ZINC AND IRON TRIALS ON FLAX - 1971

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This trial was started in 1970 to determine if flax would respond to zinc and iron fertilization. Sequestrene 138 iron and sequestrene zinc chelates were broadcast before planting and rotovated into the soil. In order to eliminate any soil nitrogen deficiency in the plot area, 120 lb per acre of ammonium nitrate were broadcast and rotovated into the soil before planting. Soil analysis is given at the bottom of table 1. Summit at 40 and Nored at 30 lb per acre were sown on May 3 and emerged May 12. The plots were harvested on September 14.

The results of zinc and iron on Summit and Nored Flax are given in table 1.

Table 1. Effect of zinc and iron on yield, oil content, and iodine value of Summit and Nored flax, 1971.

Treatment	Rate lb/A	Fertilizer lb/A	Yield bu/A	Oil content % oven dry	Iodine value No.
Summit					
Check	0	63	21.8	38.9	194
Check	0	125	22.4	38.5	193
Zinc	0.36	32	18.8	39.1	192
Zinc	0.72	63	21.7	38.1	192
Iron	0.30	63	20.2	38.2	192
Iron	0.60	125	21.0	37.6	192
LSD 5%			13.5		
Nored					
Check	0	63	20.7	40.5	191
Check	0	125	18.5	39.9	189
Zinc	0.36	32	18.1	38.8	189
Zinc	0.72	63	21.3	38.6	189
Iron	0.30	63	22.4	39.3	189
Iron	0.60	125	20.0	38.8	190
LSD 5%			11.4		

Soil test: pH 8.3 P 160 lb/A
zinc 1.5 ppm K 550 lb/A

Both materials were coated on 18-46-0 at 8 lb per 100 lb of fertilizer. The heading "Fertilizer" in table 1 gives the amount of 18-46-0 that was applied to furnish the required amount of zinc and iron per treatment. The two check plots received 63 and 125 lb of 18-46-0 so that treatments could be compared.

The stands were poor and variable and this is reflected in the high LSD values. The additon of zinc and iron did not increase the yield of Summit flax, or affect the oil content or iodine value. The two check plots had the highest yields, which might suggest that fertilizer was more important than the zinc and iron treatments.

Two treatments - zinc at 0.72 and iron at 0.30 lb - increased the yields of Nored flax, but the results were not significant. There was no essential effect on the oil content or iodine value of Nored Flax.

Table 2 gives the average results for 1970 and 1971. Two-year data show that Summit was the best yielder. The check with 125 lb fertilizer had the highest 2-year average yield. The additon of zinc and iron did not significantly increase the yield, oil content or iodine value of either flax variety.

Table 2. Effect of zinc and iron on yield, oil content, and iodine value of Summit and Nored flax, 1970-71

Treat-ment	Rate lb/A	Fertilizer LB/A	Yield bu/A	Oil content % oven dry	Iodine value No.
Summit					
Check	0	63	20.5	39.5	192
Check	0	125	22.4*	38.5*	193*
Zinc	0.36	32	21.7	39.6	190
Zinc	0.72	63	22.4	38.8	189
Iron	0.30	63	20.2	39.1	191
Iron	0.60	125	20.5	38.3	190

* 1971 Data

Continued

Table 2. Continued

Treat-ment	Rate lb/A	Fertilizer lb/A	Yield bu/A	Oil content % oven dry	Iodine value No.
Nored					
Check	0	63	17.7	40.9	192
Check	0	125	18.5**	39.9	189**
Zinc	0.36	32	17.0	39.8	191
Zinc	0.72	63	18.3	39.8	191
Iron	0.30	63	18.5	40.1	191
Iron	0.60	125	18.3	39.8	192

**1971 Data

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1971 FERTIGATION OF CORN ON A HUBBARD LOAMY COARSE SAND IN SHERBURNE COUNTY

John MacGregor, Dean Fairchild and Robert Munter

Nearly 15 percent of potential agricultural soils in Minnesota are comparatively sandy in texture. The hazard of drouth, combined with low native fertility, has resulted in minimal use of such areas for crop production purposes. Many less sandy soil areas also have less than optimum crop production in years when soil moisture becomes inadequate following insufficient or uneven precipitation distribution. Supplemental irrigation by various types of sprinkling systems has now become quite commonplace, especially with improved equipment and the discovery that many such drouthy soil areas are underlain by ample water suitable for irrigation purposes. Since all of the nutrient elements essential for plant growth can be obtained in water soluble forms, and fed to plants during the growing season, the question arises as to how much and how often fertilizer materials should be added in the irrigation water. Publications on the equipment necessary for this fertigation are available from the Department of Agricultural Engineering on the St. Paul Campus.

While phosphorus, potassium, and other nutrient elements may be necessary at times, the relatively low organic matter content of sandy soils means low available soil nitrogen levels. Since fertilizer nitrogen is relatively inexpensive, very soluble, and is readily transported in soil moisture, the high porosity and downward movement of excess moisture in such soils of low water holding capacity raises the question of how much fertilizer nitrogen could a crop of corn grown each year profitably use. In addition to the financial loss of applying nitrogen not used by the growing corn, the unused nitrogen

is readily leached beyond the reach of corn roots, and can be one source of pollution to adjoining water supplies.

The initiation of the irrigated field research station near Elk River earlier in 1968 provided an excellent opportunity to study the fertilization of corn grown each year under irrigation of the Hubbard loamy coarse sand. The soil had a pH of 5.0 to 5.4, organic matter was medium, the extractable phosphorus was very high at 200 lbs/A, with a medium potassium level of 210 lbs/A. Soil sulfur was low at 5 lbs/A and zinc was high at 2.3 lbs.

Since the experimental area soil was extremely variable in soil organic matter and the previous fertility treatments were unknown, corn was planted in 1968 with no fertility treatments to observe variability in corn growth. Observations confirmed considerable variation in corn growth and yield, and it was decided that six replications of each fertility treatment would be necessary. All nitrogen and potassium treatments were broadcast in dry form by hand, rather than by injection into the irrigation water.

1969 Study

No lime was applied, the land being plowed in mid-May and planted on May 27 to provide 23,000 plants per acre. Fertilizer phosphorus was row applied over the entire area, using the planter attachment to supply 43 lbs of P/A (100 lbs P_2O_5.) Potassium was broadcast (as KCl) to supply 0, 75, 150 and 300 lbs of K/A (0, 125, 250 and 500 lbs K_2O/A.) The nitrogen was applied as split broadcast treatments of ammonium nitrate, half at planting and the remainder one month later to supply 0, 100, 200, and 400 pounds of N per acre. Considerable vegetative burning damage resulted where the 400 lbs rate of N was

broadcast late in June, which probably decreased the ear corn yields on this treatment. Rainfall during the growing season totalled 11.5 inches, with a total of 14.75 inches being applied in weekly irrigations. The following corn yields were obtained:

Table 1. 1969 Corn yields with varying rates of nitrogen and potassium fertilization on a Hubbard loamy coarse sand in Sherburne County. (Average of 6 replications.)

Fertilizer Treatments*	1969 Yield 15.5% bu/A
0 + 43 + 0	19.9 a**
0 + 43 + 75	25.4 a
0 + 43 + 150	37.9 a
100 + 43 + 0	90.5 b
100 + 43 + 150	98.3 b
100 + 43 + 75	98.9 b
200 + 43 + 150	104.5 bc
400 + 43 + 300	119.1 cd
200 + 43 + 0	121.8 cd
200 + 43 + 75	128.9 d

* Pounds per acre of N + P + K. Applied in 1969.

**Numbers followed by the same letter are not significantly different at the 5.0% level (Duncan's New Multiple Range Test.)

There were no significant yield differences due to potassium applications, whereas the nitrogen increased yields from 4.5 to 6.5 times that of the no-nitrogen treatments.

Plans had been made to sample soils from each plot to a depth of 20 feet each fall, to study applied nutrient movement and concentration, but the extreme stoniness at a 12" depth made soil sampling essentially impossible and this phase of the study was abandoned.

1970 Study

Since the deep soil sampling late in 1969 was not accomplished, and only the N treatment had increased corn yields, the 1970 corn was

planted with no initial fertility treatments to determine if a residual effect from any of the 1969 N treatments would be evident in 1970 corn growth with a population of 30,000 plants per acre. Growing season (4/13 to 11/21) rainfall totalled 25.87" and this was supplemented by 14.05" of irrigation water applied as needed. There was no apparent residual effect on corn growth where 100 or 200 lbs N/A had been broadcast one year previously, but some increased growth was evident until late in June where the 400 lbs N/A rate had been broadcast in mid 1969. Since the 1970 corn growing on the 100 and 200 lbs N/A 1969 treated areas showed no residual N to be available, the same N treatments (as those of 1969) were then applied in late June of 1970. No N was applied in 1970 to those plots where N had been applied in 1969 at the 400 lb/A rate. Both 1969 and 1970 fertility treatments and resulting corn yields are shown in Table 2.

Table 2. The 1969 and 1970 fertilizer treatments and subsequent corn yields on an irrigated Hubbard loamy coarse sand in Sherburne County. (Average of 6 replications.)

1969				1970				1969 + 1970
Soil treatment (lbs/A)			Corn yield (bu/A)	Soil treatment (lbs/A)			Corn yield (bu/A)	yield (bu/A)
N	P	K		N	P	K		
0	43	0	19.9a[1]	0	0	0	18.5a[1]	38.4
0	43	75	25.4a	0	0	0	24.5a	49.9
0	43	150	37.9a	0	0	0	39.7a	77.6
100	43	0	90.5b	100	0	0	99.8b	190.3
100	43	150	98.3b	100	0	0	110.7b	209.8
100	43	75	98.9b	100	0	0	120.5b	219.4
200	43	150	104.5bc	200	0	0	107.7b	212.2
400	43	300	119.1cd	0	0	0	39.3a	158.4
200	43	0	121.8cd	200	0	0	113.3b	235.1
200	43	75	128.9d	200	0	0	122.7b	251.6

[1]Numbers followed by the same letter are not significantly different at the 5.0% level (Duncan's New Multiple Range Test.)

It is evident that the nitrogen fertilization at the 400 lb/A rate applied one year previously had some residual yield effect and doubled the 1970 corn yields over corn plots having no N fertilization. However, the total two year yield was considerably less than with annual treatments of nitrogen at the 100 or 200 pounds per acre.

1971 Study

Since heavy N fertilization (400 lbs/A) showed only minor increases in corn yield the following year, it was possible that a further splitting of the N treatments over the entire growing season might be more effective. Since the maximum rate of nitrogen fertilization was only 200 lbs per acre in 1970, there would be little or no residual N remaining for the 1971 corn growth. Therefore, three rates of N fertilization were studied (100, 200, and 300 lbs/A): (1) all being broadcast at planting time, or (2) split into 4 applications made at intervals of one month, (3) split into 8 applications made at bimonthly intervals. The split applications could be easily made in the irrigation water. No other fertilizer was applied and the 1971 corn population was approximately 30,000 plants per acre.

The 1971 growing season was ideal, rainfall during the growing season totalling 15.5", and this was supplemented with 15.0" of irrigation water applied as needed. Corn yields are shown in Table 3.

Table 3. The 1971 yields and N content of corn grain and of corn leaves grown on irrigated Hubbard loamy coarse sand near Elk River with different rates and times of N fertilization. (Average of 6 replications.)

Total N Applied lbs/A	Time(s) of N application	lbs N/A application	% N in leaves	Bu corn /A @15.5% moisture	Corn Grain %N	Corn Grain lbs/A
None	-------	----	0.61	43 a[1]	0.92	19
100	5/11 (at planting)	100	1.19	92 b	0.82	28
100	5/11, 6/11, 7/11, 8/11	25	1.42	154 cd	1.06	77
100	5/11 and 26, 6/11 and 26, 7/11 and 26, 8/11 and 26	12.5	1.53	136 c	1.02	66
200	5/11 (at planting)	200	1.11	158 cde	0.99	74
200	5/11, 6/11, 7/11, 8/11	50	1.89	185 def	1.15	101
200	5/11 and 26, 6/11 and 26, 7/11 and 26, 8/11 and 26	25	2.10	192 f	1.23	112
300	5/11 (at planting)	300	1.15	173 def	1.02	84
300	5/11, 6/11, 7/11, 8/11	75	2.05	195 f	1.33	122
300	5/11 and 26, 6/11 and 26, 7/11 and 26, 8/11 and 26	37.5	2.43	189 ef	1.36	121

[1] Numbers followed by the same letter are not significantly different at the 5% level. (Duncan's New Multiple Range Test.)

It is evident that using limited amounts of nitrogen, (100 lbs/A) split applications are significantly more effective for increasing corn yields instead of a single time of planting application. While monthly fertilizer treatments resulted in higher corn yields, than from the eight treatments applied at fortnightly intervals, yield differences between the two split treatments were not of significance. Nitrogen removal was greatest with the monthly treatments.

Doubling the rate of nitrogen application to 200 lbs/A resulted in somewhat higher corn yields. Monthly treatments were not significantly greater yielding than the single treatment at planting, although splitting the treatments into eight 15 day periods produced significantly more corn than the single heavy fertilization at planting. The single, or four monthly applications at 200 lbs failed to significantly increase yields over the 100 lb N rate were split into 4 monthly applications. Nitrogen removal in corn grain increased with fertilization frequency.

As expected, the use of 300 pounds of nitrogen per acre resulted in much the same corn yield, whether applied at planting, at monthly periods, or when split amounts were applied twice in each of the four months. At this heavy N fertilization rate, N in the corn grain increased with monthly treatments but not with further splits.

A general conclusion might be drawn that a single nitrogen application at planting time to sandy, irrigated soils is inefficient and wasteful of fertility. The use of N at higher rates decreases the relative importance of split treatments. Monthly N fertilization supplying a total of 100 lbs/ N/A produced about 150 bushels of corn, doubling the monthly rate produced about 185 bushels whereas the monthly 75 lb N rate per acre resulted in 195 bushels of corn per acre. It would

appear that the most economic rate would be 200 lbs N/A applied in monthly or even more frequent intervals, thus maximizing N uptake and use by the growing corn, and minimizing N leaching losses and pollution of subsoil waters. The apparent maximum efficiency of the N fertilization, based on N removal in the corn grain was approximately 50% of the fertilizer N applied.

FIELD EXPERIMENTS WITH SOIL MODIFICATION ON AN IRRIGATED HUBBARD LOAMY COARSE SAND -- ELK RIVER STATION 1969-71

R. S. Farnham, D. S. Fairchild

In the spring of 1969, a project was initiated to study the possibilities of increasing crop yields by modifying the soil root zone environment to assure optimum air, water and nutrients. The following materials were installed as detention layers:

1. Peat
2. Wood products (low grade pulp)
3. Composted garbage
4. Manure
5. Calcined clay
6. Vermiculite

The layers were installed in two ways. One, an 18 inch band, 18 inches deep directly beneath the row and two, square plots were installed with a 14 foot by 14 foot continuous layer at 18 inches below the surface. In both types of placement the detention layer was 1/2 to 1 inch thick.

There is little replication within the experiment and data should be considered accordingly.

Snap beans and field corn were crops grown in 1970 and 1971.

Field Corn - 1970

The 1970 growing season at Elk River was characterized by a relatively wet spring and early summer, but with a dry July and August. A total of 25.0 inches of precipitation was recorded at the station. An additional 15 inches of water was added periodically by irrigation.

A 102 day corn variety was planted on May 8 at 29,000 plants per acre.

The fertility program included:

1. Preplant - 300 lbs./A gypsum,
2. Preplant - 72 + 144 + 144,
3. Side dress (6/19/70) - 67 lbs. N/A, and
4. Side dress (6/29/70) - 83 lbs. N/A.

Total N + P_2O_5 + K_2O fertilizer applied was 224 + 144 + 144. The frequency of nitrogen application being very important on these coarse textured irrigated soils. Corn yields were excellent in 1970 with a definite trend of a treatment response with soil modification versus the checks.

Table 1. Corn Yields with Soil Modification Treatments on a Hubbard Loamy Coarse Sand (1970).

Treatments	1970 Bu./A 15.5% H_2O	
No Bands		
Checks	120	
	141	Average
	145	135
Continuous Layers (Square 14' X 14' Plots)		
Reed sedge peat	134	
Sphagnum peat	184	
Hydromulch (wood product)	172	
Row Bands (18" wide)		
Hydromulch	183	
Composted garbage	174	
Reed - sedge peat	171	
Sphagnum peat	180	
Decomposed peat	183	
Vermiculite 1/2"	201	
Vermiculite 3/4"	154	
Vermiculite 1"	166	
Calcined clay	174	

Snap Beans - 1970

Snap beans were planted on June 22, 1970. A total of 12.5 inches of water was added periodically by irrigation. The fertility program included:

1. Preplant - 300 lbs/A gypsum,
2. Preplant - 40 + 80 + 80,
3. Side dress (7/22/70) - 40 lbs. N/A, and
4. Side dress (8/6/70) - 42 lbs. N/A.

Total N + P_2O_5 + K_2O fertilizer applied was 122 + 80 + 80.

The row band treatment yields responded consistently above the checks and continuous layer treatments. (Table 2). Row spacing was 18 inches.

Table 2. Snap Bean Yields with Soil Modification Treatments on a Hubbard Loamy Coarse Sand -- 1970 data.

Treatments	Total Yield lbs./A
No Bands	
Checks	8,233
	9,264
Continuous Layers (14' X 14' Square)	
Surface	9,641
Vermiculite	7,158
Vermiculite (roto-tilled)	10,019
Row Bands (18" wide)	
Metro organic 1/2"	18,528
Reed - sedge peat (field)	14,317
Reed - sedge peat (greenhouse)	16,654
Sphagnum peat	17,322
Vermiculite 1/2"	14,128
Vermiculite 3/4"	12,603
Vermiculite 1"	17,192
Calcined clay	15,144

Field Corn - 1971

In 1971 the same 102 day corn variety was planted with a population of 29,000 plants per acre. Fertilizer preplant and side dress nitrogen applications were the same as in 1970

Table 3 shows the yields of corn from these experiments. The highest yield (204 bushels per acre) was obtained using fresh reed-sedge peat. This yield was slightly higher than the highest 1970 yield (201 bushels). However, the 1971 data shows some rather erratic responses due to differential herbicide injury and spotty corn borer damage. The check plots were extremely variable ranging from a low yield of 144 to a high of 184.

All plots received about 1 inch of irrigation per week in addition to the rainfall.

The results of the past two years experiments are very encouraging despite the erratic 1971 yields and future investigations will deal with possibilities of reducing irrigation frequency and amounts. The detention layers obviously are contributing to higher yields of field corn.

Table 3. Field Corn Yields with Soil Modification Treatments. 1971 season.

Treatments	1971 Bu/Acre 15.5% H_2O
No Bands (check plots)	Ave. 160 Range 144 to 184
A. Square Plots (14' X 14' Layers)	156
Reed sedge peat	144
Sphagnum peat	188
Calcined clay	166
Vermiculite	154
B. Row Plots (18" bands)	
Hydromulch	146
Composted garbage	143
Reed-sedge peat (fresh)	204
Reed-sedge peat (composted)	146
Decomposed peat	148
Vermiculite 1/2"	136
Vermiculite 1"	144
Sphagnum peat	161
Calcined clay	142

Snap Beans - 1971

Several organic and inorganic detention layers were installed during early summer of 1971 and placed at only 12 inches below the surface of the soil instead of 18 inches as in previous studies. Snap beans were planted July 17th and yields taken on September 23rd.

The data in Table 4 shows the yields obtained with the different treatments. Spacings were 30 inches because of the location of detention layers instead of 18" as in 1970 studies. Yields in 1971 for these late planted beans were considerably lower than those in 1970 because of the wider spacings. Some increases were noticeable, though, due to detention layers and in most cases the beans were of much better quality where detention layers were used. This was particularly true where Sphagnum peat and manure were used. A higher percent of total yields were grades 1 and 2 fresh beans.

Table 4. Snap Bean Yields with New Detention Layers at Shallow Depths (12 inches). 1971 data

	Treatments	Yields lbs/acre GRADES			
		Size 1 (large)	2	3(small)	Total
1A	Reed-sedge peat	2875	1864	960	5699
1B	Reed-sedge peat	2948	1676	1411	6035
2A	Vermiculite	2823	2787	2161	7771
2B	Vermiculite	4427	366	767	5560
3A	Sphagnum peat	4792	3417	990	9199
3B	Sphagnum peat	2587	2756	2063	7406
4A	Check (disturbed)*	3203	2736	1496	7435
4B	Check (disturbed)*	1860	2544	1407	7221
5A	Manure	4389	2333	871	7593
5B	Manure	4844	1851	871	7566
6A	Sphagnum peat sheet	2525	2370	667	5612
6B	Sphagnum peat sheet	3502	2215	1411	7128
7	Composted garbage	3859	2239	697	6795
8A	Check (undisturbed)**	2718	2492	1716	6926
8B	Check (undisturbed)**	2866	2270	1460	6596

* Check (disturbed) - Soil removed and replaced.
** Check (undisturbed) - Regular field soil.

SUMMARY of Results to Date

Several organic and inorganic detention layers have been evaluated for two years at the Elk River irrigation station in an attempt to increase the yield and quality of crop plants by soil modification. Many of these materials look promising and continued research is planned to evaluate their economic potential and effectiveness as a management practice.

In the future soil modification practices may become increasingly more important for the following reasons:

1. Need for conserving water resources.
2. Reduce leaching losses of nitrogen and phosphorous and they reduce pollution of waters.
3. Alternative use for organic wastes.
4. Increase in economic returns through higher yields and improved quality of agricultural products.

1971 Frequency of Irrigation Study - Elk River

C. Klint, J. Swan, C. Turnquist, R. Machmeier, G. Titrud

Both Russett Burbank and Norland potatoes were grown. Potatoes were planted May 5 and harvested September 30.

Plowed	4/17
Disked	5/1
Herbicide	5/3 - 3 lbs/A (a.1) EPTC in 70 gal/A spray and disked immediately
Fertilizer	5/5 - 1000 lbs/A (8-16-16) banded at planting
Planted	5/5 - 36 inch rows x 11 inches spacing
Dragged	5/21
Sidedressed	6/8
	6/23 - 150 lbs/A (34-0-0) Norland
	300 lbs/A (34-0-0) Russett

Regular spray program followed.

Tensiometer readings were taken in two reps (2 1/3 and 3 1/2 day frequency) on each variety at approximately the 6 inch and 10-12 inch depth. Differences between treatments were small and recorded suction never exceeded 0.3 bar. The low suctions measured and slow response of the instruments may have been partly due to contact problems in the loamy coarse sand soil.

Two irrigation frequencies were compared on potatoes:

1. 1.25 inches of water every 3 1/2 days (2/week)
2. 0.90 inches of water every 2 1/3 days (3/week)

The irrigation frequencies were replicated 8 times.

Irrigation began June 15 and ended September 8.

Irrigation Dates and Amounts

Date	Pan Evaporation Since Last Irrigation	Rainfall Since Last Irrigation	2 1/3 Day Frequency	3 1/2 Day Frequency
June 15	--	--	1.0 inches	1.0 inches
22	--	--	1.0 inches	1.0
July 9	--	--	0.9	1.25
12	--	--	0.9	1.25
14	--	--	0.9	--
16	0.53	0.14	0.9	1.25
19	0.73	0.30	0.9	1.25
21	0.44	0.16	0.9	--
23	0.35	0	0.9	1.25
26	0.73	0	0.9	1.25
28	0.33	0	0.6	--
30	0.36	0.24	0.75	1.1
Aug. 2	0.66	0.10	0.9	1.25
4	0.28	0	0.9	--
6	0.41	0	0.9	1.25
9	0.58	0	0.9	1.25
11	0.56	0.04	0.9	--
13	0.54	0	0.9	1.25
16	0.73	0.02	0.9	1.25
18	0.53	0	0.7	--
23	0.95	1.75	0.9	1.25
25	0.36	0	0.9	--
27	0.37	0	0.9	1.25
30	0.69	0	0.9	1.25
Sept. 3	0.92	1.64	0.9	1.25
8	1.15	1.52	0.9	--
Total			23 inches	21.9 inches

1971 Yield and Specific Gravity - One Year's Data Only

Russett Burbank

Irrigation Frequency	Total Yield CWT/A	U.S. No. 1's CWT/A	Pickouts CWT/A	Undersize CWT/A	Specific Gravity	Total Solid Percent
3 1/2 day	478	446	14.6	18.0	1.080	19.7
2 1/3 day	491	453	22.7	15.4	1.081	19.9
Avg.	484	450	18.7	16.7	1.081	19.9

Norland

Irrigation Frequency	Total Yield CWT/A	U.S. No. 1's CWT/A	Pickouts CWT/A	Undersize CWT/A	Specific Gravity	Total Solids Percent
3 1/2 day	510	490	3.3	16.8	1.067	16.9
2 1/3 day	514	492	5.4	16.9	1.067	16.9
Avg.	512	491	4.3	16.8	1.067	16.9

ANOVA

	DF	Number 1's F	Total Weight F	Pickouts
Reps	7	4.07 * Sig at 5% level	3.23 N.S.	1.40 N.S.
Irrigation tmts.	1	0.15 N.S.	0.51 N.Ss	2.35 N.S.
Error A	7	--	--	
Variety	1	11.75 ** Sig at 1% level	5.68 * Sig at 1% level	14.64 * Sig at 1% level
Interaction	1	0.04 N.S.	0.15 N.S.	0.64 N.S.
Error B	14	--	--	
	CV=	7.26%	6.59%	92.4%

No significant differences were found in amount of undersized potatoes produced. CV = 22.9%

Conclusions:

For 1971, there was no significant differences in total yield, U.S. No. 1's undersized, pickouts or specific gravity for the two irrigation treatments. For the weather conditions present in 1971, the longer 3 1/2 day irrigation cycle gave results equal to the shorter 2 1/3 day cycle.

There was no significant difference in the weight of undersized or pickouts produced by the two irrigation frequencies.

The amount of No. 1 potatoes produced on the different replicates were significantly different (5% level). The effect of reps on total weight and amount undersized approached significance. Even though the plot area was only 160 x 160 feet square, the differences in soil and/or microclimate were apparently sufficient to cause measurable yield differences.

Norland outyielded Russett Burbank in both total weight and number 1's and had significantly fewer pickouts.

THE RELATIVE EFFECT OF THREE TVA SULFUR COATED UREAS IN COMPARISON TO AMMONIUM NITRATE ON CORN YIELD AND COMPOSITION GROWN ON AN IRRIGATED HUBBARD LOAMY COARSE SAND IN SHERBURNE COUNTY

J. M. MacGregor, R. C. Munter
D. S. Fairchild, H. Meredith, and B. D. McCaslin

An initial experiment on the relative availability of N from a low solubility sulfur coated urea fertilizer produced by the Tennessee Valley Authority for corn on an irrigated sandy soil was conducted in 1970. This low solubility form having 3.2% N available in 3 days, 10.4% in 7 days, or 1.8% daily was selected since soluble N loss would be nearing a maximum under the irrigated sandy soil condition and all of the applied N should be available in 48 days. All 1970 N treatments were made at the 100 lb N/A rate. The results (pp. 50-55, Soil Series 87) showed that N availability in this experimental fertilizer under field conditions was not sufficient for optimum corn growth, the grain yield being only 60.2 bushels per acre, compared to 13.4 for the check, urea + sulfur yielded 141.0 bushels, urea alone yield 144.8 bushels, and NH_4NO_3 produced 150.0 bushels. Nitrogen present in the corn grain was only 27.9 lbs/A with the S urea, whereas other N fertilizers removed from 75 to 81 lbs N/A. This low N utilization indicated a possible residual N effect in 1971 where the S urea had been applied in 1970.

Corn (TXS 102 F_6) was then planted in 30" rows on May 10, 1971 for a 30,000 plant population per acre. Herbicide consisting of 2 lbs. of atrazine and 1 lbs. of Lasso per acre was applied in a 70 gallon per acre spray. No phosphorus or potassium fertilizer was applied since adequate residual amounts remained from the application of these elements in 1969.

One half of each of the 1970 plots received no fertilizer in 1971, to determine any possible residual effect remaining from the 1970 N

treatments. The remaining half of each broadcast treatments at the uniform rate of 100 lbs. of N per acre as follows:

(1) Class "C" sulfur coated urea (9.5% available in 7 days).

(2) Class "D" sulfur coated urea (18.2% available in 7 days).

(3) Class "F" sulfur coated urea (26.4% available in 7 days).

(4) Urea + sulfur (equivalent amounts as in S coated urea).

(5) NH_4NO_3 only.

There were five replications of each treatment as in 1970.

The 1971 growing season was relatively ideal for corn growth, the total May-September (inclusive) rainfall being 15.5" and this was regularly supplemented with one inch increments of sprinkler irrigation water totaling 15.0". The corn was harvested in late October, dried, and grain yields determined. These and the yields from the residual N (1970 fertilization) are reported in the following table.

The Effect of Different Nitrogen Fertilizers on Corn Yield, N Uptake and Removal from an Irrigated Hubbard Loamy Coarse Sand.

1970		1971			
N Applied (lbs/A)	Corn Yield (bu/A)	N Applied (lbs/A)	Corn Yield (bu/A)	N in Corn Grain %	N Removed (lbs/A)
----	13.4 a	----	7.3 a	1.20	4.47
----	13.4 a	S urea (C) (100N)	58.1 b	0.88	24.67
urea 100N	144.8 c	----	16.0 a	0.87	6.59
----	144.8 c	S urea (D) (100N)	102.4 c	0.90	41.56
NH_4NO_3 100N	150.0 c	----	22.9 a	0.95	10.09
----	150.0 c	S urea (F) (100N)	119.8 cd	0.89	51.39
S urea 100N	60.2 b	----	16.9 a	1.30	9.17
----	60.2 b	Urea + A (100N)	121.7 cd	0.93	52.67
Urea + S 100N	141.0 c	----	16.2 a	0.93	7.42
----	141.0 c	$NH_4NO_3^-$ (100N)	132.6 d	0.85	52.28

Although all of the 1970 N treatments doubled 1971 corn yield over the average check yield where no N was applied in either year, none of these increases were significant, and apparently very minor amounts of N remained in these sandy soils for the following 1971 corn crop. Yields improved with the sulfur coated urea from Class C (58.1 bu/A and significant yield increase) through Class D to Class F, with the latter producing approximately the same corn yield as the urea and sulfur applied separately, or the 1971 NH_4NO_3 fertilization.

Nitrogen analyses of the corn grain (the only crop actually removed from the field), show that sulfur coated urea (C) supplied about 20 pounds (20% of the N applied) to the corn grain. The (D) sulfur-urea resulted in 35 pounds (35%) more N in the corn grain per acre. The (F) sulfur urea application resulted in about 40 pounds more N in the corn grain (40% of that applied) in comparison to the 43% and 45% removed in the grain of the urea plus sulfur, and the NH_4NO_3 alone treatment respectively.

In conclusion, it is evident that the N availability to corn varies with the different S coated urea products studied (Classes C, D, and F) and this may be of economic importance in corn production under non-irrigated conditions.

LIME PLOTS, LAMBERTON, 1971

J. Grava, W. W. Nelson, D. S. Fairchild, B. D. McCaslin

A field experiment was established in the fall of 1965 to study the effects of liming on crop yields, chemical composition of plant tissue, and chemical properties of soils. The crops grown were: (a) Vernal alfalfa in series 4, and (b) in series 5, corn (1966, 1968 and 1970) and Chippewa soybeans (1967), Hark soybeans (1969) and Corsoy soybeans (1971) in a sequence. Data on crop yields, soil and plant analyses were reported in the departmental "Bluebooks"[1].

Since the initial treatments (3 and 6 tons per acre of dolomitic limestone applied in fall of 1965) had not raised the pH to the desired levels (6.5, 6.9), additional amounts were applied in the spring of 1968 and worked in the soil by disking (corn-soybean series), or by disking, plowing and disking (alfalfa series). Alfalfa was reseeded in 1968.

Soil samples were collected during summer of 1969. Lime treatments had increased the soil pH in alfalfa series from 5.7 to 6.1 with the lower (3 + 4 tons/A) lime rate, and to 6.8 with the higher rate (6 + 10 tons per acre). In the corn-soybean series, the check plots had soil pH values of 6.1 while the pH was raised to 6.6 with the lower (3 + 3 tons/A) rate and to 6.9 with the higher (6 + 6 tons/A) rate of dolomitic limestone. The subsoil is alkaline at a depth of 24 inches in the alfalfa series and at 12 inches in the corn-soybean series.

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1) See "A Report on Field Research in Soils", Feb. 1967, pp. 69-70; Soil Series 82, March 1968, pp. 38-41; Soil Series 84, March 1969, pp. 30-31; Soil Series 86, March 1970, pp. 66-69; Soil Series 87, March 1971, pp. 64-67 for results obtained in previous years.

In 1971, alfalfa received no fertilizer. Soybeans were not fertilized but all plots received 3/4 lb/A Treflan and 2 lb/A Amiben.

Alfalfa yields were not affected by liming in 1971 (Table 1). Liming, in general, did not affect chemical composition of first cutting alfalfa tissue (Table 2).

Soybean yields were not affected by lime treatments (Table 3). Chemical composition of soybean seeds is shown in Table 4.

Table 1. Yield of alfalfa, Lamberton lime plots, 1971.

Rate of Lime	First Cutting	Second Cutting	Total
Tons/Acre		Hay -- Tons/Acre	
0	2.3	1.0	3.3
7*	2.4	1.0	3.4
16**	2.3	1.0	3.3
Significance	NS***	NS	NS
CV%	6	20	6

*3 Tons/Acre applied in fall of 1965 and 4 Tons/Acre applied in spring of 1968.

**6 Tons/Acre applied in fall of 1965 and 10 Tons/Acre applied in spring of 1968.

***N.S. -- Treatment means not significantly different at the 5.0% level.

Table 2. Chemical composition of alfalfa, Lamberton lime plots, 1971.

Lime Treatment	P	K	Ca	Mg	Zn	Cu	Mo	Mn	B	Fe	Al
Tons/Acre	-- Percent in dry matter --				------- Parts per million in dry matter ---------						
					FIRST CUTTING						
0	.25ab[1]	1.31c	1.31	.35	19	6	11	25	42	79	40
7	.24a	1.24a	1.28	.34	20	5	11	19	38	79	41
16	.26b	1.23b	1.35	.37	20	5	12	20	40	83	41
Significance	*	**	NS	NS	NS	NS	NS	NS	NS	NS	NS
CV%	5	2	9	9	7	30	9	18	6	9	14

[1]Treatment means followed by different letters are significantly different at the 5.0% level.

Table 3. Yield of soybeans, Lamberton lime plots, 1971

Rate of Lime	Yield
Tons/Acre	Bu/Acre
0	31
6*	33
12*	31
Significance	NS**
CV%	6

*3 or 6 Tons/Acre applied in the fall of 1965 and again in the spring 1968.

**N.S. -- Treatment means not significantly different at the 5.0% level.

Table 4. Chemical composition of soybean seed, Lamberton lime plots, 1971.

Lime Treatment	P	K	Ca	Mg	Zn	Cu	Mo	Mn	B	Fe
Tons/Acre	-- Percent in dry matter --				---- Parts per million in dry matter ----					
0	.46	1.41	.16	.20	40	12	8	18	29	65
6	.46	1.39	.16	.20	39	11	10	18	30	83
12	.46	1.43	.16	.20	39	10	10	17	29	70

SOIL FERTILITY MATERIALS PLOTS

G. D. Holcomb, W. W. Nelson, C. J. Overdahl

Quite frequently, University personnel are asked for an opinion about various products claimed to be superior in value to commonly available fertilizer material. Claims may be made for one or more benefits such as increased yield, higher protein content of grain, improved soil tilth, lower moisture content at harvest time, less problems with disease and insects, etc.

In the spring of 1971, field trials were established at the Southwest Experiment Station, Lamberton, to compare some of the products with a conventional fertilizer program. Because it is not feasible to test all products which may be purchased as fertilizers or related materials, a soil conditioner, an organic soil builder and a liquid fertilizer (advertised for both foliar and soil applications) were selected.

TABLE 1. TREATMENTS (Acre basis rate)

1. Check (0+0+0 total applied)

2. Liquid 10-20-10: Seed plus foliar. (52+20+10 total applied).
   4 gal. with seed plus 4 gal. on foliage (2 applications at 2 gal. rate)
   200 lbs. 21-0-0 broadcast and worked in.

3. Liquid 10-20-10: Seed (47+10+5 total applied)
   Same as treatment 2 except no foliage applications.

4. Soil Conditioner: (0+0+0 total applied)
   250 lbs. broadcast and worked in.

5. Organic Soil Builder: (30+10+5 total applied)
   300 lbs. broadcast and worked in.
   200 lbs. to the side and below seed.

6. Conventional Fertilizer: (114+43+22 total applied)
   300 lbs. 33.5-0-0 broadcast and worked in.
   180 lbs. 8-24-12 to the side and below seed.

All treatments were replicated four times with and four times without broadcast applications of phosphate and potash. The purpose of the broadcast application is to have comparisons under medium to high fertility soil conditions as well as under low fertility soil conditions. The rate applied was 0-90-45. Those receiving broadcast phosphate and potash were referred to as medium + fertility trials; those not receiving it are the low fertility trials.

Weed and insect control: Except for treatments 4 and 5, all plots received a herbicide (Ramrod) and an insecticide (Bux). All plots were cultivated two times. There was no lodging. However, weeds were a slight problem in treatment 6 in the low fertility trials and a moderate problem in the medium + fertility trials. Weeds were a moderate problem in treatments 4 and 5 in the low fertility trails and severe in the medium + fertility trials.

Table 2. Initial Soil Test Values

Sample	pH	Buffer Index	Organic Matter	P	K
				lbs/A	
Rep 1	5.6	6.6	M	7	250
Rep 2	5.6	6.6	M	10	250
Rep 3	5.5.	6.5	M	8	210
Rep 4	5.6	6.6	M	5	170

The corn, Pioneer 3784, was planted May 21. Final plant population was approximately 19,000 per acre. Foliar applications were made June 22 and July 6.

RESULTS

Statistical analyses are not available at the time this summarization is being prepared.

Data in Table 3 shows the conventional fertilizer treatment producing the highest yield under both low and medium + fertility conditions Following in decreasing yield were the liquid fertilizer treatments, check, organic soil builder and soil condtioner. There was no yield increase from the foliar applications of liquid fertilizer. The yield advantage of the check treatment over the organic soil builder and the soil conditioner treatments was due to weed control.

Moisture content of the gratin at harvest was lowest from the conventional fertilizer followed by the liquid treatments. Grain moisture content was highest with the soil conditioner, organic soil builder and check treatments, with little difference among the three.

Protein conent was highest in the grain from the conventional fertilizer treatment. This was followed in order by treatment 2, 3, 1, 4, and 5. There was little difference in the last three treatments, however.

There was less problem with corn borers on the soil conditioner (treatment 4) plots. Apparently due to short growth and low preference by the corn borer moth.

In mid-June there was a height advantage and the corn was darker green on the conventional and liquid treatment plots. Tasseling under these treatments was 3 to 7 days ahead of that for the other treatments.

Mineral analyses of leaf samples taken at tasseling have not been completed.

TABLE 3. MEASUREMENTS - FERTILITY MATERIALS PLOTS, LAMBERTON, 1971

Low Fertility Trials (No P & K broadcast)

Treatment	Ext. Leaf Hgt. on June 21	Date 50% Tasseled	% Stalks w/ borers Aug. 3	% Barren Stalks	% Moist. at Harv.	Shelling %	% Protein in Grain	Yield Bu/A
1	17.5	7-31	25	2.3	41.0	79.7	7.4	64
2	21.8	7-27	26	2.3	38.7	81.0	9.3	76
3	21.3	7-27	40	4.3	39.6	80.3	9.1	79
4	17.3	8-2	3	13.3	41.6	79.8	7.8	49
5	18.0	8-1	19	4.5	42.9	77.9	7.6	53
6	24.0	7-27	18	7.5	37.7	81.2	10.1	83
Medium + Fertility Trials (0+90+45 broadcast)								
1	21.0	7-28	31	5.3	38.5	80.6	7.6	71
2	23.8	7-24	56	8.5	36.4	83.0	8.6	79
3	25.0	7-25	58	14.5	36.6	79.1	8.3	78
4	20.8	8-1	26	21.5	39.9	77.1	6.7	39
5	22.5	7-28	41	12.0	38.3	75.8	6.6	45
6	24.3	7-24	33	12.3	35.2	82.4	10.1	93

TWELVE YEARS OF FIELD EXPERIMENTS WITH NITROGEN SOURCE, PLACEMENT AND TIME OF NITROGEN APPLICATION TO A WEBSTER-CLAY LOAM AT LAMBERTON FROM 1960 THROUGH 1971

John M. MacGregor, Wallace W. Nelson and Robert C. Munter

A field fertilizer experiment for continuous corn was commenced in the spring of 1960 to determine the relative effectiveness of annually applied N as either ammonium nitrate or as urea. The nitrogen was broadcast and plowed down, or simply broadcast and left on the plowed surface over winter, or broadcast in the spring and worked in during the usual seedbed preparation, or broadcast as a sidedressing in late June. Four replications of 18 different annual treatments were applied in a randomized block, each plot being 20 feet wide and 77.5 feet long. A starter fertilizer such as 8-24-12 is applied annually with the planter fertilizer attachment over the entire field at planting at approximately 175 pounds per acre (14+42+21). The corn seed for several years was drilled lengthwise over each plot in a 40 inch row spacing to obtain about 18,000-20,000 plants per acre, but the row direction was later reversed and a 30 inch row spacing supplied the same population. Many different studies have been made during the 12 years of continuous corn growing on the effect of N application in this experiment, with results reported each year in Soil Series 76-87. The entire field was tiled in 1963. Soil pH is approximately 6.6

Total precipitation during 1971 was 24.7", which is approximately normal for the area. June rainfall totaled 7.11" with a total of only 4.24" in the 3 month period following. The relatively dry July through September growing season resulted in decreased corn production. Fall frost was not a problem in 1971. Ear corn yields during the entire 12 year period are shown in Table 1.

All of the broadcast N treatments have significantly increased the 12 year average corn yields over the four plot average where only the starter fertilizer (containing 14 lbs N/A) was annually applied. Although the N-urea treated plots produced an average of 2.3 bushels more corn than where NH_4NO_3-N was applied, none of the individual treatments were significantly larger, illustrating that the two N sources are equally effective for increasing corn production in this soil.

Effect of Time of N Fertilizer Application

Fourteen pounds of N per acre in the annual starter fertilizer (175 lbs of 8-24-12) has resulted in average corn yields over the 12 year period of 65.7 bushels. Applying 40 lbs N/A in the fall increased yields nearly 20 bushels (85.3); the same rate at time of planting produced 26.6 bushels more corn (92.3 bu/A);whereas sidedressing N treatments produced corn yields averaging 92.7 bushels with the minimal N fertilization rate (totaling 54 lbs N/A).

Eighty pounds of N/A applied late each fall resulted in average corn yields of 100.2 bushels; N at time of planting corn yields averaged 105.7 bushels; and as a sidedressing, 102.1 bushels.

Fertilizing in the fall at the rate of 160 lbs of N/A with 14 lbs more in spring starter (total of 174 lbs N/A) produced an average of 106.5 bushels; and 104.8 bushels where a similar sidedressed rate of N was made in the following June.

It is apparent that N fertilization at such minimal rates of 54 pounds per acre is more effectively applied either at spring planting, or as a June sidedressing. When heavier rates of N are applied, corn yields were less affected by time of N fertilization.

Fall Plowdown N Versus Fall Surface N

This is most effectively shown by comparing the two sets of fall 40 lb N treatments (treatments 2 and 3, with 4 and 5). The fall plowed down N averaged 83.2 bushels, whereas the 8 plots with the 2 nitrogen fertilizers (NH_4NO_3 and urea) left over winter on the plowed surface soil have averaged 87.5 bushels. While not mathematically significant, this would mean about 50 bushels more per acre over the entire 12 year period for the N left over winter on the plowed surface. No comparison is available for the two heavier N treatments, since these were both plowed down each fall.

Rate of N Application Effect

The 8 treatments with 40 pounds of N per acre in addition to the starter fertilizer N (an average of 32 plots) has averaged 89.0 bushels of corn per acre over the 12 year period, which is 23.3 bushels above the starter fertilized only corn yield. The six treatments (24 plot average) with 80 lbs N/A, (94 lb total) has averaged 101.7 bushels or 36 bushels more for 80 lbs N/A. The three 160 lb/A N treatments (totaling 174 lbs N/A on 12 plots) has produced a 12 year average of 105.9 bu/A, or 40.2 bushels more corn annually than with the starter N alone. It is apparent that the 80 pounds of additional N per acre over the 14 pounds of starter has probably been the most practical in the experimental area for continuous corn.

Nitrogen Content of Corn Leaves and N Removal in Corn Grain

The effect of fertilization on the N content of the "index" or sixth leaf from the ground, and the amount actually removed in the corn grain is important. The relative concentrations of N in the leaves is

an indication of amounts of N returned to the soil in plant tissues, whereas the N in the grain is removed. The 1971 grain yields, leaf and grain N are shown in Table 2.

Nitrogen in the sixth leaf is increased from about 2% to a maximum of approximately 2.5% in the heaviest N fertilization. Nitrogen in grain increased from 1.10% to 1.67%, but the large yield increase quadrupled total N per acre removal in the grain. In general the 94 lb/A rate (80+14) of N application approximately equalled the amount of N removed in grain, with lesser N fertilization rates removing more N than that supplied in the fertilizer. It is obvious that the 174 lb N/A rate is not providing an economic increase in corn yield and that the excess beyond that removed by the corn grain may be contributing to undesirable amounts of N in drainage and/or subterranean waters.

Analyses of Subsoil Waters of N Plots

An extremely dry July, August, and September resulted in very dry subsoil conditions, and no subsoil water samples were collected or analyzed in 1971.

Table 1. Yields of ear corn during 12 years on a tiled Webster clay loam near Lamberton with annual applications of NH_4NO_3 or Urea nitrogen at different rates, times, and placement. (Average of 4 replications)

N applied annually in lbs/A[1]	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	12 Year Average
	Ear corn yield in bushels per acre												
Check	49.5	88.2	26.1	132.6	72.9	33.1	11.1	53.4	102.4	92.8	85.7	40.8	65.7a
40 as NH_4NO_3 - fpd[2]	42.3	87.5	30.9	148.6	88.3	34.9	26.8	75.7	131.6	109.3	96.3	88.7	80.1b
40 as urea - fpd	55.1	78.2	29.1	148.8	100.3	38.8	19.8	86.9	132.5	124.5	120.4	100.7	86.2bcd
40 as NH_4NO_3 - fps[3]	49.0	96.7	29.6	140.1	101.5	45.6	24.3	75.1	135.2	124.6	122.5	81.5	85.5bc
40 as urea - fps	62.3	101.3	37.0	140.7	84.1	57.4	30.9	87.2	134.0	136.1	121.2	82.4	89.5cde
80 as NH_4NO_3 - fpd	67.4	97.9	43.6	149.6	100.8	63.4	47.3	114.8	131.2	146.8	134.7	108.0	100.5ghi
80 as urea - fpd	61.7	76.9	36.7	154.5	104.9	73.0	37.8	117.2	142.6	144.3	141.4	107.8	99.9fghi
160 as NH_4NO_3 - fpd	69.8	97.9	46.7	147.7	100.9	70.8	38.5	127.4	140.2	158.7	141.7	120.2	105.1hi
160 as urea - fpd	79.4	112.5	43.5	152.8	112.4	73.5	37.7	121.3	149.9	161.0	140.4	110.6	107.9i
40 as NH_4NO_3 - std[4]	66.2	92.0	45.4	152.2	99.8	63.4	23.7	99.8	128.0	142.0	125.6	84.0	93.5cdefg
40 as urea - std	45.4	91.1	31.4	147.6	100.6	59.8	33.8	95.0	140.5	143.4	118.9	94.6	91.9cdef
80 as NH_4NO_3 - std	59.3	90.0	32.7	149.2	112.5	74.2	49.0	128.3	144.7	159.5	140.4	122.7	105.2hi
80 as urea - std	57.7	99.1	40.5	149.3	115.7	84.4	41.8	128.6	138.7	155.9	146.2	116.0	106.1i
40 as NH_4NO_3 - sd[5]	63.6	92.6	39.5	148.6	90.4	54.8	38.6	96.8	133.4	142.3	127.1	104.5	94.3defg
40 as urea - sd	57.7	95.6	24.9	142.3	94.1	48.4	50.4	86.1	132.2	143.3	117.7	100.5	91.1cde
80 as NH_4NO_3 - sd	50.4	98.4	46.7	140.7	113.0	68.1	43.8	101.6	137.7	140.3	127.7	97.6	97.2efgh
80 as urea - sd	76.9	86.4	48.2	143.8	121.4	64.7	47.3	117.0	146.9	166.2	140.5	124.4	107.0i
160 as NH_4NO_3 - sd	40.7	97.4	77.7	151.7	109.5	77.6	51.4	120.2	141.5	148.3	136.9	104.2	104.8hi
Average annual corn yield in bu/A	58.6	93.3	39.4	147.7	101.3	60.3	36.3	101.8	135.7	140.9	127.0	99.4	

[1]The entire area received an additional 14 lbs N/A as starter fertilizer annually (8-24-12 @ 175 lbs/A)
[2]fpd -- fall plow down
[3]fps -- fall plow-surface
[4]std -- spring topdress
[5]sd -- sidedress

Table 2. Percentage N in sixth leaf, yield of dry shelled corn, percentage nitrogen and nitrogen removal in corn grain per acre from NH_4NO_3-urea treated continuous corn on Webster clay loam at Lamberton in 1971.

Treatment (lbs N/A)[1]	% N in sixth leaf[2]	Yield in bu/A (15.5% moisture)	Dry shelled corn (lbs/A)	% N (in grain)	lbs N removed/A	Fertilizer N applied (lbs/A)	Soil N status[3]
Check	1.97	41a	2382	1.10a	24a	14	-10.2
40# N/A stalks, fall	2.10	89bcd	5185	1.31bcde	67bc	54	-13.4
40# urea stalks, fall	2.22	101bcdeg	5904	1.33bcdeg	78c	54	-24.3
40# N/A plow, fall	2.23	82b	4765	1.24ab	60b	54	- 5.9
40# urea plow, fall	2.13	82b	4817	1.47cdefg	60b	54	- 5.6
80# N/A stalks, fall	2.31	108defg	5531	1.51fgh	94de	94	- 0.1
80# urea stalks, fall	2.28	108defg	6298	1.50efgh	94de	94	- 0.1
160# N/A stalks, fall	2.39	120fg	7026	1.62gh	114g	174	+60.8
160# urea stalks, fall	2.50	111defg	6466	1.62gh	104efg	174	+69.8
40# N/A before spr. plt.	2.16	84bc	4909	1.22ab	60b	54	- 5.5
40# urea before spr. plt.	2.22	95bcde	5517	1.30bcd	72bc	54	-18.1
80# N/A before spr. plt.	2.78	122fg	7170	1.35bcdef	97def	94	- 2.6
80# urea before spr. plt.	2.34	116efg	6780	1.41bcdef	96def	94	- 1.5
40# N/A sidedress	2.01	105cdefg	6108	1.33bcdef	81cd	54	-27.0
40# urea sidedress	2.29	100bcdef	5873	1.29abc	74bc	54	-20.1
80# N/A sidedress	2.31	98bcde	5705	1.47cdefg	84cd	94	+10.4
80# urea sidedress	2.10	124g	7271	1.49defgh	109fg	94	-14.5
160# N/A sidedress	2.50	104cdefg	6093	1.67h	101efg	174	+73.2
Significance							
Rep		N.S.		N.S.	N.S.		
Treatment		**		**	**		
C.V.		13.33		8.70	12.47		

[1]The entire area received an additional 14 lbs N/A annually as starter fertilizer (8-24-12 @ 175 lbs/A).
[2]None of these values were significantly different (N.S.).
[3]Fertilizer N minus N removal in corn grain in lbs/A.

WINTER VERSUS SPRING FERTILIZATION ON 1968, 1969, 1970, and 1971 CORN YIELDS AT LAMBERTON

W. W. Nelson and J. M. MacGregor

This experiment was conducted during the late winter, spring, and summer of 1968 and 1969 on two sloping fields (1% and 5%) on the Soils Unit of the Minnesota Agricultural Experiment Station near Rosemount, and on a nearly level, untiled Webster clay loam at the Southwest Experiment Station near Lamberton in 1968, 1969, 1970, and in 1971. Four replications of randomized paired plots 50 ft. long and 20 ft. wide were broadcast fertilized in mid-January (on snow) or in April, using N, P_2O_5, and K_2O and combinations of these at Rosemount, but only N and P_2O_5 combinations near Lamberton.

Snow during the four winters was not sufficiently deep to prohibit the operation of large fertilizer spreading trucks. Although all of the fertilizer was broadcast by hand, on each of four replications the granules appeared to sink a short distance into the snow almost immediately, with little resultant lateral movement into adjoining areas.

Results

Both of the sloping fields near Rosemount unfortunately failed to show significant increases in corn yield from any of the fertilizer applications, making it impossible to determine the relative effects of winter or of spring broadcasting fertilizer. Since these yields have previously been reported in Soil Series 84, 86, and 87 the results will not be included here.

The relatively level Webster silty clay loam at Lamberton produced significantly more corn with fertilization and the results are shown in the four following tables. The same plot areas were re-used in each of the four years.

Table 1. Yield of Ear Corn at Lamberton in 1968 on a Webster Silty Clay Loam When Fertilized in January or in April, 1968.

Treatment (lbs/A)	Time fertilizer broadcast	I	II	III	IV	Average
		Bushels ear corn/A @ 15.5% moisture				
None		105.1	104.1	99.1	67.0	93.8 a
40+0+0	January 17	110.2	109.1	127.8	94.8	110.5 b
40+0+0	April 2	114.4	117.9	113.1	121.5	116.7 b
0+40+0	January 17	97.1	104.3	102.8	102.0	101.6 ab
0+40+0	April 2	105.0	93.2	103.1	71.6	93.2 a
40+40+0	January 17	110.2	118.0	118.1	112.4	114.7 b
40+40+0	April 2	112.0	122.6	104.8	106.4	111.5 b

The N (40+0+0) and the NP (40+40+0) produced significant increases in 1968 corn yield, with no significant difference for different times of fertilizer application.

The autumn of 1968 and the spring of 1969 were extremely wet, and it was not possible to plow this untiled silty clay loam until the end of May of 1969. This resulted in such late planting that it was necessary to base 1969 yields on silage corn, rather than the usual corn grain. Silage corn yields are shown in Table 2.

Table 2. The Yield of Silage Corn in 1969 From Webster Silty Clay Loam Near Lamberton Following Fertilization in January or May, 1969.

Treatment (lbs/A)	Time of Fertilization	I	II	III	IV	Average
		Yield of silage corn (tons/A)				
None		8.09	8.09	8.67	6.55	7.89 ab
40+0+0	January	10.88	8.79	10.59	7.57	9.46 bc
40+0+0	May	10.85	12.76	13.40	7.74	11.17 c
0+40+0	January	10.03	7.28	8.29	7.71	8.33 ab
0+40+0	May	8.50	7.60	6.84	5.97	7.23 a
40+40+0	January	9.98	11.14	8.70	8.32	9.54 bc
40+40+0	May	9.98	11.02	7.48	8.35	9.19 b

The 1969 silage yield results were rather inconclusive and it was decided to extend the experiment for several more growing seasons. The 1970 yields of ear corn are shown in Table 3.

Table 3. Yield of Ear Corn Grown in 1970 on a Webster Silty Clay Loam Near Lamberton Following Fertilization in Mid-January or Early April, 1970.

Treatment (lbs/A)	Fertilizer broadcast in:	I	II	III	IV	Average
		Ear corn yield in bu/A @ 15.5% moisture				
None		61.2	68.8	60.6	66.2	64.2 a
40+0+0	January	94.4	87.3	90.3	90.3	90.6 b
40+0+0	April	94.9	94.5	93.1	97.0	94.9 lb
0+40+0	January	63.6	82.3	62.8	68.2	69.5 a
0+40+0	April	51.4	79.6	64.9	70.2	66.5 a
40+40+0	January	105.1	94.9	96.6	115.5	103.0 c
40+40+0	April	102.9	110.6	102.4	105.3	105.3 c

Corn yields from either winter or spring fertilization were not significantly different in the preceding 3 growing seasons (1968-69-70), but in 1971 there was evidently some fertilizer N loss where applied in January as compared to the later application. Although 1971 annual precipitation was nearly normal (24.70"), distribution was extremely variable with a total of 16.25" falling in only 4 months (2.10" in February, 7.11" in June, 4.41" in October, and 2.63" in November). The remaining months were comparatively dry, and this resulted in much lower corn yields than those of the preceding years. Ear corn yields, average N present in grain, and N removed per acre in the grain are shown in the following Table.

Table 4. Ear Corn Yield, Percentage N in Grain and N Removal Per Acre in 1971 From a Webster Silty Clay Loam Near Lamberton When Fertilized in January or in April.

Fert. Trt. (lbs/A)	Fert. broadcast in:	I	II	III	IV	Yield	Average Grain %N	Average Grain lbsN/A
		Bu/A ear corn @ 15.5% Moisture						
None		36.7	26.3	32.2	12.0	26.8 ab	1.03	16.6
40+0+0	January	52.3	72.7	50.7	32.5	52.1 c	1.03	32.2
40+0+0	April	55.8	72.2	74.5	61.3	66.0 de	1.08	42.1
0+40+0	January	33.6	44.4	37.7	35.1	37.7 b	0.98	21.8
0+40+0	April	10.4	29.8	37.8	12.1	22.5 a	0.98	12.9
40+40+0	January	50.5	49.5	62.3	55.1	54.4 cd	1.05	33.8
40+40+0	April	71.8	75.8	83.1	61.2	73.0 e	1.10	47.5

Although the first three years of this field experiment indicated no significant loss of either N or of NP applied in January, the relatively dry growing season of 1971 indicate a significant advantage for the spring application of either N or of NP. The relatively low N content of the grain, and low grain yields in comparison to previous years, indicate the apparent low fertility level of the experimental area. The higher yield with the winter applied P is not readily explainable.

Conclusions

It is evident that broadcasting of N fertilizers in January, even on the relatively level Webster soil at Lamberton is sometimes less effective for corn production than similar treatments broadcast a few months later. The 1971 corn yields and grain composition indicate that larger amounts of the spring applied N remain available, at least in some growing seasons.

WEST CENTRAL EXPERIMENT STATION - MORRIS

WEATHER SUMMARY - 1971

Month	Period	Precipitation 1971	Precipitation 84 yr. Av.	Precipitation Dev from Av.	Air Temperature 1971	Air Temperature 84 yr. Av.	Air Temperature Dev. from Av.	Soil (10cm) Temperature 1971	Soil (10cm) Temperature 4 yr.Av.
January	1-31	1.18	.66	+.52	2.6	8.6	-6.0	19.0	21.4
February	1-28	1.63	.65	+.98	12.2	12.8	-0.6	24.6	24.3
March	1-31	.31	1.04	-.73	26.4	26.8	-0.4	27.6	28.9
April	1-10	.09	.60	-.51	37.2	38.3	-1.1	34.3	
	11-20	.35	.63	-.28	51.4	44.3	+7.1	41.6	
	21.30	1.17	1.10	+.07	45.7	48.4	-2.7	46.3	
Total or Average		1.61	2.33	-.72	44.8	43.7	+1.1	40.7	41.0
May	1-10	0	.81	-.81	50.7	52.1	-1.4	50.4	
	11-20	.59	1.01	-.42	55.3	55.6	-0.3	57.8	
	21-31	1.59	1.18	+.41	54.8	60.0	-5.2	53.0	
Total or Average		2.18	3.00	-.82	53.7	56.0	-2.3	53.7	55.5
June	1-10	2.15	1.34	+.81	63.8	62.9	+0.9	63.1	
	11-21	3.67	1.16	+2.51	73.1	66.6	+6.5	74.9	
	21-30	1.80	1.41	+.39	69.4	68.2	+1.2	71.2	
Total or Average		7.62	3.91	+3.71	68.8	65.9	+2.9	69.7	68.3
July	1-10	1.51	1.57	-.06	68.8	69.9	-1.1	71.6	
	11-20	.44	1.06	-.62	66.9	71.4	-4.5	73.0	
	21-31	.14	.94	-.80	62.2	71.7	-9.5	69.8	
Total or Average		2.09	3.57	-1.48	65.9	71.0	-5.1	71.4	75.0
August	1-10	Trace	1.10	-1.10	66.0	70.6	-4.6	71.4	
	11-20	.27	.91	-.64	71.5	69.1	+2.4	75.8	
	21-31	4.27	.96	+3.31	67.4	66.8	+0.6	72.1	
Total or Average		4.54	2.97	+1.57	68.3	68.8	-0.5	73.0	74.8
September	1-30	2.05	2.26	-.21	58.4	59.3	-0.9	61.5	61.8
October	1-31	7.11	1.52	+5.59	49.0	47.5	+1.5	49.4	47.4
November	1-30	2.52	0.88	+1.64	29.2	29.9	+0.7	34.8	34.4
December	1-31	.32	0.19	-.37	12.0	15.8	-3.8	33.0	25.1
April - August	Growing Season	18.04	15.78	+2.26	60.3	61.2	-0.9	61.7	62.9
January-December	Annual	33.16	23.47	+9.69	41.1	42.2	-1.1	46.5	46.5

CONTINUOUS CORN SILAGE

West Central Experiment Station - Morris

Samuel D. Evans

In 1965 an experiment was initiated on McIntosh silt loam to determine the effect of removal of continuous corn silage and fertilizer application on corn grain and corn silage yields. Rates of fertilizer were 74 + 48 + 48 and 148 + 96 + 96. All plots received a broadcast application of 10 lbs. of zinc as zinc sulfate in the fall of 1965.

1971 Silage Yields and Grain Percentage

Dry Matter, tons/acre

	Total Yield	% Grain
On plots harvested as grain 1965-71:		
Low fertility (74 + 48 + 48)	6.30	50
High fertility (148 + 96 + 96)	6.81	48
On plots harvested as silage 1965-71:		
Low fertility (74 + 48 + 48)	6.15	50
High fertility (148 + 96 + 96)	7.19	49

1971 Grain Yields

Bushels/acre @ 15.5% Moisture

On plots harvested as grain 1965-71:	
Low fertility (74 + 48 + 48)	100.57
High fertility (148 + 96 + 96)	119.07

In addition an unfertilized, unreplicated check adjacent to the experimental area yielded as follows:

Grain (0 + 0 + 0)	63.42 bu/acre
Silage (0 + 0 + 0)	3.79 tons/acre

There is still no reduction in yields after growing 7 years of continuous corn silage. Higher fertility increased both silage and grain yields in 1971.

Variety - Pioneer 3935 Plant date - May 7.

FERTILIZER MATERIAL PLOTS

West Central Experiment Station - Morris

S. D. Evans, O. Gunderson, G. Holcomb, and C. Overdahl

An investigation of the effect of soil conditioners, organic fertilizers, and liquid fertilizers was commenced on field corn in the spring of 1971 at Morris. The experiment was set up on a site consisting of Tara and McIntosh silt loams. The initial soil tests are given in table 1.

Table 1. Initial soil test values on Morris Fertilizer Materials Plot.

Sample	pH	Organic Matter	P	K	Zn
			---lbs/A------		ppm
Rep 1	7.8	M	8	370	3.0
Rep 2	7.9	M	5	240	2.7
Rep 3	7.5	M	8	240	3.3
Rep 4	7.4	M	17	220	1.4

The experiment was set up in a split block design of 4 replications. Main blocks were (1) no broadcast fertilizer and (2) 80 lbs. P_2O_5 broadcast. Ten individual fertilizer treatments were superimposed across each main block pair. The individual treatments are described in table 2.

As can be seen in table 3, there was no significant effect of the broadcast phosphorus. Comparison of the standard fertilizer material (H) with the other materials (table 4) shows no advantage for the other materials. In all measurements listed in table 4, treatment H is equal to or better than any of the other treatments.

Table 2. 1971 Morris Fertilizer Materials Trial.

Treatment Letter	Treatment Description	Herbicide	Insecticide
A	Check	Yes	Yes
B	200 lbs/A of ammonium sulfate (21-0-0) broadcast before planting + 5 gal/A of 10-20-10 with seed at planting + 2 foliar applications of 2 gal/A each on 6-21 and 7-20	Yes	Yes
C	Same as B but without foliar treatments	Yes	Yes
D	Wonderlife (0-0-0), a soil conditioner, at 250 lbs/A broadcast before planting	No	No
E	Same as D	Yes	Yes
F	Shurgro (6-2-1), an organic fertilizer, at 300 lbs/A broadcast before planting + 200 lbs/A with planter	No	No
G	Same as F	Yes	Yes
H	105 lbs/A of N as 33 1/2-0-0 broadcast before planting + 190 lbs/A of 8-32-16 at planting	Yes	Yes
J	Same as H but with an additional 100 lbs/A of N as 33 1/2-0-0 and 100 lbs/A of K_2O as 0-0-60 broadcast before planting	Yes	Yes
K	Same as H but with an additional 5 gal/A of liquid 7-21-7 with seed at planting	Yes	Yes

Leaf samples were taken in all plots at silking. The leaf used was the one opposite and below the top ear. Chemical analysis of the leaves (table 5) shows significant changes in % N, % P, % Ca, % Mg ppm Zn, ppm Cu, ppm Mn, and ppm B. There was no treatment effect on % K, ppm Fe, or ppm Mo. There was no effect of broadcast phosphorus on the leaf content of any of the elements measured.

Conclusion

From one year's results the standard fertilizer materials at recommended rates give the highest yield at the most economical cost.

The hybrid used was Pioneer 3956A(N) planted on May 14. Furadan at 10 lbs/A was applied to all treatments but D and F. Lasso at 2 1/2 lbs/A was broadcast on all treatments but D and F on May 17.

Table 3. Effect of Broadcast Phosphorus on Plant Measurements.

	No P	80 lbs/A of P_2O_5
Extended leaf		
Height on June 22	15.1 inches	15.6 inches
Date 50% silked	Aug. 2	Aug. 2
Date 50% of plants shedding pollen	Aug. 7	Aug. 7
No. of plants/acre at Harvest	20,059	20,005
% broken stalks	0.7%	0.9%
% root lodged	35.7%	35.9%
% ears normal in size and/or shape	74%	76%
% ear moisture at harvest	33.86%	33.61%
% protein in grain	8.6%	8.2%
Yield @ 15.5% moisture	63 bu/A	64 bu/A

Table 4. Effect of Fertilizer Materials on Plant Measurements*

Treatment Letter	Ext. Leaf Ht. on June 22	Date 50% Silked	Date 50% of Plants Shedding Pollen	No. of Plants per Acre at Harvest	% Broken Stalks	% Root Lodged	% Ears Normal in Size and/or Shape	% Ear Moisture at Harvest	% Protein in Grain	Yield Bu/A
A	12.4 AB	8-5 DE	8-10 D	19675 A	0.3 A	20.3 A	73 B	34.41 C	7.7 CD	40 D
B	16.8 CD	7-31 AB	8-5 BC	20979 ABC	0.8 A	20.8 A	89 C	30.64 DE	8.5 BC	78 B
C	15.6 BCD	8-2 C	8-7 C	21319 BC	0.8 A	21.0 A	89 C	32.78 CDE	8.8 AB	72 BC
D	12.4 AB	8-6 E	8-12 E	20412 AB	0.3 A	95.8 B	21 A	39.83 A	7.6 CD	20 E
E	12.0 A	8-5 DE	8-9 D	20752 ABC	0.3 A	17.1 A	75 B	34.49 C	7.5 D	47 D
F	14.4 ABC	8-4 D	8-10 DE	19618 A	0.0 A	94.9 B	28 A	37.51 B	7.4 D	24 E
G	15.8 CD	7-31 BC	8-5 BC	21376 BC	0.8 A	19.1 A	91 C	32.56 CDE	7.8 CD	65 C
H	17.8 DE	7-31 AB	8-5 AB	21830 C	1.5 A	27.3 A	95 C	31.79 DE	9.6 A	94 A
J	16.6 CD	7-30 AB	8-5 B	21716 BC	2.2 A	20.8 A	95 C	33.08 CD	9.5 A	94 A
K	19.8 E	7-29 A	8-3 A	20922 ABC	1.1 A	20.8 A	95 C	30.28 E	9.6 A	92 A

* Values followed by different letters in the same column are significantly different at the 5% level.

Table 5. Effect of Fertilizer Materials on Leaf Analysis (Leaves Sampled at Silking)*

Treatment Letter	N %	P %	Ca %	Mg %	Zn ppm	Cu ppm	Mn ppm	B ppm
A	1.42 ABC	.14 BCD	.54 A	.63 AB	9.1 AB	4.2 AB	69 AB	13 B
B	2.19 DE	.17 CD	.61 AB	.63 AB	9.1 AB	8.1 C	90 CD	10 A
C	2.00 CDE	.16 CD	.63 AB	.64 AB	8.8 AB	8.6 C	94 D	11 A
D	.88 A	.11 A	.55 A	.57 A	7.4 A	2.2 A	61 A	13 B
E	1.50 BC	.14 ABC	.60 AB	.66 AB	13.0 B	5.0 B	75 BC	12 AB
F	1.30 AB	.12 AB	.61 AB	.67 AB	7.8 AB	2.9 AB	61 A	13 B
G	1.84 BCD	.18 DE	.66 B	.64 AB	11.7 AB	7.8 C	81 BCD	10 A
H	2.49 E	.21 EF	.63 AB	.76 B	8.8 AB	11.7 D	118 E	10 A
J	2.51 E	.21 EF	.60 AB	.71 AB	9.3 AB	11.2 D	117 E	10 A
K	2.51 E	.24 F	.67 B	.71 AB	9.4 AB	12.6 D	122 E	10 A

* Values in the same column followed by different letters are significantly different at the 5% level.