970	7-18 Inch Depth K lbs./A 1972
30	0	6.1	6.4	50	30	230	160	6.0	5.6	5	14	200	160
150	0	6.0	6.3	60	60	200	160	5.8	5.7	7	17	200	150
30	60	6.1	6.4	50	30	260	170	6.0	5.7	5	16	190	160
150	60	6.1	6.2	75	55	250	170	5.9	5.8	7	17	210	160
30	300	6.1	6.2	50	30	425	280	5.8	5.8	6	14	210	160
150	300	5.9	6.3	75	50	310	220	5.9	5.7	8	14	220	170

* samples from Saranac plots only.

Table 4. Influence of phosphorus and potassium fertilization on percent phosphorus and potassium in plant tissue, Waseca 1972. (cut 3).*

P_2O_5 lbs./A	K_2O lbs./A	% P	% K
30	0	0.30	1.54
150	0	0.39	1.70
30	60	0.30	1.65
150	60	0.35	1.69
30	300	0.28	2.23
150	300	0.33	2.28

* samples from Saranac only.

CORN TILLAGE STUDY

Waseca, 1972

G. W. Randall, W. E. Lueschen, J. B. Swan and J. A. True

A field experiment was initiated in 1969 to evaluate tillage systems for continuous corn production in south-central Minnesota. Eleven tillage treatments were established in a randomized complete-block design with four replications. Each treatment has been super-imposed on the same plot since establishment. The experiment is located on a LeSueur clay loam soil with a 2-5% south-facing slope. Tile lines spaced 75' apart lie perpendicular to the rows within all plots.

A broadcast application of fertilizer (0+60+90 lbs. $N+P_2O_5+K_2O$/A) was applied on October 15 and was followed immediately by the fall primary tillage operations. Nitrogen (175 lbs. N/A as ammonium nitrate) was broadcast on the surface on April 25. The spring primary tillage treatments were installed on April 27 and the secondary treatments on May 8.

Corn (Minhybrid 4201) was planted at a rate of 26,000 ppA on May 9. An Allis Chalmers minimum tillage planter with fluted coulters was used to plant the plots which did not receive primary tillage. For those plots which did receive primary tillage, the fluted coulters were removed.

Starter fertilizer (13+35+45 lbs. $N+P_2O_5+K_2O$/A) and an insecticide (1 lb. active Furadan/A) were applied at planting time. Chemical weed control consisted of 5 lbs. propachlor/A (A.I.) applied at planting in a 14" band and 2 lbs. atrazine (A.I.) + 1½ qt. vegetable oil/A applied postemergence on June 10. With the exception of the fall chisel-none and no-tillage treatments where too much surface residue prevented cultivation, each treatment was cultivated once.

Small plant weights were obtained on June 14 by randomly selecting 10 plants from each plot and oven drying them. Grain yields were determined by combine harvesting two center rows from each plot on October 5.

Small plant weight, weed infestation and moisture content of the grain at harvest were affected significantly, by the tillage treatments (Table 1). In general, early plant growth was greater, the weeds were less numerous and the corn was drier from the moldboard plow treatments, irregardless of secondary treatments. The smallest early plant growth and the wettest corn at harvest resulted from the no-tillage treatment. Highest weed infestation resulted from the fall chisel treatment with no secondary tillage. Quackgrass and fall panicum were the dominant species found. Final population, lodging and yield were not affected by the tillage treatments. In addition the correlation coefficient between yield and small plant weight (.130) was not significant. This was the third year in this study in which final yield was not related to early growth. Weed infestation had

Table 1. Influence of tillage treatments on continuous corn production at Waseca in 1972.

Tillage Treatments Primary	Secondary	Small plant weight g/dry plant	Weed[1/] infestation 1-5	Final population x 1000	Lodged %	Moisture at harvest %	Yield (@15.5%) bu/A
Fall Plow	None	7.4	2.2	24.6	7.9	28.2	135.3
" "	Conventional	6.8	1.8	25.0	6.4	27.7	131.8
" "	Field Cult.	6.1	1.5	24.0	6.7	27.8	136.2
Spring Plow	Conventional	6.8	1.5	25.0	5.8	27.3	134.9
Fall Chisel	"	6.0	2.5	25.4	3.0	28.5	130.8
" "	Field Cult.	5.8	2.8	24.9	6.1	29.1	133.1
" "	None	5.6	4.0	24.9	2.6	30.0	126.2
Spring Chisel	Conventional	6.4	2.8	24.1	6.8	29.2	139.9
" "	Disk	5.3	3.0	25.1	4.0	29.5	133.6
None	None	3.9	3.0	25.0	1.0	31.2	130.1
None	Disk	5.3	2.8	24.9	2.0	30.4	130.8
	Significance:	**	**	ns	ns	**	ns
	CV (%) :	12.9	25.8	5.0	86.6	2.6	5.1
	BLSD						
	.05 :	1.1	1.0			1.0	
	.01 :	1.5	1.3			1.3	

1/ Weed infestation rating of 1-5 : 1 = None 5 = Severe

no effect on the yield (r= -.006).

Other physical measurements as affected by certain tillage treatments were recorded during the growing season. Surface residue accumulation (mulch from the preceding corn crops) was shown to increase markedly with the chisel and no-tillage treatments (Table 2). These accumulations of 3.78 and 6.06 T/A, respectively, are more than 2x as high as in 1971, which shows the additive effect of leaving residues from continuous corn on the surface.

The effect of this mulch on the soil temperature is shown in Fig. 1. These measurements were obtained by using thermocouples installed two days after planting to a depth of 4" beneath the corn row. The minimum and maximum daily temperatures were averaged each day for approximately one month. During the early part of this period, the fall plow-field cultivate treatment showed a 2 to 3 ^{o}F advantage over the fall chisel-field cultivate treatment. Temperatures from the latter treatment were consistently to 1° higher than the no-tillage treatment. Later in the season the temperature differences among treatments were not as great, but the same pattern still held.

May was warmer than normal with temperatures ranging between 83 and 90° from the 16th. thru the 24th.. This resulted in soil temperatures rising well above 50° in all treatments. Consequently, emergence of corn was not affected by tillage treatment.

Depth to the perched water table was monitored in two

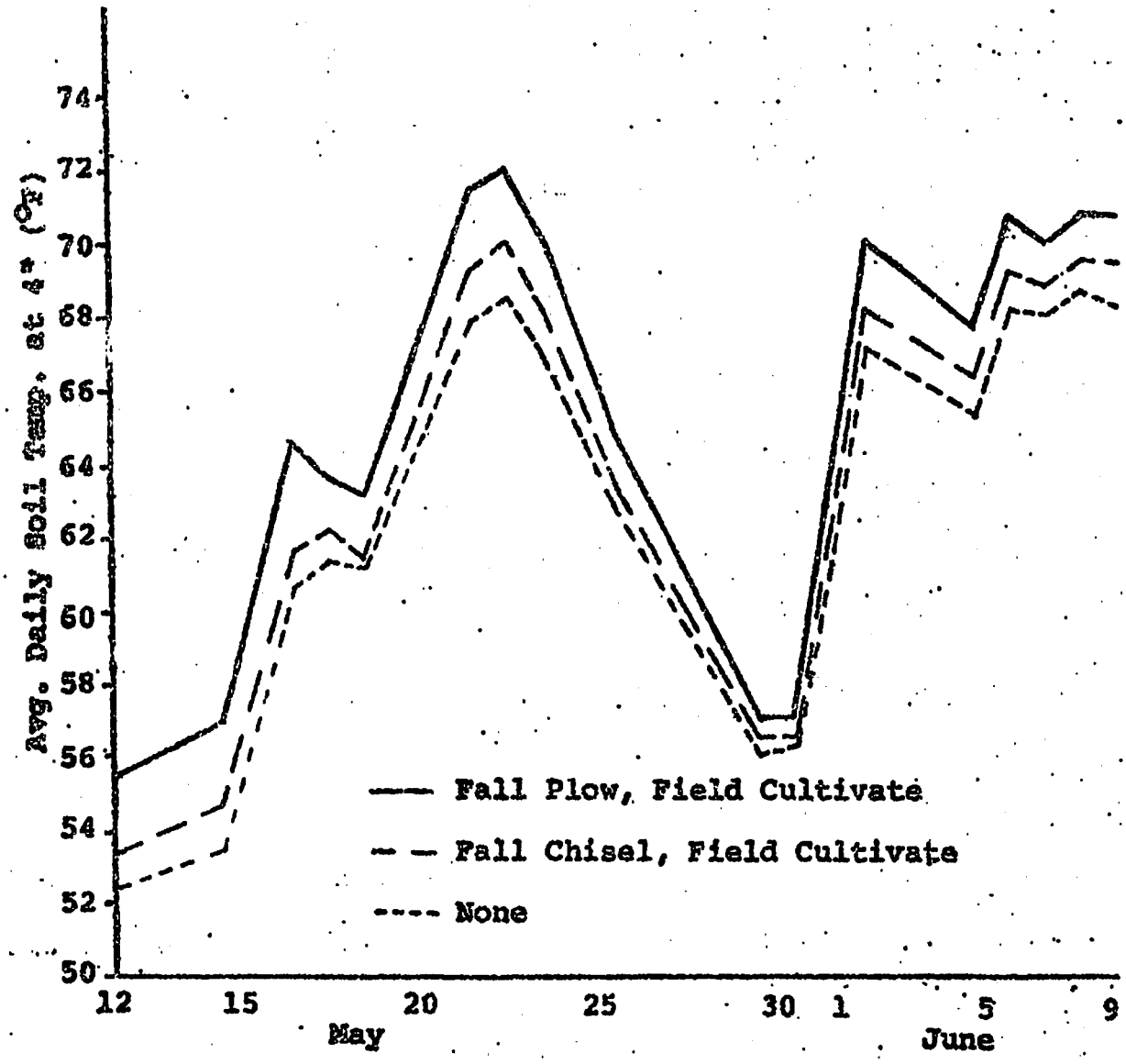


Fig. 1. Influence of three tillage treatments on the 4" soil temperature from May 12 thru June 9.

Table 2. Effect of primary tillage treatments on the surface residue accumulation after three years of continuous corn at Waseca.

Tillage treatment		Surface residue
Primary	Secondary	T/A (Dry Matter)
Fall Plow	None	Trace
Fall Chisel	None	3.78
None	None	6.06

tillage treatments from late June thru mid-September with open-end, 2-inch plastic pipes (Fig. 2). Differences between the water table levels of the fall plow-field cultivate and the no tillage treatments were not apparent throughout the season. The effect of the high July rainfall (7.74", which is 4.48" above normal) is shown by the water table rising from 46" on June 29 to 27" on Aug. 1. August precipitation (1.54") was 1.94" below normal and is reflected by the water table dropping to 60" on Sept. 11. With the water table varying from 27" to 60" during the growing season, it is doubtful that available soil moisture was limiting in 1972.

Attempts were made to take neutron probe moisture data on two tillage treatments throughout the 1972 growing season (Fig. 3). Four stoppered tubes were placed in each of the two treatments from two replications. A complete set of measurements was taken on June 29. Due to the high July rainfall, measurements were not taken until Aug. 28.

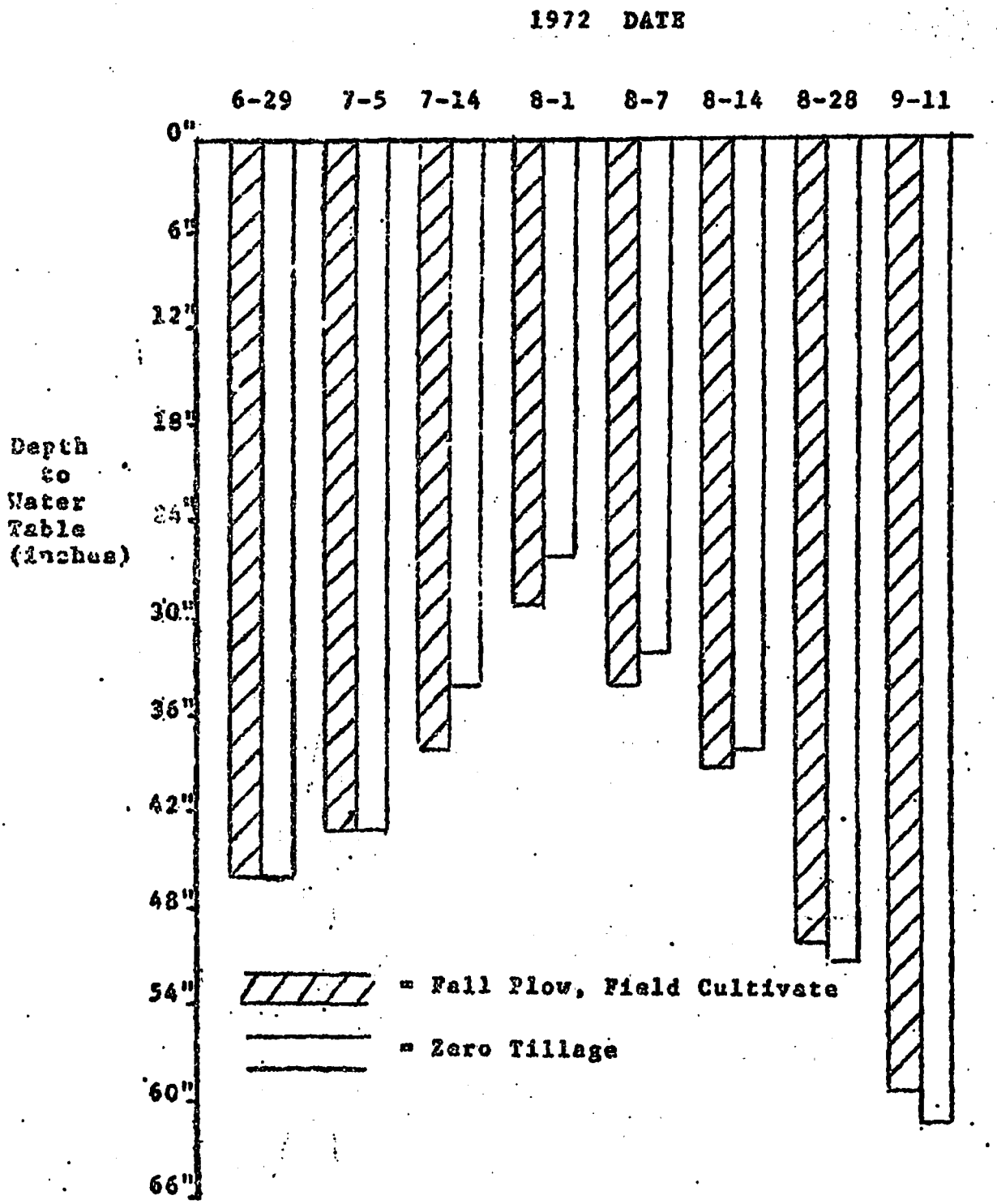


Fig. 2. Water table fluctuation during the 1972 season under two tillage systems.

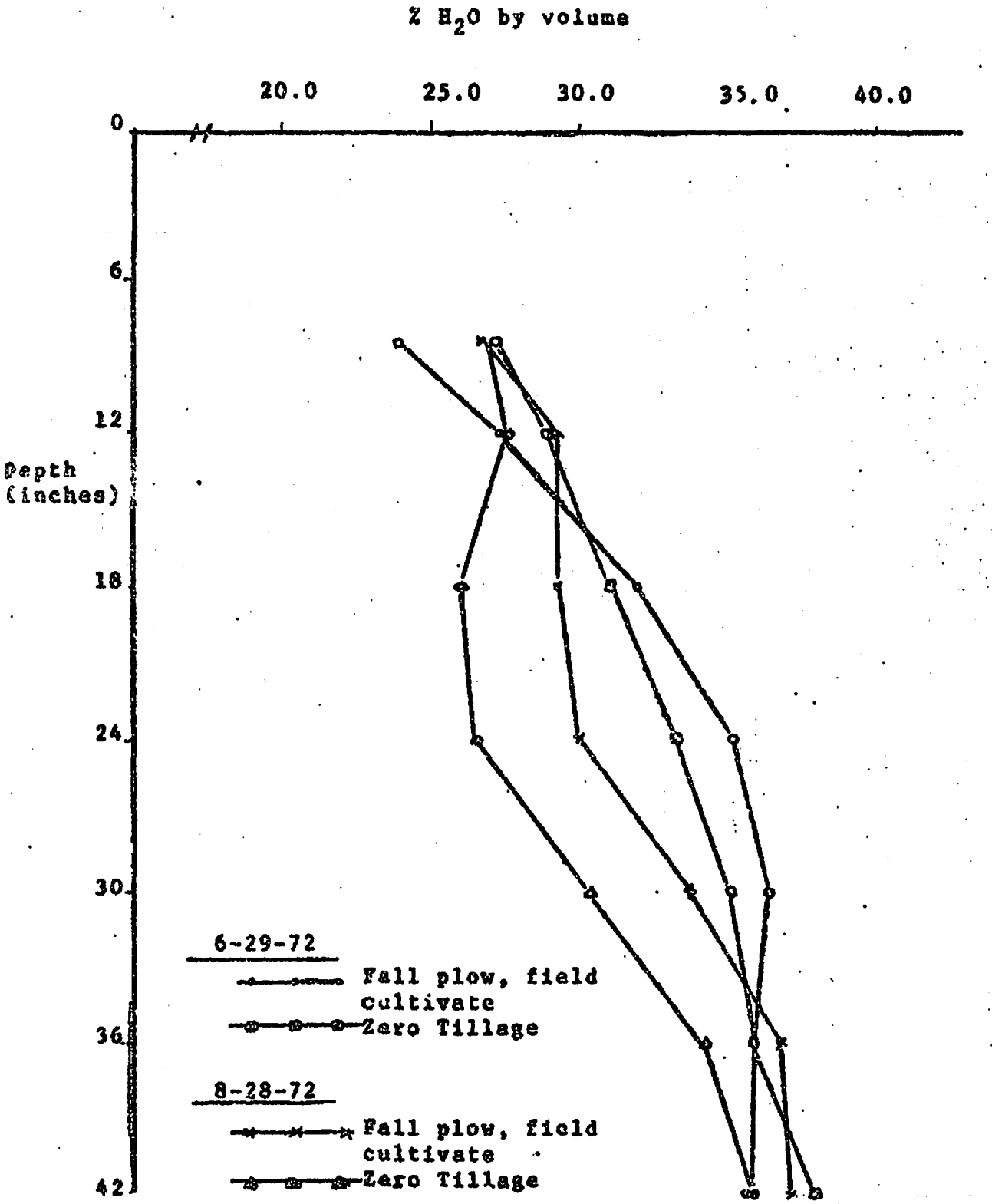


Fig. 3. Effect of tillage treatment on % H_2O by volume at two different dates at Waseca.

Instrumental problems terminated further measurements. In late June soil moisture at the 8" and 12" depths was higher for the no tillage treatment than for the fall plow-field cultivate treatment. This may have been due to the lesser plant growth on the no tillage treatments and the absence of tillage which promotes surface evaporation. However, at the 18, 24 and 30" depths in both June and August, the moisture was greater when fall plowed and field cultivated. This would indicate that infiltration conditions on the tilled treatments were better which allowed the spring and summer rains to soak in rather than partially running off as was the case for the no tillage treatment.

LIME PLOTS, WASECA, 1972

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

A field experiment was established at the Southern Experiment Station in spring of 1971 to study the effects of liming on yield and chemical composition of corn, and chemical properties of soil[1]. In 1971, lime treatments did not affect corn yield and had no effect on the chemical composition of leaf tissue. This investigation was continued in 1972.

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

Passing 8 - Mesh Sieve 96.3%

Passing 60 - Mesh Sieve 38.7%

Calcium Carbonate Equivalent 96.4%.

The lime rates used were as follows: 0, 2.5, 5.0, 7.5, 10.0 tons per acre. The treatments were replicated six times. Limestone was applied on April 26, 1972. Individual plots were 20 feet wide and 30 feet long. Average soil test results of samples collected prior to the establishment of the experiment are given in Table 1.

Table 1. Soil test results (soybean - alfalfa area, April 1972).

Area	Soil pH	SMP Buffer Index	P LB/A	K LB/A	Zn ppm	S ppm	Lime Requirement Tons/A
Soybeans	5.5	6.0	100	290	3.5	19	6.5-7.5
Alfalfa	5.5	6.1	105	290	3.3	15	5.5-7.0

[1] See "A Report on Field Research in Soils," Soil Series 88, March 1972, pp. 140-141, for results obtained during 1971.

Following is information on management practices, yields, etc. of the three lime experiments during 1972.

Corn

All plots received the following: (a) 193+74+95 LB/A of plant nutrients, expressed as N, P_2O_5, K_2O; (b) herbicide: pre-emergence Sutan 3 LB/A, post emergence atrazine and oil 2 LB/A and 1 1/4 GAL/A; (c) insecticide: Furadan 1 LB/A. Pioneer 3582 Hybrid was planted on May 9, planting rate: 26,000. Corn was cultivated on June 13.

The yield of corn and chemical composition of sixth leaf at tasseling are given in Tables 2 and 3. Lime treatments had no effect on corn yield nor did they affect the concentration of nutrient elements in leaf tissue.

Soybeans

Corsoy soybeans were planted on May 16 in 30-inch rows, 9 beans per foot. All plots received the following: 13+34+45 LB/A of plant nutrients in row; herbicide: 1 LB/A Treflan.

The yield of soybeans and chemical composition of the upper-most mature trifoliate are given in Tables 4 and 5. Neither the yield nor the concentration of plant nutrients in soybean trifoliate were affected by lime treatment.

Alfalfa

Vernal alfalfa was seeded on May 12. All plots received: (a) broadcast 0+46+60 LB/A; (b) 1 LB/A Treflan. No yield was obtained in 1972.

Table 2. Yield of corn, Waseca lime plots, 1972.

Rate of Lime Tons/Acre	Yield Bu/Acre
0	116
2.5	110
5.0	112
7.5	108
10.0	113
Significance	NS*
CV,%	5

*NS - Treatment means not significantly different at the 5% level.

Table 3. Chemical composition of sixth corn leaf at tasseling, Waseca lime plots, 1972.

Rate of Lime	N	P	K	Ca	Mg	Zn	Cu	Mn	B	Fe	Al
	----------Percent in Dry Matter----------					------Parts Per Million in Dry Matter-------					
0	2.56	.32	1.88	.65	.25	39	9	72	6	116a	37
2.5	2.53	.34	1.92	.63	.26	39	9	68	7	115a	34
5.0	2.54	.33	1.86	.66	.27	39	9	60	7	115a	33
7.5	2.61	.34	1.96	.69	.28	45	9	67	7	130b	45
10.0	2.44	.34	1.92	.64	.27	39	9	58	6	120ab	37
Significance	NS	NS	NS	NS	NS	NS	NS	NS	NS	*	NS
CV,%	4	5	6	7	11	11	9	20	8	6	20

Table 4. Yield of soybeans, Waseca lime plots, 1972.

Rate of Lime Tons/Acre	Yield Bu/Acre
0	51
2.5	51
5.0	49
7.5	52
10.0	51
Significance	NS
CV,%	9

Table 5. Chemical composition of soybean trifoliate, Waseca lime plots, 1972.

Rate of Lime	P	K	Ca	Mg	Zn	Cu	Mn	B	Fe	Al
	-----Percent in Dry Matter-----				-------Parts Per Million in Dry Matter-----					
0	.46	2.10	1.09	.37	46	7	61	47	88	25
2.5	.48	2.18	1.08	.38	45	7	53	47	95	34
5.0	.44	2.0	1.07	.38	44	7	53	45	92	27
7.5	.46	2.13	1.09	.38	46	8	54	47	93	27
10.0	.47	2.09	1.06	.37	67	4	55	47	94	30
Significance	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
CV,%	7	6	8	8	51	248	15	5	7	26

DETERMINING NITROGEN NEEDS FOR CORN

W. E. Fenster and C. J. Overdahl

In the fall of 1969, nitrogen experiments were established with continuous corn on highly productive land to determine what rates of nitrogen would result in highest economic yields with a minimum of nitrate movement through the soil profile. It is quite apparent that both nitrification and denitrification play major roles in ascertaining amounts of fertilizer nitrogen that should or should not be applied, in any given year, on fine textured, high organic matter soils. This is well illustrated in the Waseca experiment where, in 1971, nitrogen deficiency was noted with nitrogen applications up to and including 200 pounds per acre. After the soil had warmed up in the spring of 1971, excessive amounts of rain kept the soil waterlogged for a period of about 2 or 3 weeks after which time very little moisture fell for the rest of the season. These weather conditions were ideal for excess denitrification (loss of nitrogen to the atmosphere) early in the year and very little nitrification (the forming of nitrates from ammonium forms) later in the summer and early fall. The combination of these two biotic reactions caused severe N deficiency, even with N applications normally considered adequate for maximum corn production.

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

The yield, tissue, and nitrate-nitrogen results from the Waseca experiment are given in tables 1-3.

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

N (lbs/A) annually	Yield (bu/A) 1971	1972
0	43 a	118 a
50	63 b	138 b
100	93 c	134 b
150	131 d	144 b
200	144 e	141 b
400	151 f	144 b

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

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

The soil is classified as Webster silty clay loam.

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

N (lbs/A	1971 %	1972 %
0	1.5	2.4
50	1.7	2.6
100	2.2	2.6
150	2.6	2.7
200	2.9	2.7
400	3.0	2.7

* sixth leaf at tasseling

Table 3. Amount of nitrate-nitrogen in the soil profile on continuous corn in Waseca county.

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

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

Two adjacent nitrogen experiments, one on continuous corn and one established to continuous corn on a virgin soil, were also established in Martin County. The continuous corn experiment was established the same time (fall 1969) as the Waseca experiment and the one on the virgin soil was established one year later. In 1972, a hail storm severely damaged the corn crop. Because of this, the yields are quite low and no meaningful statistical analysis could be run. Also, because of this hail damage, it is apparent that the crop did not draw down the nitrogen in the soil at a normal or expected rate. Yield, tissue, and nitrate-nitrogen results from these experiments are given in the following tables for the years 1971 and 1972.

Table 4. Martin county corn yields as influenced by nitrogen treatments (8 replications).

N (lbs/A) annually	Yield (bu/A) Continuous corn plots 1971	Continuous corn plots 1972	Virgin plots 1971	Virgin plots 1972
0	130 a[1]	68 [2]	179 a	103
50	142 b	78	190 bc	107
100	151 b	68	187 bc	88
150	144 b	76	183 b	103
200	147 b	69	194 c	96
400	153 b	64	190 bc	103

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

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

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

Table 5. Percentage nitrogen in tissue* (July) as related to nitrogen application on corn in Martin county.

N (lbs/A)	% Nitrogen in Tissue Continuous corn 1971	Continuous corn 1972	Virgin plots 1971	Virgin plots 1972
0	2.5	2.4	2.8	2.9
50	2.7	2.9	2.7	2.8
100	2.6	2.8	2.8	2.8
150	2.9	2.7	2.8	2.8
200	2.9	2.9	2.8	2.9
400	2.9	2.7	2.9	2.8

* sixth leaf at tasseling

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

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

Average of 4 replicates.

Table 7. Amount of nitrate-nitrogen in the soil profile on virgin soil planted to corn in Martin county.

Soil Depth (ft.)	ppm NO_3-N Treatment - lbs N per acre applied 0		50		100		150		200		400	
	1971	1972	1971	1972	1971	1972	1971	1972	1971	1972	1971	1972
0-1	17	10	19	17	24	17	15	30	31	24	40	22
1-2	10	6	23	14	32	24	29	38	47	33	32	42
2-3	7	6	9	18	8	25	14	32	14	28	11	56
3-4	3	6	5	11	4	15	5	16	4	21	5	45
4-5	3	5	3	9	4	11	5	12	6	16	3	31
5-6	4	5	3	7	4	9	4	9	6	13	4	22

Average of 4 replicates.

NITROGEN FERTILIZATION OF CORN

Waseca, 1972

G. W. Randall and W. E. Lueschen

Two field experiments were initiated in the fall of 1971 and spring of 1972 to obtain additional information on nitrogen fertilization of corn in south-central Minnesota. Hopefully, results gained from these new studies will supplement information obtained from long-term experiments initiated in 1969 by Fenster, Overdahl and Frazier. Results from the initial experiments have been reported in Soil Series 87, 88 and again are reported herein.

Experiment I

To evaluate various sources of N fertilizer, an experiment involving four sources of N applied at two rates in both the fall and the spring was established at the Southern Experiment Station on a Cordova silty clay loam. The experimental design was a randomized complete-block, replicated four times.

Soil test P and K values were high. Broadcast rates of 26# P/A and 75# K/A were applied before fall-plowing on 11-8-71. All sources of N were fall-applied on 11-10-71 and spring applied on 4-28-72. Soil conditions for both the fall and spring applications were good with adequate moisture.

Corn (Minhybrid 4201) was planted at 24,000 ppA in 30" rows on May 11. Row fertilizer (11+13+32 lbs. N+P+K/A) and

an insecticide (1 lb. active Furadan) was applied at planting time. Weeds were controlled with a combination of Lasso + Atrazine herbicides applied preemergence and one cultivation. The leaf opposite and below the ear leaf was sampled August 8 and was submitted for analysis by Kjeldahl methods. Yields were obtained on October 9 by combine harvesting the center two rows from each plot.

Results

The weather conditions during the 1972 growing season were favorable for soil nitrification processes which probably supplied much of the needed N. Consequently, neither leaf N concentrations nor yields of corn were affected significantly by the 16 N treatments (Table 1). Nitrogen rates of 75# N/A, irregardless of N source or time of application, appeared sufficient for maximum yields under these expermental conditions.

Experiment II

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

To evaluate split applications of N fertilizer on these poorly drained, fine textured, high organic matter soils, an

Table 1. Effect of source, rate and time of application of nitrogen on the leaf N concentration and yield of corn at Waseca in 1972. (Experiment I)

Treatment				
Source	Rate	Time	Leaf N	Yield (@15.5%)
	lbs.N/A		%	bu/A
Anhydrous Am.	75	Fall	2.38	144.8
"	75	Spring	2.46	142.4
"	150	Fall	2.33	149.7
"	150	Spring	2.40	149.9
Urea	75	Fall	2.45	154.0
"	75	Spring	2.28	160.1
"	150	Fall	2.42	151.9
"	150	Spring	2.46	150.0
Am. Nitrate	75	Fall	2.44	153.7
"	75	Spring	2.30	153.2
"	150	Fall	2.35	140.8
"	150	Spring	2.40	147.7
Aqua Am.	75	Fall	2.50	147.4
"	75	Spring	2.29	151.1
"	150	Fall	2.42	151.7
"	150	Spring	2.21	147.8
Significance			ns	ns
CV (%)			6.6	6.0

Individual Factors:

Source

Anhydrous Am.		2.39	146.7
Urea		2.40	154.0
Am. Nitrate		2.37	148.8
Aqua Am.		2.35	149.5
	Significance	ns	ns

Rate

75# N		2.39	150.8
150# N		2.37	148.7
	Significance	ns	ns

Time

Fall		2.41	149.2
Spring		2.35	150.3
	Significance	ns	ns

experiment was established on a LeSueur clay loam soil on the Roy Lukken farm, which is the site used by Fenster, Overdahl and Randall in other corn fertilization studies. The site for this experiment has 92% of its area within 50' of tile lines, which should provide adequate internal drainage. The experimental design was a randomized complete-block, replicated five times.

Corn had been grown continuously on this site since 1969 with an annual N application of 200# N/A. Broadcast rates of 66# P/A and 166# K/A were applied annually before fall plowing. The first application of N was applied and disked in on May 8. Three of the treatments received a split application of N to the soil surface on June 15 and were followed immediately by cultivation to incorporate the fertilizer. Ammonium nitrate was the N source for all treatments.

Corn (Northrup King PX 47E) was planted at 26,000 ppA in 30" rows on May 9. Row fertilizer (13+15+37 lbs. N+P+K/A) and insecticide (1 lb. active Furadan) was applied at planting time. Weeds were chemically controlled with a combination of Lasso + Atrazine applied preemergence plus one cultivation. The leaf opposite and below the ear leaf was sampled on July 24 and was submitted for analysis by Kjeldahl methods. Yields were obtained by hand harvesting 16' of row from each of the center two rows of each plot.

Results

Leaf N was increased significantly over the check by the N rates (Table 2). However, no significant differences were

noted among the concentrations due to the rates above and including 100#/A.

Table 2. Effect of rate and application method of nitrogen on the leaf N concentration and yield of corn at Waseca in 1972. (Experiment II).

Treatment Date and Rate				
5-8-72	6-15-72	Total N Applied	Leaf N	Yield (@15.5%)
lbs.N/A		lbs./A	%	bu/A
0	0	0	2.27	154.0
50	50	100	2.47	157.1
100	0	100	2.47	150.7
100	100	200	2.54	160.6
200	0	200	2.42	156.6
250	0	250	2.53	149.7
150	150	300	2.44	155.4
300	0	300	2.49	151.7
		Significance	*	ns
		CV (%)	4.3	6.1
		BLSD (.10)	.12	
		(.05)	.15	

A combination of the weather conditions during 1972 and the past high fertility program probably accounted for the lack of yield response. Apparently, adequate amounts of N required for maximum corn yields were produced by soil nitrification reactions. During 1972, weather conditions which may promote denitrification did not exist. Consequently, split applications of N did not improve corn yields over single applications.

BROADCAST PHOSPHORUS AND POTASSIUM FOR CORN ON HIGH TESTING SOILS

C. J. Overdahl and W. E. Fenster

This was the third year of the broadcast experiment in Martin and Waseca counties. In 1972, similar trials for potassium were initiated in Chippewa and Kandiyohi counties.

The soil test level and plant analysis of the check plots are the best observation point in evaluating response or the lack of it. In Martin County (table 3), there was a significant response to potassium. Soil tests from year to year are quite variable.

In spite of no broadcast response on the P plot in Martin County and on the K plot in Chippewa County, there was a response due to row fertilizer.

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

Table 1. 1970, 1971 and 1972 corn yields, plant analyses and soil tests in Martin County according to broadcast phosphorus treatment. (200+0+300+20 Zn applied over all phosphorus plots)

P_2O_5	Yields bu/acre			% P leaves			Soil Test P lbs/acre		
lbs/acre	1970	1971	1972	1970	1971	1972	1970	1971	1972
0	155	137a	136	.26	.28	.38	46	37	47
50	151	137a	127	.26	.27	.37	36	39	47
100	162	156b	136	.27	.30	.40	56	55	96
150	146	146ab	129	.28	.30	.40	65	63	94
200	145	154ab	130	.28	.30	.44	64	55	109
	N.S.	10%	N.S.						

	1970	1971	1972
Avg. starter response	4*	2	7*
Avg. % N in leaves	-	2.7	2.7
Avg. K soil test	263	352	488
Avg. % K in leaves	1.70	1.88	1.83
Avg. soil pH	7.7	7.2	7.3
Avg. Zn leaves ppm	19 low	17 low	22 suf.
Avg. Zn soil ppm	-	5.3 high	-

Efforts of Dean Fairchild, Bob Schoper, Charles Behrens, Bob McCaslin, Floyd Bellin, Martin Co. Extension Agent and Dick Lambert, Martin Co. Associate Extension Agent are greatly appreciated.

Table 2. 1970, 1971 and 1972 corn yields, plant analyses and soil tests in Waseca County according to broadcast phosphorus treatment. (200+0+200 applied over all phosphorus plots)

P_2O_5	Yields bu/acre			% P leaves			Soil Test P lbs/acre		
lbs/acre	1970	1971	1972	1970	1971	1972	1970	1971	1972
0	133	139	140	.31	.28	.29	34	27	39
50	136	133	142	.30	.27	.30	31	33	62
100	132	132	144	.28	.27	.32	31	40	91
150	136	135	141	.29	.30	.35	40	44	87
200	138	130	144	.29	.30	.33	53	45	79

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

Table 3. 1970, 1971 and 1972 corn yields, plant analyses and soil tests in Martin County according to broadcast potassium treatment. (200+150+0+20 Zn applied over all potassium plots)

K_2O	Yields bu/acre			% K leaves			Soil Test K lbs/acre		
lbs/acre	1970	1971	1972	1970	1971	1972	1970	1971	1972
0	156	148	120a	1.7	1.8	1.6	202	230	295
50	147	154	127ab	1.7	1.8	1.6	212	258	360
100	152	149	129ab	1.6	2.1	1.8	222	278	328
200	147	143	130ab	1.8	2.1	1.9	270	328	415
400	160	149	132b	1.8	1.9	2.1	243	320	490
			5%						

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

Table 4. 1970, 1971 and 1972 corn yields, plant analyses and soil tests in Waseca County according to broadcast potassium treatment. (200+150+0 applied over all potassium plots)

K_2O	Yields bu/acre			% K leaves			Soil Test K lbs/acre		
lbs/acre	1970	1971	1972	1970	1971	1972	1970	1971	1972
0	134	123	136	1.6	1.4	1.3	260	210	282
50	129	120	138	1.7	1.7	1.5	275	213	322
100	139	131	139	1.7	1.7	1.7	260	220	318
200	132	116	141	1.8	1.8	1.9	262	223	352
400	134	120	143	2.2	1.9	2.1	312	310	478
	N.S.	N.S.	N.S.						

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

Table 5. 1972 corn yields, plant analyses and soil tests in Kandiyohi County related to broadcast potash treatments. Russell Schow farm. (200+150+0+20 Zn applied over all plots)*

K_2O lbs/acre	Yields bu/acre	% K leaves	Soil Test K lbs/acre
0	146	1.86	430
50	146	1.78	460
100	147	1.91	410
200	142	1.92	440
400	142	2.00	500

Avg. starter response	7 bu/a
Avg. % N in leaves	2.8
Avg. P soil test	87 lbs/a
Avg. % P in leaves	.36
Avg. soil pH	7.6
Avg. Zn in leaves ppm	19 suf.

* Efforts of Marvin Olson, Kandiyohi Extension Agent, Philip Ness, Asst. Extension Agent, Kandiyohi Co., and J. E. Ellis, Area Extension Agent, Soils, are gratefully acknowledged.

Table 6. 1972 corn yields, plant analyses and soil tests in Chippewa County related to broadcast potash treatments. Bernard Brummer farm. (200+150+0+20 Zn applied over all plots)*

K_2O	Yields	% K	Soil Test
lbs/acre	bu/acre	leaves	K lbs/acre
0	172	1.65a	278
50	176	1.68ab	304
100	171	1.85c	317
200	177	1.83bc	330
400	174	1.93c	402

Avg. starter response	10** bu/a
Avg. % N in leaves	2.4
Avg. P soil test	40 lbs/a
Avg. % P in leaves	.33
Avg. soil pH	7.7
Avg. Zn in leaves ppm	11 low

Boron Trial on Corn

A boron trial was superimposed on the potash experiment in Waseca County by Dr. Randall from the Southern Experiment Station at Waseca. He applied 2 pounds of boron per acre on 4 replicates and none on the other 4. There were no differences in yield due to boron in 1972.

	Boron Added	No Boron	
Yield bu/a	137	141	N.S.
B ppm leaves	9	7	N.S.

The boron content in 1971 was on the borderline of being insufficient, probably due to dry weather. In 1972, rainfall was more plentiful.

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* Efforts of Orville M. Gunderson, Area Extension Agent, Soils, Roger Larson, Chippewa County Extension Agent and Gary Miest, Chippewa County Associate Extension Agent are gratefully acknowledged.

STALK ROT AS INFLUENCED BY BROADCAST K

Stalk rot diseases leading to the lodging of corn were quite prevalent in southern Minnesota in the fall of 1972. Climatic conditions during the summer were primarily responsible for the incidence of these diseases. In addition, certain hybrids appeared more susceptible than others.

Application of K fertilizers commonly has been shown to reduce stalk lodging of corn. To determine the effects of broadcast K applied to these fine textured, high K-testing soils, the incidence of stalk rot and lodging was noted in the K experiment. The rotting of the stalks was measured at harvest by squeezing the internodal area between the first and second nodes above ground on 40 plants per plot. If this area collapsed easily, the stalks were considered hollow as a result of the disease organisms. The term "hollow stalks" was then considered to be a measurement of stalk rot.

Results

The incidence of hollow stalks was reduced significantly by the broadcast K treatments; however, differences did not exist among the K rates (table 1). Fifty pounds of broadcast K_2O, in addition to the row-applied K, reduced the "hollow stalk" numbers as much as any K treatment.

Although many of the stalks were hollow, the exterior shell of the corn stalk appeared very strong. With the rigid, sturdy shell prevailing on this corn hybrid, lodging was minimal and was not affected by broadcast K treatments.

Table 1. Effect of broadcast K on the hollow stalk incidence and lodging of corn.

Broadcast[1] K Rate lbs. K_2O/A	Hollow Stalks %	Lodging %
0	45.0	3.4
50	33.4	2.2
100	34.4	2.2
200	33.4	2.8
400	29.7	5.3
Significance	+	N.S.
CV (%)	31.	110.
BLSD (.10)	11.1	

[1] In addition, all plots received 45 lbs. K_2O/A as a row treatment.

SOYBEAN-NITROGEN FERTILIZER RATE AND PLANTING DATE STUDY

G. E. Ham and G. W. Randall

Ammonium nitrate at the rate of 50 and 100 pound nitrogen per acre was plowed down the preceding fall with the corn residues. Soybean varieties, number of seeds per foot of row, planting date and seed yields are shown in Table 1. Only the seed yield of Corsoy planted on May 8th was increased significantly.

Table 1. Effect of nitrogen rates, planting date and soybean genotype on soybean seed yield at Waseca (1972).

Date planted	Soybean variety	Number seeds planted	Nitrogen applied (lb/acre) 0	50	100
		ft.row^{-1}	----------bu/acre-------		
May 8	Steele	6	44	42	45
	Steele	10	41	42	42
	Corsoy	10	44	49*	52*
	Teweles 505	6	42	39	40
	Teweles	10	40	40	41
June 7	Steele	6	39	42	39
	Steele	10	37	36	36
	Corsoy	10	40	40	38
	Teweles	6	33	33	33
	Teweles	10	34	31	31

* Yield significantly greater than the check of the same variety.

FERTILIZER RATE STUDY WITH "NEW" VARIETIES OF TIMOTHY AND KENTUCKY BLUEGRASS-1972[1]

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

Three field experiments were conducted on mineral soils in 1972 to study effects of N, P, K rates on seed production of timothy and bluegrass varieties that are being introduced in northwestern Minnesota. These experiments were established on growers' fields in fall of 1970.

Past experimental work in Minnesota had been mainly with Park Kentucky Bluegrass and Climax Timothy. Attention has been focused on optimum rates of fertilizer, time of fertilization, and the needs for sulfur and trace elements.

Grass seed production in Minnesota is expanding and under-going some changes. A number of growers are producing timothy seed under contract for foreign markets, and seed of several new bluegrass varieties is produced by some growers. Continued research is required to keep abreast of these new developments.

General information on the experimental sites is given in Table 1. Soil tests of samples collected in summer of 1971 indicated high P and K availability for field no. 1, while the soil test results for field no. 2 and 3 indicated low P and K availability. The soils are alkaline on all three fields.

A randomized block design was used with nine treatments replicated four times. Individual plots were 9 feet wide and 20 feet long. The fertilizer treatments were as follows:

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[1] See "A Report on Field Research in Soils," Soil Series 88, March 1972, pp. 159-167 for results obtained from similar investigations conducted in 1971.