Table 2. Effects of N and P rates and application methods on elemental analyses of whole plant samples of spring wheat taken at boot.

N		P_2O_5		Elemental Analyses								
Rate	Method	Rate	Method	N	P	K	Ca	Mg	Mn	Zn	Cu	B
lb/A		lb/A		- - - - - - - - % - - - - - - - -					- - - - - - ppm - - - - -			
0	--	0	--	2.41	0.32	2.60	0.37	0.35	39	33	6	5
0	--	40	DB	2.44	0.32	2.78	0.40	0.38	36	25	4	6
50	DB	40	DB	2.56	0.35	2.90	0.49	0.44	46	30	5	5
100	DB	40	DB	2.54	0.32	2.42	0.48	0.45	47	30	5	5
50	DB	80	DB	2.49	0.35	2.22	0.54	0.47	49	25	4	6
100	DB	80	DB	2.80	0.39	2.57	0.65	0.55	57	30	4	6
50	B	40	B	2.70	0.37	2.77	0.50	0.44	49	30	5	6
100	B	80	B	2.56	0.35	2.32	0.52	0.49	46	26	4	5
50	DB	80	B	2.52	0.38	2.36	0.51	0.48	47	27	4	6
50	B	40	DB	2.73	0.36	2.78	0.54	0.51	55	33	5	6
Significance				*	**	N.S.	**	**	**	**	**	N.S.
B.L.S.D. (.05)				0.24	0.04		0.09	0.10	9	5	1	
C.V. (%)				5.7	7.6	18.3	12.7	14.0	12.8	10.6	16.9	12.0

Table 3. Effects of N and P rates and application methods on elemental analyses of whole plant samples of spring wheat taken at soft dough (maturity).

N		P_2O_5		Elemental Analyses								
Rate	Method	Rate	Method	N	P	K	Ca	Mg	Mn	Zn	Cu	B
lb/A		lb/A		- - - - - - - - % - - - - - - - -					- - - - - - ppm - - - - -			
0	--	0	--	1.59	0.22	0.92	0.12	0.16	14	25	3	2
0	--	40	DB	1.64	0.23	0.93	0.12	0.17	14	21	2	3
50	DB	40	DB	1.73	0.23	0.94	0.13	0.17	15	24	2	2
100	DB	40	DB	1.65	0.22	0.84	0.17	0.20	17	23	3	3
50	DB	80	DB	1.72	0.25	0.80	0.14	0.19	18	20	2	3
100	DB	80	DB	1.77	0.26	0.84	0.14	0.19	16	21	2	3
50	B	40	B	1.73	0.24	0.98	0.14	0.19	17	21	2	3
100	B	80	B	1.77	0.26	0.85	0.16	0.20	17	19	2	3
50	DB	80	B	1.67	0.26	0.91	0.15	0.20	15	20	2	2
50	B	40	DB	1.71	0.24	0.88	0.13	0.19	18	23	3	3
Significance				N.S.	*	N.S.	N.S.	*	N.S.	**	*	N.S.
B.L.S.D. (.05)					0.03			0.03		3	1	
C.V. (%)				5.9	8.0	14.9	20.0	10.4	13.7	9.6	20.4	18.8

Table 4. Effects on N and P rates and application methods on grain yield, test weight, protein, N removal, forage yield, N, P, and K uptake of spring wheat.

N		P_2O_5		Grain				Forage			
					Test		N	Dry Matter	Uptake		
Rate	Method	Rate	Method	Yield	Weight	Protein	Removal	Yield	N	P	K
lb/A		lb/A		Bu/A	lb/Bu	%	lb/A	lb/A	- - - lb/A - - -		
0	--	0	--	42.8	57.0	14.3	64.3	4768	75.9	10.4	43.6
0	--	40	DB	43.5	56.0	14.5	66.5	5330	87.9	12.4	50.0
50	DB	40	DB	39.9	56.0	15.1	63.6	4957	85.5	11.5	47.2
100	DB	40	DB	42.5	55.1	14.8	66.5	4806	79.4	10.6	40.5
50	DB	80	DB	38.2	56.3	14.0	56.5	5060	87.0	12.8	40.7
100	DB	80	DB	40.0	54.6	14.8	62.4	5358	94.2	13.7	44.6
50	B	40	B	42.2	55.3	15.2	67.3	4759	82.4	11.6	46.8
100	B	80	B	37.9	54.5	14.8	59.0	5028	88.8	13.0	42.5
50	DB	80	B	41.0	55.3	14.2	61.2	5049	84.3	13.0	46.6
50	B	40	DB	40.4	55.9	15.0	63.5	4753	81.2	11.3	42.4
Significance				*	**	N.S.	*	N.S.	N.S.	N.S.	N.S.
B.L.S.D. (.05)				4.6	1.4		7.0				
C.V. (%)				6.3	1.5	3.8	6.6	9.8	11.3	14.2	21.9

EFFECTS OF HIGH NITROGEN RATES IN STARTER FERTILIZERS ON SPRING WHEAT

G. E. Varvel and R. K. Severson

Many studies have been done at different locations to determine how much N can be applied with the seed of various crops at planting time. This study was initiated because results from other trials at Crookston had indicated that fairly high N rates could be applied with the seed of spring wheat without reducing germination or yield on a Wheatville loam soil.

Experimental Procedure:

Two materials, urea (46-0-0) and diammonium phosphate (18-46-0), were used in the study. Four treatments were randomized in a complete block design with four replications. Era wheat was seeded on May 20, 1982 and harvested August 24, 1982. Emergence (stand counts) were taken on June 4, 1982. Whole plant samples taken at soft dough (Aug. 11, 1982) were analyzed for nutrient content and used to calculate forage yield and nutrient uptake. Soil test results for the study were: pH - 8.3, $NaHCO_3$ P - 15 lb/A, exchangeable K - 300 lb/A, and NO_3-N (0-2') - 105 lb/A.

Results:

The treatments used are shown in Table 1. No significant differences in the elemental analyses of the samples taken at soft dough were obtained between the treatments (Table 1). Significant differences in stand count, grain yield, protein, test weight, and N removal were obtained between the treatments (Table 2).

Discussion:

Addition of high rates of N with the seed at planting time did reduce germination, but conditions were such that this reduction did not translate into a yield loss. Soil conditions promoted increased tillering which compensated for the loss in stand and generally resulted in higher yield and protein. The high rate of urea did decrease test weight, but since the N level in the soil was high, this was expected. Further studies will be conducted to evaluate the effects of large amounts of N in starter fertilizers on spring wheat.

Table 1. Effects of starter fertilizers on the elemental analyses of whole plant samples of spring wheat taken at soft dough (maturity).

		Elemental Analyses											
Source	N Rate	N	P	K	Ca	Mg	Al	Fe	Na	Mn	Zn	Cu	B
	lb/A	%					ppm						
Check	0	1.46	0.25	1.10	0.12	0.13	41	57	13	26	17	2	2
18-46-0	50	1.43	0.24	1.27	0.14	0.14	46	65	19	26	14	1	2
Urea	48	1.38	0.25	1.16	0.12	0.13	51	68	17	26	17	2	2
Urea	80	1.60	0.24	1.31	0.13	0.14	36	54	23	25	17	2	2
Significance		N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
C.V. (%)		8.5	13.8	15.8	29.9	7.0	67.7	46.8	23.2	8.2	16.9	27.2	34.0

Table 2. Effects of starter fertilizers on emergence, grain yield, protein, test weight, N removal, forage yield, N and P uptake of spring wheat.

			Grain				Forage		
		Stand			Test	N	Dry Matter	Uptake	
Source	N Rate	Count	Yield	Protein	Weight	Removal	Yield	N	P
	lb/A	Plants/A	Bu/A	%	lb/Bu	lb/A	lb/A		
Check	0	1,047,240	47.0	12.8	58.9	63.7	7126	105.3	17.4
18-46-0	50	939,210	51.2	13.4	58.6	72.2	7908	112.7	18.8
Urea	48	955,760	46.1	12.5	59.0	60.8	7343	101.5	18.4
Urea	80	798,940	49.8	13.9	56.8	73.1	7271	115.9	17.3
Significance		**	*	*	**	**	N.S.	N.S.	N.S.
B.L.S.D. (.05)		72,060	4.5	0.8	1.1	5.7			
C.V. (%)		4.9	5.2	3.7	1.1	5.2	8.1	13.1	14.9

SOIL TEST LEVELS AND CROP QUALITY AS AFFECTED BY DIFFERENT FERTILIZER PROGRAMS IN A CONTINUOUS WHEAT CROPPING SYSTEM

G. E. Varvel and R. K. Severson

The objective of this study was to measure the effects of different fertilizer programs, maintenance versus build, over a 10-year period on soil test levels and crop quality in a continuous wheat cropping system. Soil test and crop quality measurements are taken to provide information for evaluation and determination of the most effective program.

Experimental Procedure: Five treatments with 4 replications were arranged in a randomized complete block design. Each of these 5 fertilizer treatments was based upon soil test data from the plots on which that treatment had been applied to in the previous year. All of the treatments were applied in the fall of 1981 and plowed down. Era wheat was planted May 8, 1982 and harvested Aug. 17, 1982. Whole plant samples were taken at late-tillering (June 15, 1982) for elemental analyses. Whole plant samples taken Aug. 3, 1982 at soft dough were used to determine forage yields and analyzed for nutrient content so that N, P, and K uptake could be calculated. Soil samples taken Aug. 24, 1982 were analyzed for N, P, and K to determine the effects of the treatments and to establish the 1983 treatments.

Results: The effects of the treatments on elemental analyses of whole plant samples taken at the late-tillering and soft dough stages are shown in Tables 1 and 2, respectively. Significant differences in N, P, K, Na, Cu, and B levels at late-tillering and in N, P, K, Mg, Na, Zn, and B levels at maturity were obtained between the treatments. The effects of the treatments on grain and forage are shown in Table 3. Significant differences were obtained with respect to all the measured variables at grain and forage harvest except for protein content.

Soil test results from the fall of 1982 sampling are shown in Tables 4 and 5. Table 4 contains results from the samples taken for NO_3-N at the various depths and total NO_3-N for the 0-2' and 0-5' depths. No significant differences were obtained between NO_3-N levels at any depth or total NO_3-N in the 0-2' and 0-5' depths. Table 5 contains P and K soil test results for samples taken from the 0-6" and 6-12" depths. These samples were analyzed by both the University of Minnesota and North Dakota State University soil testing labs and results are presented from both of them. Significant differences in P levels between treatments were obtained by both labs except when the Bray 1 was used with the 10:1 extraction ratio. No differences in exchangeable K were obtained by either lab.

Discussion: All of the fertilizer programs have increased yields and some soil test levels over those of the check plot. Nitrogen has given the largest yield increases, but very little buildup in the soil has occurred to date. Phosphorus appears to be having a slight affect on yield and soil test levels are significantly higher than the check in all cases. Potassium has had no affect on yield or soil test levels. Yields have been extremely good, even though wheat has been grown for 5 years in a row.

Table 1. The effect of the different fertilizer programs on elemental analyses of whole plant samples taken at the late-tillering stage in a continuous wheat cropping system.

Treatment			Elemental Analyses											
N	P_2O_5	K_2O	N	P	K	Ca	Mg	Al	Fe	Na	Mn	Zn	Cu	B
lbs/A			%					ppm						
0	0	0	3.64	0.38	4.55	0.55	0.44	154	212	157	93	39	6	10
80	45	25	4.41	0.52	5.44	0.64	0.50	158	232	299	102	43	7	8
90	45	55	4.37	0.49	5.54	0.58	0.48	165	241	237	100	39	7	8
110	45	25	4.48	0.50	5.37	0.64	0.46	254	325	252	105	42	7	8
90	75	25	4.32	0.55	5.16	0.66	0.49	163	281	295	96	37	7	8
Significance			**	**	**	N.S.	N.S.	N.S.	N.S.	*	N.S.	N.S.	**	*
B.L.S.D. (.05)			0.20	0.03	0.40					93			1	1
C.V. (%)			3.2	4.7	5.0	8.8	7.9	47.5	39.8	22.7	5.5	8.3	5.9	8.6

Table 2. The effect of the different fertilizer programs on elemental analyses of whole plant samples taken at the soft dough stage in a continuous wheat cropping system.

Treatment N	Treatment P_2O_5	Treatment K_2O	Elemental Analyses N	P	K	Ca	Mg	Al	Fe	Na	Mn	Zn	Cu	B
- - - lbs/A - - -			- - - - - - - - % - - - - - - - -					- - - - - - - - - - - - ppm - - - - - - - - - - - -						
0	0	0	1.02	0.20	1.61	0.17	0.17	102	127	31	34	18	1	3
80	45	25	1.15	0.17	2.07	0.20	0.20	69	89	58	33	16	1	4
90	45	55	1.10	0.17	2.15	0.18	0.20	74	96	50	33	15	1	4
110	45	25	1.26	0.15	2.13	0.24	0.22	64	84	71	32	16	1	4
90	75	25	1.09	0.16	2.20	0.22	0.21	60	78	57	31	13	1	4
Significance			*	**	**	N.S.	*	N.S.	N.S.	*	N.S.	**	N.S.	*
B.L.S.D. (.05)			0.17	0.02	0.23		0.04			27		3		1
C.V. (%)			13.1		11.3	24.5	15.5	49.0	42.9	43.6	11.1	15.7	33.9	19.0

Table 3. The effect of the different fertilizer programs on grain yield, test weight, protein, N removal, forage yield, N, P, and K uptake in a continuous wheat cropping system.

Treatment N	Treatment P_2O_5	Treatment K_2O	Grain Yield	Grain Test Weight	Grain Protein	Grain N Removal	Forage Dry Matter Yield	Forage Uptake N	Forage Uptake P	Forage Uptake K
- - - lbs/A - - -			Bu/A	lb/Bu	%	lb/A	- - - - - - - - lb/A - - - - - - - -			
0	0	0	37.0	59.6	12.5	48.2	4906	50.4	9.6	79.4
80	45	25	66.1	59.0	12.7	88.5	8458	97.5	14.3	175.1
90	45	55	65.6	60.4	12.4	85.2	8464	93.9	14.4	182.4
110	45	25	61.6	57.4	12.6	81.0	8678	108.8	13.2	185.1
90	75	25	68.0	58.8	12.2	87.0	8843	96.6	13.9	194.6
Significance			**	**	N.S.	**	**	**	**	**
B.L.S.D. (.05)			5.6	1.3		11.0	791	16.1	2.2	22.2
C.V. (%)			10.1	2.1	13.7	14.8	10.7	18.7	16.5	14.5

Table 4. The effect of different fertilizer programs on residual NO_3-N soil test levels after 5 years in a continuous wheat cropping system.

Treatment N	Treatment P_2O_5	Treatment K_2O	NO_3-N 0-1'	1-2'	2-3'	3-4'	4-5'	Total NO_3-N 0-2'	0-5'
- - - lbs/A - - -			- - - - - - - - - - - - lb/depth - - - - - - - - - - - -					- - - lb/A - - -	
0	0	0	24	10	9	11	3	34	66
80	45	25	21	10	23	26	17	31	96
90	45	55	20	13	15	21	19	33	87
110	45	25	23	15	24	22	16	38	99
90	75	25	18	12	20	26	19	30	94
Significance			N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
C.V. (%)			24.1	47.7	67.2	51.9	34.4	30.0	35.3

Table 5. The effect of different fertilizer programs on residual P and K soil test levels after 5 years in a continuous wheat cropping system as determined by two soil testing laboratories.

Treatment N	Treatment P_2O_5	Treatment K_2O	N.D.S.U. $NaHCO_3$ P 0-6"	N.D.S.U. $NaHCO_3$ P 6-12"	N.D.S.U. Exchangeable K 0-6"	N.D.S.U. Exchangeable K 6-12"	University of Minnesota Bray P-1 10:1 0-6"	Bray P-1 10:1 6-12"	Bray P-1 50:1 0-6"	Bray P-1 50:1 6-12"	$NaHCO_3$ P 0-6"	$NaHCO_3$ P 6-12"	Exchangeable K 0-6"	Exchangeable K 6-12"
- - - lb/A - - -			- - - - - - lb/A - - - -				- - - - - - - - - - - - - - - - lb/A - - - - - - - - - - - -							
0	0	0	8	5	294	245	3	2	40	22	8	5	258	204
80	45	25	18	9	295	250	5	2	59	31	16	9	249	209
90	45	55	14	10	294	256	4	2	58	36	16	11	262	215
110	45	25	16	11	298	259	6	6	66	43	16	11	253	205
90	75	25	22	14	285	249	14	7	75	38	24	16	247	197
Significance			**	**	N.S.	N.S.	N.S.	N.S.	**	+	**	**	N.S.	N.S.
B.L.S.D. (.05)			5	5					15		4	5		
C.V. (%)			19.9	31.3	5.7	7.1	114.5	117.3	16.3	29.5	17.5	31.9	4.7	8.2

NITROGEN FERTILIZATION AND UTILIZATION BY TWELVE SMALL GRAIN VARIETIES - CROOKSTON, MN - 1982*

G.L. Malzer, S. Comfort, G. Varvel, R. Busch and T. Graff

The semi-dwarf varieties of hard red spring wheat account for a major portion of the acreage planted to hard red spring wheat in Minnesota. The development of these wheat varieties not only provided improved physical characteristics, but also provided the potential for a plant system which might be capable of responding to higher rates of nitrogen application without lodging. The reason why some wheat varieties respond more to nitrogen fertilization than other, is not well understood, but it has been suggested that it may be related to favorable plant characteristics both above and below the ground. Experiments were established in 1982 to examine some of the differences which exist between wheat varieties in their ability to provide a yield response to nitrogen fertilization and to ascertain differences in nitrogen utilization. Existing popular varieties as well as older varieties and experimental varieties were included for comparison in responsiveness to added fertilizer nitrogen as well to overall nitrogen utilization. Similar trials were conducted at Morris as well as Crookston, MN.

EXPERIMENTAL PROCEDURES

Twelve varieties of hard red spring wheat were compared at nitrogen application rates of 0, 60 and 120 # N/A at the Northwest Experiment Station at Crookston, MN. Nitrogen was applied as a spring application of ammonium nitrate broadcast and incorporated. The treatments were arranged in a split plot design with nitrogen as the main effect and the twelve varieties planted within a uniformly fertilized area. All treatments were replicated four times. Experimental plots were planted into areas 5' x 20' on April 29, utilizing a cone seeder.

Total plant dry matter production was determined at approximately the "soft dough" stage of growth (August 2nd) and samples were collected for nitrogen content and calculation of nitrogen uptake. Yield grain was harvested August 11 by harvesting 14 ft^2 of plot area. The above ground growth (grain and straw) was removed from the experimental plot and placed in a forced air dryer. After drying the samples were weighed, thrashed and the grain reweighed for yield determination. Straw weight was determined by difference. Samples of both the grain and the straw were collected for determination of nitrogen content and total nitrogen removal.

GENERAL RESULTS

The yield results obtained at Crookston in 1982 were excellent. Grain yields ranged from 38-76 bu/A. Grain yields were influenced by both variety and nitrogen rate. A significant nitrogen rate by variety interaction suggested that all varieties did not respond to nitrogen application in the same manner. One of the more interesting aspects of the interaction was the ability of certain varieties to continue to respond to additional nitrogen fertilizer when other "good" varieties did not increase in yield. Varieties which stood out in this respect included Marshall, Mn 7125, Olaf, MN 7357, MN 73167 and James. These varieties were capable of increasing their yields 7, 7, 7, 12, 12 and 10 bu/A when the nitrogen rate was increased from 60 # N/A to 120 # N/A. Other varieties either showed very little increase or yield reductions.

The nitrogen content of the grain which provides an index of grain protein, was significantly influenced by both nitrogen rate and variety. Grain protein was increased up through the highest rate of N application. Of the varieties mentioned above with good yielding characteristics at the 120 # N/A rate of application Olaf and James had a substantially higher N (protein content) concentration in the grain. In a similar comparison, MN 7125, MN 73167 and Olaf were the most effective in total N removal from the soil when 120 # N/A were applied.

*This project was financed through support in part by the Minnesota Wheat Council.

Table 1. Influence of nitrogen fertilizer and variety on yield, N content and test weight of 12 hard red spring wheat varieties from Crookston, MN - 1982.

Nitrogen Rate	Variety	Grain Yield	Grain N Content	Grain Test wt.	Forage Total Dry Matter	Forage N Content
#/A		bu/A	%	#/bu	T/A	%
0		43.3	2.13	59.1	3.35	0.63
60		58.6	2.35	59.5	4.46	0.89
120		62.9	2.61	58.6	4.62	1.13
Significance			**	NS	**	**
BLSD (.05)			0.01	--	0.11	0.05
-	Butte	54.8	2.33	60.8	4.56	0.76
-	Coteau	49.3	2.92	59.8	4.17	0.88
-	Era	54.2	2.19	59.4	3.68	0.91
-	Marshall	59.4	2.36	60.6	4.21	0.94
-	MN 7125	62.1	2.22	58.5	4.20	0.88
-	Mn 7222	52.8	2.25	57.9	3.99	0.87
-	Olaf	49.6	2.70	57.8	4.14	0.96
-	Thatcher	42.6	2.46	58.3	3.97	0.81
-	MN 7357	59.4	2.15	58.5	4.17	0.88
-	MN 73167	61.6	2.21	59.5	4.18	0.79
-	MN 73168	59.9	2.18	58.1	4.21	1.04
-	James	53.9	2.45	59.2	4.23	0.86
Significance			**	**	**	**
BLSD (.05)			0.01	0.9	0.24	0.12
Interaction - N rate x Variety						
0	Butte	47.8	1.98	60.4	4.08	0.62
0	Coteau	46.3	2.73	60.1	3.55	0.54
0	Era	40.1	1.98	59.0	2.85	0.58
0	Marshall	44.5	2.17	60.1	3.27	0.71
0	MN 7125	45.6	1.97	58.6	3.31	0.65
0	MN 7122	40.7	2.01	58.5	3.32	0.72
0	Olaf	37.8	2.51	57.9	3.26	0.62
0	Thatcher	38.0	2.16	58.2	3.27	0.57
0	MN 7357	43.1	1.88	58.2	3.30	0.61
0	MN 73167	45.5	2.03	59.6	3.40	0.59
0	MN 73168	47.1	1.97	59.0	3.18	0.66
0	James	43.8	2.22	58.9	3.42	0.64
60	Butte	61.3	2.31	61.0	4.84	0.70
60	Coteau	52.0	3.02	59.7	4.57	1.00
60	Era	59.6	2.12	60.1	4.14	0.94
60	Marshall	63.3	2.40	61.1	4.58	0.91
60	Mn 7125	67.0	2.23	59.1	4.69	0.89
60	MN 7222	56.1	2.15	58.5	4.12	0.87
60	Olaf	52.0	2.72	57.4	4.57	0.94
60	Thatcher	47.6	2.30	58.9	4.36	0.78
60	MN 7357	61.6	2.18	58.8	4.50	0.86
60	MN 37167	63.5	2.18	60.1	4.27	0.75
60	MN 73168	65.3	2.15	58.8	4.47	1.22
60	James	54.3	2.41	60.1	4.36	0.85

Table 1 continued on page after next

Table 2. Influence of nitrogen fertilization and variety on straw production and nitrogen uptake by forage, straw, and grain by 12 hard red spring wheat varieties from Crookston - 1982.

Nitrogen Rate	Variety	Harvest Straw Dry Matter	Harvest Straw N Content	Nitrogen Removal Forage	Nitrogen Removal Straw	Nitrogen Removal Grain	Grain α Straw
#/A		T/A	%	#/A			
0		1.61	0.27	42.3	8.7	48.4	57.1
60		2.25	0.40	80.2	18.0	58.6	76.6
120		2.58	0.59	104.1	30.8	62.9	93.7
Significance		**	**	**	**		
BLSD (.05)		0.09	0.03	5.2	1.8		
-	Butte	2.32	0.34	69.8	16.5	67.0	83.5
-	Coteau	2.45	0.45	75.4	22.7	75.4	98.1
-	Era	1.94	0.45	69.6	18.8	62.8	81.6
-	Marshall	2.19	0.38	82.3	17.5	74.0	91.5
-	MN 7125	2.12	0.46	76.5	20.7	73.5	94.2
-	MN 7222	1.93	0.45	70.6	18.7	62.8	81.5
-	Olaf	2.30	0.44	82.9	22.2	70.8	93.0
-	Thatcher	2.16	0.36	66.1	16.2	54.8	71.0
-	MN 7357	1.97	0.43	76.6	18.2	68.1	86.3
-	MN 73167	2.11	0.43	68.6	19.1	71.9	91.1
-	MN 73168	2.04	0.45	92.8	19.9	68.8	88.7
-	James	2.25	0.40	74.8	19.4	69.8	89.2
Significance		**	**	**	*		
BLSD (.05)		0.20	0.06	12.7	5.4		
Interaction - N rate x Variety							
0	Butte	1.89	0.22	51.6	8.5	49.5	58.0
0	Coteau	2.06	0.28	39.0	11.7	66.8	78.5
0	Era	1.44	0.27	33.4	7.8	41.6	49.4
0	Marshall	1.73	0.25	47.2	8.6	50.5	59.1
0	MN 7125	1.55	0.30	42.8	9.2	47.2	56.4
0	MN 7222	1.27	0.35	48.1	8.9	42.5	51.4
0	Olaf	1.63	0.23	40.1	7.6	49.7	57.3
0	Thatcher	1.66	0.25	37.3	8.5	43.2	51.7
0	MN 7357	1.35	0.28	40.9	7.4	42.3	49.7
0	MN 73167	1.64	0.29	40.4	9.5	48.0	57.5
0	MN 73168	1.48	0.25	42.6	7.4	48.5	55.9
0	James	1.62	0.30	44.0	9.8	51.0	60.8
60	Butte	2.42	0.30	68.4	14.5	73.5	88.0
60	Coteau	2.59	0.51	91.9	26.4	82.1	108.5
60	Era	2.06	0.43	79.2	17.7	65.7	83.4
60	Marshall	2.22	0.34	83.4	15.0	79.4	94.4
60	MN 7125	2.22	0.45	84.9	19.9	78.2	98.1
60	MN 7222	2.07	0.36	72.4	15.1	63.0	78.1
60	Olaf	2.45	0.43	87.8	21.7	74.4	96.1
60	Thatcher	2.45	0.36	67.7	17.5	57.4	74.9
60	MN 7357	1.99	0.38	77.9	15.1	70.4	85.5
60	MN 73167	2.13	0.41	64.0	17.7	72.5	90.2
60	MN 73168	2.15	0.45	110.0	19.7	73.4	93.1
60	James	2.26	0.34	74.1	15.6	68.4	84.0

Table 2 continued on next page

Table 1. Influence of nitrogen fertilizer and variety on yield, N content and test weight of 12 hard red spring wheat varieties from Crookston, MN - 1982. (cont.)

Nitrogen Rate	Variety	Grain Yield	Grain N Content	Grain Test wt.	Forage Total Dry Matter	Forage N Content
#/A		bu/A	%	#/bu	T/A	%
120	Butte	55.3	2.69	60.9	4.76	0.94
120	Coteau	49.6	3.00	59.6	4.40	1.08
120	Era	62.9	2.47	59.2	4.03	1.20
120	Marshall	70.4	2.51	60.5	4.78	1.21
120	MN 7125	73.6	2.46	57.8	4.58	1.11
120	MN 7222	61.7	2.58	56.7	4.54	1.01
120	Olaf	59.0	2.87	58.1	4.60	1.31
120	Thatcher	42.3	2.90	57.7	4.28	1.09
120	MN 7357	73.7	2.37	58.4	4.71	1.18
120	MN 73167	75.7	2.41	58.9	4.87	1.04
120	MN 73168	67.2	2.41	56.6	4.97	1.26
120	James	63.8	2.72	58.5	4.91	1.08
Significance		**	NS	NS	NS	NS

Table 2. Influence of nitrogen fertilization and variety on straw production and nitrogen uptake (cont.) by forage, straw, and grain by 12 hard red spring wheat varieties from Crookston - 1982.

Nitrogen Rate	Variety	Harvest Straw Dry Matter	Harvest Straw N Content	Nitrogen Removal Forage	Nitrogen Removal Straw	Nitrogen Removal Grain	Grain α Straw
#/A		T/A	%	#/A			
120	Butte	2.66	0.49	89.4	26.5	77.8	104.3
120	Coteau	2.70	0.56	95.4	30.2	77.3	107.5
120	Era	2.32	0.66	96.3	30.7	81.1	111.8
120	Marshall	2.61	0.56	115.8	28.9	92.1	121.0
120	MN 7125	2.60	0.62	101.8	33.0	94.9	127.9
120	MN 7222	2.45	0.65	91.3	32.1	82.9	115.0
120	Olaf	2.81	0.65	120.9	37.3	88.4	125.7
120	Thatcher	2.37	0.48	93.3	22.6	63.9	86.5
120	MN 7357	2.58	0.62	110.9	31.9	91.5	123.4
120	MN 73167	2.57	0.59	101.4	30.5	95.3	125.8
120	MN 73168	2.48	0.64	126.0	32.8	84.5	117.3
120	James	2.86	0.57	106.4	32.7	90.2	122.9
Significance		NS	NS	NS	NS	**	*

COMPARISON OF NITROGEN SOURCES ON SPRING WHEAT AND BARLEY

G. E. Varvel and R. K. Severson

Nitrogen fertilization is one of the largest investments for small grain farmers in northern Minnesota. Information on the source and amount to use is available, but the release of new varieties presents the need for additional evaluation of N rates and sources. These studies were designed to evaluate N sources on both spring wheat and barley.

Experimental Procedure:

Four sources, each at 2 N levels, were used. The 4 sources were anhydrous ammonia (82-0-0), urea (46-0-0), UAN solution (28-0-0), and ammonium nitrate (34-0-0). A check plot was also included. A randomized complete block design with 4 replications was used in both studies. All fertilizer treatments were applied on May 7, 1982 and incorporated with a field cultivator. Era wheat and Robust barley were seeded on May 8, 1982 in the respective studies. Whole plant samples were taken on June 21, 1982 for total N analyses on both studies. Whole plant samples taken at soft dough (July 23, 1982 for barley and August 9, 1982 for wheat) were analyzed for total N and used to calculate forage yields and N uptake. Grain was harvested August 9, 1982 from the barley and August 23, 1982 from the wheat study. Soil test NO_3-N (0-2') results from the two studies were 50 lb/A for the barley study and 40 lb/A for the wheat study.

Results:

The effects of the treatments are shown in Tables 1 and 2 for the barley and wheat studies, respectively. Significant differences were obtained in all the measured variables except test weight for both crops when the check plot was included in the analyses. Elimination of the check plot from the analyses enabled the treatments to be broken down into the N rate and source effects. These analyses indicated that most of the differences were due to the N rates. Some differences were obtained between sources, but these were obtained because of an application error with anhydrous ammonia.

Table 1. The effect of N source and rate on barley yield and quality.

N		Early Plant	Grain					Forage			
Source	Rate	N	Yield	Test Weight	Plumps	Protein	N Removal	Dry Matter Yield	N	N Uptake	Lodging
		%	Bu/A	lb/Bu	%	%	lb/A	lb/A	%	lb/A	
--	0	2.76	57.7	48.6	91.5	11.1	49.6	5352	0.98	52.6	1.6
82-0-0	50	3.05	80.0	48.1	90.3	10.9	67.0	6657	0.96	63.6	3.5
	100	3.91	79.7	47.4	86.0	11.8	72.4	7499	1.23	91.6	5.5
46-0-0	50	3.63	77.2	48.4	87.4	11.6	68.8	7229	1.29	92.3	3.5
	100	3.98	77.5	47.3	83.6	12.2	72.8	7711	1.18	90.8	6.6
28-0-0	50	3.59	81.0	47.9	85.5	11.9	74.0	7766	1.14	88.4	4.9
	100	4.19	76.0	47.7	84.1	12.5	73.4	7365	1.42	103.3	5.9
34-0-0	50	3.59	72.2	48.0	87.5	11.3	62.6	6986	1.14	78.6	3.9
	100	3.87	76.3	47.8	85.3	11.8	69.5	7528	1.25	94.9	6.4
Significance		**	**	N.S.	**	**	**	**	**	**	**
B.L.S.D. (.05)		0.39	9.8		3.8	0.8	11.3	1013	0.21	14.5	2.7
C.V. (%)		10.4	11.8	2.0	3.8	6.1	14.9	12.8	15.6	16.4	49.8
Main Effects											
Source											
82-0-0		3.48	79.9	47.8	88.1	11.4	69.7	7078	1.09	77.6	4.5
46-0-0		3.80	77.3	47.8	85.5	11.9	70.8	7470	1.23	91.5	5.1
28-0-0		3.89	78.5	47.8	84.8	12.2	73.7	7565	1.28	95.8	5.4
34-0-0		3.73	74.2	47.9	86.4	11.6	66.1	7257	1.20	86.8	5.1
Significance		N.S.	N.S.	N.S.	N.S.	*	N.S.	N.S.	N.S.	*	N.S.
N Rate (lb/A)											
50		3.52	77.3	48.1	87.3	11.5	68.2	7231	1.16	83.2	4.0
100		4.00	77.0	47.6	84.6	12.1	72.0	7530	1.28	95.7	6.2
Significance		**	N.S.	*	**	*	N.S.	N.S.	*	**	**

Discussion:
Results from the study on barley indicated that the 50 lb/A N application was sufficient for maximum yields with all the N sources used. Additional N reduced quality and increased lodging with all of the N sources.

Results from the study on wheat indicated that the 50 lb/A N application was insufficient for maximum yield, but the 100 lb/A application was probably too high with all of the N sources. Maximum yield and suitable quality could probably have been obtained with 70 lb/A N applied which would correspond very well with current N recommendations for spring wheat.

Further studies will be used to compare application methods of the N sources in an attempt to increase N efficiency.

Table 2. The effect on N source and rate on spring wheat yield and quality.

N Source	N Rate	Early Plant N	Grain Yield	Grain Test Weight	Grain Protein	Grain N Removal	Forage Dry Matter Yield	Forage N	Forage N Uptake
	lb/A	%	Bu/A	lb/Bu	%	lb/A	lb/A	%	lb/A
--	0	2.80	31.8	59.4	11.0	36.9	4685	1.79	55.4
82-0-0	50	2.80	45.1	59.0	10.7	50.5	6789	1.02	69.4
	100	3.49	59.9	59.5	11.5	72.2	8902	1.38	122.3
46-0-0	50	3.28	52.2	59.9	11.4	62.9	7655	1.18	90.7
	100	3.83	59.2	59.6	12.1	75.3	8873	1.37	121.3
28-0-0	50	3.41	53.2	59.5	11.2	62.6	7905	1.19	94.2
	100	4.00	56.4	59.2	12.6	74.9	8670	1.40	120.1
34-0-0	50	3.36	52.3	59.7	11.3	62.0	7514	1.27	94.7
	100	3.90	57.8	58.8	12.3	74.4	8674	1.32	114.7
Significance		**	**	N.S.	**	**	**	**	**
B.L.S.D. (.05)		0.34	3.8		0.7	5.5	764	0.18	15.1
C.V. (%)		9.5	7.4	1.5	5.8	8.7	9.9	11.9	15.1
Main Effects									
Source									
82-0-0		3.15	52.5	59.2	11.1	61.4	7845	1.20	95.9
46-0-0		3.55	55.7	59.8	11.8	69.1	8264	1.28	106.0
28-0-0		3.70	54.8	59.3	11.9	68.9	8287	1.29	107.2
34-0-0		3.63	55.0	59.2	11.8	68.2	8094	1.30	104.7
Significance		**	N.S.	N.S.	*	**	N.S.	N.S.	N.S.
N Rate (lb/A)									
50		3.27	51.5	59.6	11.2	60.8	7562	1.19	89.8
100		3.85	58.1	59.3	12.2	74.5	8763	1.36	119.2
Significance		**	**	N.S.	**	*	**	**	**

EFFECTS OF NITROGEN RATE AND PLACEMENT ON TWO MALTING BARLEY VARIETIES

G. E. Varvel and R. K. Severson

The importance of malting barley in Northwestern Minnesota has generated the need for additional information on N fertilization with the release of new higher yielding varieties. The higher yield potential of these varieties is due in part to greater straw strength and disease resistance, which may allow greater N fertilization. This study was established to evaluate two varieties, Morex and Glenn, under various N management programs.

Experimental Procedure:

The treatments consisted of N from UAN solution (28-0-0) at rates of 0, 50, 100, and 150 lb/A both surface applied (broadcast) and injected (6 inches deep, 12 inches apart), on two malting barley varieties in a factorial arrangement. A randomized complete block design with 4 replications was used. Initial soil test results indicated 50 lb NO_3-N/A available in the top 2 feet.

The fertilizer was applied and varieties planted on May 8, 1982. Whole plant samples were taken at late-tillering (June 21, 1982) and soft dough (July 23, 1982) for N analyses. The samples taken at soft dough (maturity) were used to calculate forage yield and N uptake. Grain was harvested August 9, 1982 for yield and quality determinations. Lodging ratings were made on July 26, 1982.

Results:

The effects of variety, N rate, placement, and the variety by N rate interaction are shown in Table 1. All possible interactions were analyzed, but only the variety by N rate interaction was significant with respect to any of the measured variables. Those variables were grain yield, test weight, plump kernels, and lodging. Lodging differences between the varieties at the various N levels appeared to be the main cause of the interaction. Glenn was able to withstand the higher N rates without lodging as greatly as Morex under the same conditions. The lodging differences then caused most of the differences in grain yield, test weight, and plump kernels which resulted in the interaction being significant for those variables also.

Significant differences in early plant N content, forage yield, and forage N content were obtained between varieties (Table 1). Morex had a significantly higher early plant N and forage yield but Glenn was significantly higher in forage N content.

Early plant N content, forage yield, forage N content, N uptake, protein, and grain N removal were all significantly increased with increased N rate (Table 1).

Nitrogen placement had no effect on any of the measured variables in 1982 (Table 1).

Discussion:

Results obtained in 1982 were similar to those obtained in the 1981 study except that lodging appeared to be more of a problem in 1982. Results from both years emphasize the importance of N management and the need for additional information with respect to the new varieties.

Table 1. Effects of variety, N rate, N placement, and variety by N rate interaction on early plant N content, forage yield, forage N content, N uptake, grain yield, test weight, protein, plump kernels, grain N removal, and lodging of barley.

Interaction			Forage			Grain					
Variety	N-Rate	N[1/]	D.M. Yield	N[2/]	N Uptake	Yield	Test Weight	Protein	Plump Kernels	N Removal	Lodging[3/]
	lb/A	%	lb/A	%	lb/A	Bu/A	lb/Bu	%	%	lb/A	
Morex	0	3.22	5217	1.40	72.6	64.4	46.6	11.7	84.2	57.8	1.7
Morex	50	3.78	6122	1.45	87.8	65.7	45.8	11.9	79.5	60.1	3.0
Morex	100	4.25	6297	1.69	106.8	66.4	43.9	13.1	69.5	66.6	6.0
Morex	150	4.35	6681	1.81	121.3	62.7	42.4	13.7	57.2	66.0	7.5
Glenn	0	3.23	5340	1.45	77.3	54.9	45.7	11.6	87.3	49.1	1.0
Glenn	50	3.84	5235	1.61	84.2	62.6	44.8	11.9	84.3	57.1	1.7
Glenn	100	3.97	5907	1.88	110.8	64.3	43.9	12.9	77.0	64.0	1.7
Glenn	150	3.96	5570	1.96	108.2	68.2	43.7	12.8	78.5	67.2	3.2
Significance		N.S.	N.S.	N.S.	N.S.	*	**	N.S.	*	N.S.	**
Main Effects											
Variety											
Morex		3.90	6079	1.59	97.1	64.8	44.7	12.6	72.6	62.6	4.5
Glenn		3.75	5513	1.72	95.1	62.5	44.5	12.3	81.8	59.4	1.9
Significance		*	**	*	N.S.	--	--	N.S.	--	N.S.	--
N Rate (lb/A)											
0		3.22	5279	1.42	74.9	59.6	46.1	11.7	85.8	53.5	1.3
50		3.81	5679	1.53	86.0	64.1	45.3	11.9	81.9	58.6	2.3
100		4.11	6102	1.79	108.8	65.3	43.9	13.0	73.3	65.3	3.8
150		4.15	6125	1.88	114.8	65.4	43.0	13.3	67.8	66.6	5.3
Significance		**	*	**	**	--	--	**	--	**	--
N Placement											
Surface		3.78	5912	1.62	96.0	63.3	44.8	12.4	76.5	60.3	3.2
Injected		3.87	5680	1.69	96.3	63.9	44.4	12.5	77.9	61.7	3.3
Significance		N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.

1/ Kjeldahl N (whole plant at late-tillering)

2/ Kjeldahl N

3/ Lodging scores (1=erect, 10=flat)

EFFECTS OF NITROGEN ON SUNFLOWER

G. E. Varvel and R. K. Severson

The objective of these studies was to evaluate various N management practices on sunflower. These practices included determining the effect of anhydrous ammonia applied at planting time on the germination of sunflower and comparison of N carriers, broadcast and injected, on sunflower.

Experimental Methods:

Experiment 1 consisted of 4 rates of N (0, 50, 100, and 150 lb/A) as anhydrous ammonia. A randomized complete block design with 4 replications was used. The anhydrous application was made at a depth of 4-5 inches with a knife spacing of 12 inches on May 27, 1982. Sunflower, Dahlgren 844, was planted in 30 inch rows immediately after the anhydrous was applied. Stand counts were taken on June 8, 1982 to determine the effects of the treatments on germination.

Experiment 2 contained 12 treatments in a randomized complete block design with 4 replications. The treatment consisted of a broadcast and injected check (applicator pulled through), anhydrous ammonia (82-0-0) injected at 2 N rates, urea (46-0-0) broadcast and injected at 2 N rates, and UAN solution (28-0-0) broadcast and injected at 2 N rates. Sunflower, Dahlgren 844, was planted in 30 inch rows on May 27, 1982. Soil test results for the study were: pH - 8.4, $NaHCO_3$ P - 11 lb/A, exchangeable K - 260 lb/A, and NO_3-N (0-2') - 108 lb/A.

Leaf samples were taken from both experiments on August 2, 1982 to evaluate the effects of the treatments.

Results:

Sunflower midge destroyed both experiments so only stand counts and leaf N analyses information was obtained.

The effect of N as anhydrous ammonia on stand counts (germination) and leaf N analyses in experiment 1 is shown in Table 1. A significant reduction in germination was obtained with the highest N rate and the N in the leaf increased significantly as N rate increased.

The effect of the treatments on leaf N analyses in experiment 2 is shown in Table 2. Leaf N content increased with N rate, but carrier and placement had no effect.

Discussion:

The reduction (approximately 10%) in stand with anhydrous ammonia at planting time was obtained at the 150 N/A rate which indicates that N rates commonly applied to sunflower could be made safely at planting time. Further studies are planned to evaluate these effects.

Table 1. The effects of anhydrous ammonia at planting time on sunflower germination and leaf nitrogen analyses

N Rate	Stand Count	Leaf N
lb/A	Plants/Plot	%
0	454	2.47
50	453	2.72
100	447	3.30
150	415	3.51
Significance	*	*
B.L.S.D. (.05)	36	0.8
C.V. (%)	4.6	15.8

Table 2. The effects of nitrogen rate, carrier, and application method on sunflower leaf nitrogen analyses.

N Rate	Leaf N
lb/A	%
0	3.10
50	3.16
100	3.43
Significance	*
Carrier	
82-0-0	3.35
46-0-0	3.36
28-0-0	3.20
Significance	N.S.
Placement	
Broadcast	3.36
Injected	3.25
Significance	N.S.

NITROGEN, PHOSPHORUS, AND POTASSIUM FERTILITY STUDIES ON OILSEED SUNFLOWER

G. E. Varvel and R. K. Severson

Fertilizer response data for sunflower in Minnesota is limited in nature and amount. These studies were designed to generate additional information on the effects of N, P, and K fertilization on sunflower growth and yield.

Experimental Procedure:
Two experiments were established in the spring of 1982. These experiments were located near Fertile (location 1) and Fosston (location 2). Additional information on the two experiments is shown in the table below:

	Soil Tests						Date (1982)	
Location	pH	NO_3-N	$NaHCO_3$ P	Exch. K	Variety	Plant Population	Planting	Harvest
		lb/A-2'	lb/A	lb/A		Plants/A		
1	7.3	34	14	170	Cargill 205	22,590	6-6	10-12
2	8.4	75	6	240	USDA 894	17,860	6-9	10-15

Preliminary information from the 2 sites indicated that location 1 was low in soil test K and location 2 was low in soil test P. Based upon this information, the treatments at location 1 consisted of 2 N levels (0 and 100 lb/A), 2 P_2O_5 levels (0 and 80 lb/A), and 3 K_2O levels (0, 100, and 200 lb/A) in a factorial arrangement. The treatments at location 2 consisted of 2 N levels (0 and 100 lb/A), 3 P_2O_5 levels (0, 40, and 80 lb/A), and 2 K_2O levels (0 and 100 lb/A) in a factorial arrangement. Location 1 also had 100 lb/A N applied by the farmer-cooperator.

Whole plant samples were taken twice at location 1 and once at location 2 for elemental analyses and total dry matter yields. Leaf samples were also taken at 50% pollination for elemental analyses. Seed yields were taken on the dates shown in Table 1. Seed from the various treatments was then used for oil and elemental analyses.

Results:
All results will be reported with respect to the main effects since no significant interactions were obtained.

Location 1: The effects of the N, P, and K treatments on sunflower are shown in Tables 1 through 5.

Nitrogen significantly increased N, Na, and Mn content in the plant and N and K uptake at the first sampling (Table 1), had no effect at the second sampling (Table 2), significantly increased N and Zn content and decreased K and Ca content in the leaf (Table 3), significantly decreased oil content in the seed and increased N removal at harvest (Table 4), and significantly increased N, Fe, Mn, and Zn content and decreased K, Mg, Ca, Al, and Cu content in the seed at harvest (Table 5).

Phosphorus significantly increased early plant growth, N, P, and K uptake, and P, Mg, and B content and decreased Al, Fe, and Zn content in the plant at the first sampling (Table 1), had no effect at the second sampling (Table 2), significantly increased P and Mg content and decreased K, Zn, and Cu content in the leaf (Table 3), significantly increased seed yield, and P and K removal at harvest (Table 4), and significantly increased P and Mg content and decreased Cu content in the seed at harvest (Table 5).

Potassium significantly increased K uptake and K content and decreased Ca and Mg content in the plant at the first sampling (Table 1), significantly decreased Al and Fe content in the plant at the second sampling (Table 2), significantly increased K and B content and decreased Mg content in the leaf (Table 3), significantly increased seed yield, oil content, oil yield, N removal, and K removal at harvest (Table 4) and significantly increased Mn content and decreased Mg content in the seed at harvest (Table 5).

Location 2: The effects of N, P, and K treatments on sunflower are shown in Tables 6 through 9.

Nitrogen had no effect at the early sampling (Table 6), significantly increased Zn content in the leaf (Table 7), had no effect on any of the yield variables at harvest (Table 8), and significantly increased N content and decreased Al content in the seed at harvest (Table 9).

Phosphorus significantly increased early plant growth, N, P, and K uptake and decreased Mn content in the plant at the early sampling (Table 6), significantly increased P and B content and decreased K, Zn, and Cu content in the leaf (Table 7), significantly increased seed yield, oil yield, and N, P, and K removal by the seed at harvest (Table 8), and significantly increased P, Mg, and Mn content and decreased Ca, Al, Zn, and Cu content in the seed at harvest (Table 9).

Potassium significantly decreased N uptake, and N and Na content in the plant at the early sampling (Table 6), significantly decreased Ca content in the leaf (Table 7), had no effect on any of the yield variables at harvest (Table 8), and significantly decreased Al content in the seed at harvest (Table 9).

Discussion:
The results obtained in 1982 are similar to those reported in previous years. Phosphorus increases early plant growth when soil test levels are in the low to medium range as they were in 1982 at both locations. At later samplings, the difference in growth is usually lost and only by using elemental analyses can differences be obtained. Even then, increased seed yield cannot be predicted. From leaf analyses one does appear to be able to discern differences, but these may be the result of luxury consumption, so precautions must be taken. The best method to predict the probability of a response to N, P, and K is to use a soil test. In 1982, as well as in previous years, if the soil test was in the low to medium range, significant increases in yield were usually obtained. The plant and seed analyses does provide valuable information which can be used to evaluate the effectiveness of the fertilizer treatments and also provides information on nutrient uptake and removal by sunflower.

Table 1. Effects of N, P, and K on early plant growth, nutrient uptake, and elemental analyses of sunflower at location 1 at the V13-R1 stage.[1/]

Main Effects	T.D.M. Yield	Uptake N	Uptake P	Uptake K	Elemental Analyses N	P	K	Ca	Mg	Al	Fe	Na	Mn	Zn	Cu	B
	- - - -	lbs/A	- - -		- - - - - -		%	- - - - - -		- - - - - - - -			ppm	- - - - - -		
N Rate (lb/A)																
0	596	23.9	2.6	30.9	4.03	.44	5.14	2.81	1.18	355	431	142	122	58	5	69
80	635	26.6	2.9	34.3	4.20	.45	5.37	2.89	1.26	361	416	176	155	60	5	63
Significance	N.S.	**	N.S.	+	**	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	*	*	N.S.	N.S.	N.S.
P_2O_5 Rate (lb/A)																
0	547	22.7	2.4	29.0	4.16	.43	5.26	2.80	1.16	394	453	147	131	59	5	65
80	684	27.9	3.2	36.2	4.06	.46	5.26	2.90	1.28	322	394	172	146	58	4	68
Significance	**	**	**	**	N.S.	**	N.S.	N.S.	*	**	*	N.S.	N.S.	N.S.	**	**
K_2O Rate (lb/A)																
0	596	24.5	2.8	27.3	4.12	.46	4.59	2.99	1.36	375	426	164	122	55	5	66
100	625	25.5	2.8	32.8	4.10	.44	5.20	2.84	1.24	356	425	151	143	59	5	65
200	626	25.8	2.7	37.7	4.12	.43	5.99	2.72	1.06	343	421	162	151	62	5	67
Significance	N.S.	N.S.	N.S.	**	N.S.	N.S.	**	**	**	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.

[1/] Schneiter, A.A. and J.F. Miller. 1981. Description of sunflower growth stages. Crop Sci. 21:901-903.

Table 2. Effects of N, P, and K on plant growth, nutrient uptake, and elemental analyses of sunflower at location 1 at the R 5.5 stage.

Main Effects	T.D.M. Yield	Uptake N	Uptake P	Uptake K	Elemental Analyses N	P	K	Ca	Mg	Al	Fe	Na	Mn	Zn	Cu	B
	- - - - lbs/A - - -				- - - - - - % - - - - - -					- - - - - - - - ppm - - - - - - -						
N Rate (lb/A)																
0	5401	95.8	15.3	137.9	1.77	.28	2.56	1.75	.78	140	176	49	85	27	5	44
80	5158	87.1	14.2	137.9	1.68	.27	2.67	1.76	.75	131	166	45	79	26	4	44
Significance	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
P_2O_5 Rate (lb/A)																
0	5304	89.2	14.9	132.6	1.67	.28	2.50	1.74	.78	135	168	52	77	25	5	43
80	5255	93.7	14.6	143.2	1.78	.28	2.73	1.77	.76	137	174	41	87	27	5	45
Significance	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
K_2O Rate (lb/A)																
0	5173	90.0	14.5	137.2	1.73	.28	2.66	1.77	.76	144	179	48	82	27	5	43
100	5460	92.8	14.6	134.4	1.69	.27	2.46	1.70	.77	142	178	41	89	26	5	43
200	5206	91.6	15.1	142.0	1.75	.29	2.72	1.79	.77	122	155	51	76	26	5	47
Significance	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.

Table 3. Effects of N, P, and K treatments on elemental analyses of sunflower leaves at location 1 at the R 5.5 stage.

Main Effects	Elemental Analyses N	P	K	Ca	Mg	Al	Fe	Mn	Zn	Cu	B
	- - - - - - - - % - - - - - - - -					- - - - - - - - - - - ppm - - - - - - - - -					
N Rate (lb/A)											
0	3.56	0.39	3.25	3.67	0.97	30	84	148	32	9	60
80	3.91	0.40	3.08	3.34	1.05	28	84	172	39	9	54
Significance	**	N.S.	**	**	N.S.	N.S.	N.S.	N.S.	**	N.S.	N.S.
P_2O_5 Rate (lb/A)											
0	3.74	0.39	3.25	3.41	0.95	29	85	157	37	10	58
80	3.73	0.41	3.08	3.60	1.08	30	84	163	34	8	56
Significance	N.S.	*	**	+	**	N.S.	N.S.	N.S.	**	**	N.S.
K_2O Rate (lb/A)											
0	3.75	0.41	2.84	3.65	1.16	29	84	143	35	9	55
100	3.68	0.38	3.07	3.44	1.02	31	85	169	35	9	51
200	3.78	0.40	3.59	3.43	0.86	28	83	168	36	9	64
Significance	N.S.	+	**	N.S.	**	N.S.	N.S.	N.S.	N.S.	N.S.	*

Table 4. Effect of N, P, and K treatments on seed and oil yield, oil content, nutrient removal, and plant population at harvest at location 1.

Main Effects	Seed Yield	Seed Oil	Seed Oil Yield	Seed N Removal	Seed P Removal	Seed K Removal	Total Population
	lb/A	%	lb/A	lb/A	lb/A	lb/A	Plants/A
N Rate (lb/A)							
0	1843	48.1	887	45.9	10.8	17.3	22,772
80	1939	46.6	904	53.3	11.1	17.6	22,409
Significance	N.S.	**	N.S.	**	N.S.	N.S.	N.S.
P_2O_5 Rate (lb/A)							
0	1828	47.5	868	48.0	10.2	16.9	22,554
80	1954	47.2	923	51.2	11.7	18.0	22,627
Significance	+	N.S.	N.S.	N.S.	**	+	N.S.
K_2O Rate (lb/A)							
0	1810	46.5	842	47.3	10.8	16.6	22,724
100	1856	47.8	886	48.0	10.4	17.0	22,724
200	2007	47.8	958	53.5	11.6	18.8	22,325
Significance	+	**	*	+	N.S.	*	N.S.

Table 5. Effects of N, P, and K treatments on elemental analyses of the seed at harvest at location 1.

Main Effects	N	P	K	Ca	Mg	Al	Fe	Mn	Zn	Cu	B
	%					ppm					
N Rate (lb/A)											
0	2.47	.58	.94	.21	.34	4.9	48	24	42	9.4	14.6
80	2.75	.57	.91	.19	.33	4.4	52	26	50	8.7	14.9
Significance	**	N.S.	*	**	+	**	**	**	**	+	N.S.
P_2O_5 Rate (lb/A)											
0	2.61	.56	.92	.20	.33	4.6	50	25	47	9.5	14.6
80	2.61	.60	.92	.20	.34	4.7	50	26	45	8.6	14.9
Significance	N.S.	**	N.S.	N.S.	**	N.S.	N.S.	N.S.	N.S.	*	N.S.
K_2O Rate (lb/A)											
0	2.61	.59	.92	.20	.35	4.4	49	24	47	9.3	14.8
100	2.57	.56	.92	.21	.33	4.6	50	26	45	9.3	14.4
200	2.66	.58	.94	.21	.33	4.9	52	26	47	8.7	15.0
Significance	N.S.	N.S.	N.S.	N.S.	**	N.S.	N.S.	*	N.S.	N.S.	N.S.

Table 6. The effects of N, P, and K treatments on early plant growth, nutrient uptake, and elemental analyses of sunflower at location 2 at the V13-R1 stage.

Main Effects	T.D.M. Yield	Uptake N	Uptake P	Uptake K	Elemental Analyses N	P	K	Ca	Mg	Al	Fe	Na	Mn	Zn	Cu	B
	- - - lbs/A - - -				- - - - - - - - - - % - - - - - - - - - -							- - - - - ppm - - - -				
N Rate (lb/A)																
0	321	11.7	.97	14.3	3.61	.30	4.51	3.48	1.33	.33	.27	362	169	37	8.9	44
80	314	11.2	.93	14.3	3.55	.29	4.53	3.68	1.35	.33	.28	351	174	39	9.3	43
Significance	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
P_2O_5 Rate (lb/A)																
0	282	10.1	.82	12.8	3.54	.29	4.58	3.78	1.38	.35	.29	371	177	38	9.5	43
40	326	11.8	.98	14.5	3.61	.30	4.47	3.48	1.29	.32	.27	344	171	39	9.0	43
80	346	12.4	1.05	15.7	3.59	.30	4.51	3.47	1.35	.32	.26	354	166	36	8.7	44
Significance	**	**	**	*	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	*	N.S.	N.S.	N.S.
K_2O Rate (lb/A)																
0	331	12.0	.99	14.4	3.62	.30	4.40	3.57	1.37	.34	.27	373	170	37	9.0	44
100	305	10.8	.90	14.3	3.54	.29	4.65	3.59	1.32	.33	.27	340	173	39	9.1	43
Significance	N.S.	*	N.S.	N.S.	+	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	+	N.S.	N.S.	N.S.	N.S.

Table 7. The effects of N, P, and K treatments on elemental analyses of sunflower leaves at location 2 at the R 5.5 stage.

Main Effects	Elemental Analyses N	P	K	Ca	Mg	Al	Fe	Mn	Zn	Cu	B
	- - - - - - - - - % - - - - - - - - -					- - - - - - - - - ppm - - - - - - - - -					
N Rate (lb/A)											
0	4.43	.41	3.37	2.36	1.09	29	90	71	45	19	105
80	4.50	.41	3.36	2.35	1.11	33	93	71	48	19	104
Significance	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	**	N.S.	N.S.
P_2O_5 Rate (lb/A)											
0	4.54	.38	3.52	2.30	1.06	37	94	70	52	21	100
40	4.45	.41	3.32	2.37	1.09	27	90	73	45	18	104
80	4.41	.44	3.26	2.38	1.14	29	92	71	43	17	109
Significance	N.S.	**	*	N.S.	N.S.	N.S.	N.S.	N.S.	**	**	**
K_2O Rate (lb/A)											
0	4.43	.41	3.25	2.40	1.13	36	96	72	47	19	104
100	4.50	.41	3.48	2.31	1.07	26	87	70	46	18	104
Significance	N.S.	N.S.	N.S.	+	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.

Table 8. The effects of N, P, and K treatments on seed and oil yield, oil content, nutrient removal by the seed, and plant population at location 2 at harvest.

Main Effects	Seed Yield	Oil	Oil Yield	N Removal	P Removal	K Removal	Total Population
	lb/A	%	lb/A	- - - - - - - - lbs/A - - - - - - - -			Plants/A
N Rate (lb/A)							
0	1388	41.5	577	37.4	6.8	13.0	17,530
80	1378	41.5	572	38.5	6.6	12.9	18,190
Significance	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
P_2O_5 Rate (lb/A)							
0	1162	41.5	483	31.4	5.0	11.0	18,392
40	1412	41.4	585	38.9	6.8	13.1	17,206
80	1602	41.6	667	44.3	8.4	15.2	18,049
Significance	**	N.S.	**	**	**	**	N.S.
K_2O Rate (lb/A)							
0	1387	41.5	577	38.1	6.8	13.0	18,058
100	1379	41.5	573	37.8	6.6	13.0	17,662
Significance	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.

Table 9. The effects of N, P, and K treatments on elemental analyses of sunflower seed at location 2 at harvest.

Main Effects	Elemental Analyses N	P	K	Ca	Mg	Al	Fe	Mn	Zn	Cu	B
	- - - - - - - - % - - - - - - - -					- - - - - - - - - - - - ppm - - - - - - - - - -					
N Rate (lb/A)											
0	2.70	.49	.94	.17	.32	3.2	56	18.3	73	19	15
80	2.79	.47	.94	.17	.31	2.6	54	18.1	74	18	15
Significance	*	N.S.	N.S.	N.S.	N.S.	**	N.S.	N.S.	N.S.	N.S.	N.S.
P_2O_5 Rate (lb/A)											
0	2.71	.44	.95	.18	.30	3.1	55	17.5	77	20	15
40	2.76	.48	.93	.17	.32	2.9	55	18.3	74	18	15
80	2.76	.52	.95	.17	.34	2.6	55	18.8	68	17	15
Significance	N.S.	**	N.S.	**	**	+	N.S.	**	**	**	N.S.
K_2O Rate (lb/A)											
0	2.75	.48	.94	.17	.32	3.1	55	18.2	73	19	15
100	2.74	.47	.94	.17	.31	2.7	56	18.2	73	81	15
Significance	N.S.	N.S.	N.S.	N.S.	N.S.	*	N.S.	N.S.	N.S.	N.S.	N.S.

LONG-TERM SOIL MOISTURE RECORD

D.G. Baker, Soil Science Dept., and W.W. Nelson, S.W. Expt. Sta.

A most interesting and valuable soil moisture record is the 23 year-sequence from the Southwest Agricultural Experiment Station, Lamberton. This is shown in Fig. 6. The progression of the total plant-available soil moisture for each season (the darker of the two lines) can be compared to the 1960-1976 mean (the lighter line). Several features can seen at a glance:

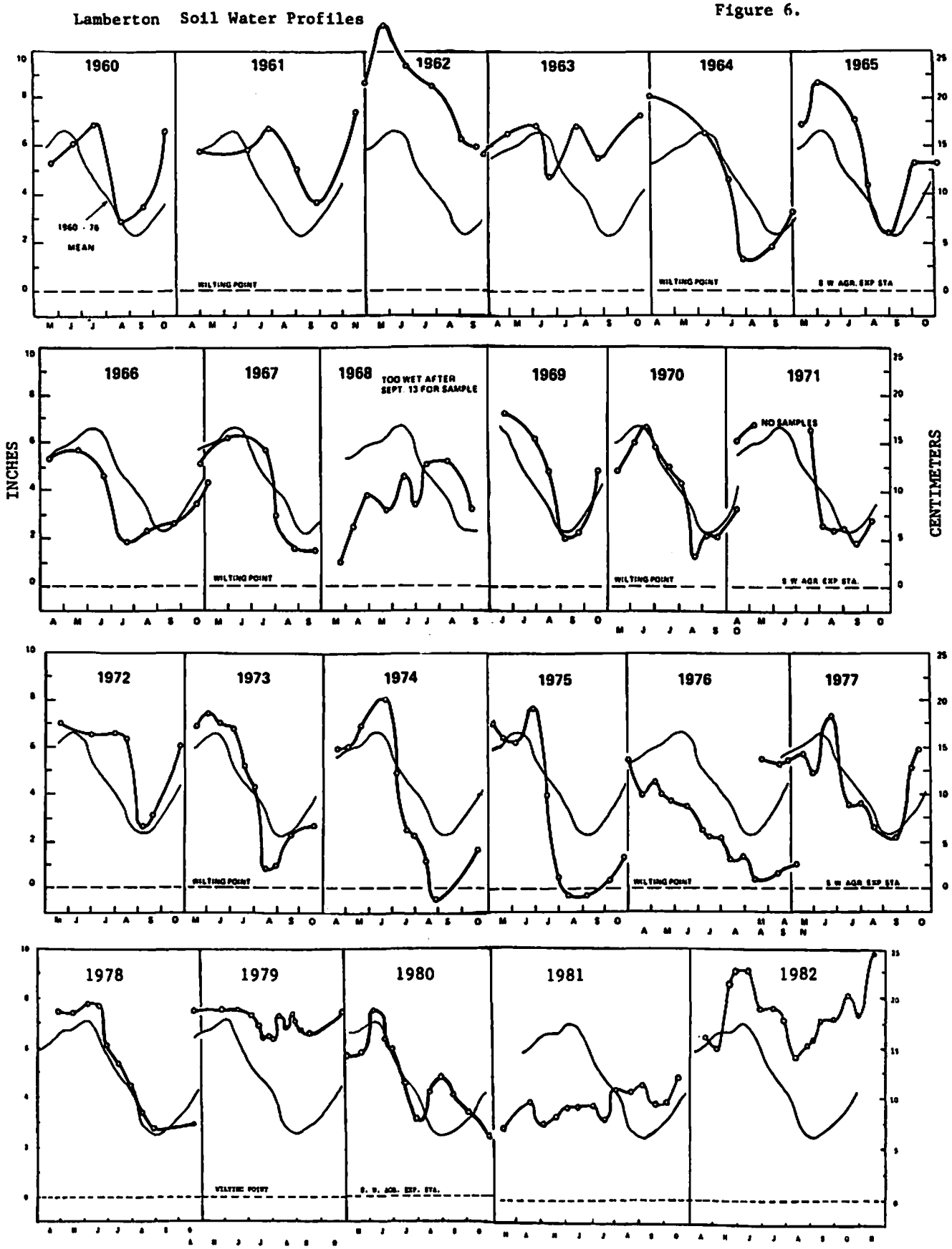
1. Years of highest soil moisture: 1962, 1972, and 1979.and 1982

2. Years of most average condition: 1969, 1970, and 1978

3. Years of lowest soil moisture: 1975 and 1976

Lamberton Soil Water Profiles

Figure 6.



TWENTY-THREE YEARS OF FIELD EXPERIMENTATION WITH NITROGEN SOURCE, PLACEMENT, AND TIME OF APPLICATION TO A WEBSTER LOAM NEAR LAMBERTON, MN

G.L. Malzer, W.W. Nelson, and R. Munter

(Annual reports of this experiment have been reported in Soil Series 74 through 112 and some of this information will not be included here).

The fertilizer treatments have now been applied annually to the same plot area for 23 years. After ear corn removal and stalk cutting, the fall plow down N treatments are broadcast on their respective plots and the entire area is then plowed to an approximate 12 inch depth. The fall surface N treatments are then broadcast, with no further working of the plow area. Each plot is 20' by 77.5' and the 4 replications are arranged in a randomized block. Spring N treatments are broadcast before seedbed preparation late in April or early May. The corn is planted in 30 inch rows at a plant population of 20,000 plants/A, using a band starter fertilizer of 8-24-12 at a rate of 180 lbs/A over the entire experimental area, thus supplying an additional 14 # N/A to all the plots. Nitrogen sidedressing treatments were broadcast in June.

The yields obtained in 1982 were above average when considering the long term previous average for this experiment. Treatment averages in 1982 appeared to follow the trends which had been established with the long term average yields.

TWENTY-TWO YEAR AVERAGE

The average grain yields for the twenty-one years of this experiment are shown in Table 2. Only modest differences were obtained between nitrogen forms, time of application, and incorporation in the 1982 experiment. In 1982 with 40 # N/A applied, urea fall plow down was superior to ammonium nitrate fall plow down. When both materials were applied at the same rate to the surface there was essentially no difference. When urea was applied as a spring top dressed treatment, ammonium nitrate was superior to urea. This is not observed in the long term average.

Plowing down 80 # N/A in the fall was much more effective than the lower N rates and approached the yields that were obtained with the highest treatment of fall applied N. Urea applied in the fall produced similar yields to the spring applications, although ammonium nitrate applied in the fall was inferior to spring applications at the 40 # N/A rate of application.

Table 1. Average N in 6th leaf, and grain yield at 15.5% moisture from a Webster loam fertilized annually with NH_4NO_3 or Urea - Lamberton Mn - 1982.

N applied annually #/A[1]	Leaf %N	Yield Grain Bu/A Rep I	Rep II	Rep III	Rep IV	Ave
Check	1.68	91.9	61.5	64.4	66.0	71.0
40 NH_4NO_3 - fpd[2]	1.93	96.9	94.2	82.0	92.8	91.5
40 Urea - fpd	2.20	121.7	119.6	108.9	126.2	119.1
40 NH_4NO_3 - fps[3]	2.15	124.9	100.2	89.5	114.9	107.4
40 Urea - fps	2.25	109.8	112.1	122.3	108.0	113.0
80 NH_4NO_3 - fpd	2.60	139.2	127.9	129.5	131.2	132.0
80 Urea - fpd	2.81	127.4	134.1	129.5	134.5	131.4
160 NH_4NO_3 - fpd	3.04	131.5	133.9	151.0	136.4	138.2
160 Urea - fpd	3.06	144.5	130.7	130.3	129.8	133.8
40 NH_4NO_3 - std[4]	2.32	115.6	129.4	99.9	115.1	115.0
40 Urea - std	2.29	107.4	99.3	102.7	100.2	102.4
80 NH_4NO_3 - std	2.80	121.5	136.2	150.1	131.8	134.9
80 Urea - std	2.69	124.7	120.0	128.1	130.8	125.9
40 NH_4NO_3 - sd[5]	2.45	119.3	114.5	121.6	108.9	116.1
40 Urea - sd	2.23	104.6	105.0	146.2	109.0	116.2
80 NH_4NO_3 - sd	2.70	138.2	126.9	138.2	137.4	135.2
80 Urea - sd	2.60	145.2	127.3	128.5	122.9	131.0
160 NH_4NO_3 - sd	2.82	142.1	126.0	144.0	133.1	136.3
Significance	**					**
BLSD (.05)	0.22					12.6

[1]The entire area received an additional 14 lbs N/A as starter fertilizer annually (180 #/A of 8-24-12)

[2]fpd - fall plow down

[3]fps - fall plow surface

[4]std - spring top dress

[5]sd - sidedress

Table 2. Yields of ear corn during 22 years on a tiled Webster 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	1972
	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	75.6
40 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	113.6
40 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	113.9
40 NH_4NO-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	109.9
40 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	106.7
80 NH_4NO_3-fpd	67.4	97.9	43.6	149.6	100.8	63.4	47.3	114.3	131.2	146.8	134.7	108.0	143.1
80 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	140.1
160 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	147.6
160 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	151.7
40 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	117.0
40 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	116.5
80 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	142.7
80 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	142.1
40 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	136.0
40 Urea-sd	57.7	95.6	24.9	142.3	94.1	48.4	50.4	86.1	132.2	143.3	117.1	100.5	133.9
80 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	124.7
80 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	149.8
160 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	150.0
Ave. Annual corn yield in bu/A	58.6	93.3	39.4	147.5	101.3	60.3	37.8	101.8	135.7	140.9	127.0	99.4	128.6

[1]The entire area received an additional 14 lbs N/A as starter fertilizer annually (8-24-12 @ 180 #/A).

[2]2fpd - fall plow down

[3]fps - fall plow surface

[4]std - spring topdress

[5]sd - sidedress

Table 2. (cont.)

	1973	1974	1975§	1977	1978	1979	1980	1981	1982	22 yr. Ave.
Check	69.2	53.4	58.3	141.2	64.6	37.6	46.5	65.8	71.0	63.5
40 NH_4NO_3-fpd[2]	92.0	80.5	88.6	145.1	98.1	63.1	67.6	77.4	91.5	81.4
40 Urea-fpd	101.5	96.9	96.6	165.2	110.2	76.7	65.2	87.0	119.1	89.0
40 NH_4NO_3-fps[3]	93.0	88.3	78.2	149.4	101.3	64.6	69.7	89.4	107.4	84.8
40 Urea-fps	97.8	85.0	78.9	156.8	101.4	80.2	63.8	80.5	113.0	87.7
80 NH_4NO_3-fpd	121.7	103.6	89.2	156.9	128.4	94.8	90.3	89.6	132.0	101.5
80 Urea-fpd	117.9	107.2	96.9	146.0	123.6	86.2	84.7	101.8	131.4	100.3
160 NH_4NO_3-fpd	121.0	113.1	90.4	149.8	129.3	108.7	109.3	91.3	138.2	106.0
160 Urea-fpd	114.9	105.1	82.4	163.0	124.4	127.3	103.7	97.6	133.8	107.8
40 NH_4NO_3std[4]	104.0	82.8	88.0	160.0	97.4	86.6	77.2	90.0	115.0	92.1
40 Urea-std	97.1	94.5	89.0	165.2	103.9	74.5	64.3	86.6	102.4	90.4
80 NH_4NO_3-std	118.0	92.9	97.6	162.9	117.1	87.3	74.4	101.4	134.9	103.0
80 Urea-std	117.6	108.5	93.6	162.2	127.4	100.3	84.4	102.8	125.9	104.9
40 NH_4NO_3-sd[5]	99.1	82.7	91.8	153.8	106.8	99.2	71.9	83.6	116.1	93.4
40 Urea-sd	103.9	80.4	92.6	165.4	104.8	94.2	80.4	87.4	116.2	93.0
80 NH_4NO_3-sd	109.4	87.6	95.3	163.2	110.6	106.3	76.9	79.3	135.2	97.2
80 Urea-sd	124.0	95.6	90.1	162.8	126.7	118.1	89.6	87.4	131.0	106.0
160 NH_4NO_3	117.1	105.5	91.3	160.3	126.0	148.0	109.8	96.7	136.3	108.0
Ave. annual corn yield in bu/A	106.6	92.4	88.3	157.2	111.2	91.9	79.4	88.6	119.5	95.0
Significance									**	**
C.V. (%)									8.1	10.0
BLSD (.05)									12.6	5.0

§ 1976 No Yields Taken

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

[2]fpd - fall plow down

[3]fps - fall plow surface

[4]std - spring topdress

[5]sd - sidedress

AVAILABILITY OF RESIDUAL NITRATE-N TO CORN

Lamberton, 1980-82

G.W. Randall and W.W. Nelson

Application of fertilizer N at rates exceeding crop removal can result in rather significant amounts of residual N left in the soil for the succeeding crop. For instance, after a very dry season, the quantity of residual N may be such that crop response to added fertilizer N may not be obtained. The purpose of this study is to determine crop response to residual NO_3-N and to measure loss of this N to tile lines.

Experimental Procedures

Nitrogen fertilizer was applied as urea annually from 1973-1979 to tile drained plots each measuring 45' x 50' and lined with plastic at Lamberton. Rates of 18, 100, 200, and 400 lb N/A were replicated three times. Two additional treatments (true check, which did not receive N, a herbicide or an insecticide; and 200# N/A as soybean meal) were not applied to isolated plots and thus were not included in the original replications. Consequently, statistical analyses have been performed only on the former four treatments.

Corn has been continuously grown from 1973 thru 1982. The grain has been removed and all residue plowed down annually. Nitrogen removal in the grain has been calculated. In addition, N losses thru the tile lines have been determined by measuring flow rate and NO_3-N concentrations when tile flow occurred. Each fall (when possible) soil samples have been taken to a 10-foot depth to determine residual NO_3-N in the soil.

Because some of the N treatments exceeded the N removal rates, substantial amounts of NO_3-N accumulated from 1973-1979. Consequently, no fertilizer N has been applied to the plots since May 1979. Research efforts since 1979 have attempted to monitor the availability of the residual NO_3-N to corn and to follow the movement of NO_3-N either in the soil or into the tile lines.

In 1981 and 1982, 125 lb N/A as anhydrous ammonia was applied to an isolated 6-row strip between the plots so that crop response to the residual N could be compared to this annual application. Weeds and insects have been controlled adequately on all plots (except the true check) by pesticides. All plots have been moldboard plowed each fall.

Results

The effects of the annual N applications over the seven-year period can be seen on the amount of residual NO_3-N remaining in the 0-10' profile after harvest of the 1979 crop (Table 1). A substantial amount of N carried over from the 400-lb treatment while significant amounts were also present with the 200-lb rate. Less NO_3-N was found with the organic N source than with the inorganic source. Most NO_3-N accumulated between 1 and 6'. Almost no NO_3-N was found below 8' at this time.

Corn grain yields shown in Table 2 indicate responses of 52 and 31 bu/A to residual N in 1980 and 1981, respectively. In the first year following N application, yield was improved significantly by the carryover from the 100-lb rate even though NO_3-N in the soil profile at the start of the season was not high. Yields were further improved by carryover from the 200 and 400-lb rates with no difference between them. The carryover from the 200-lb organic N treatment produced the highest yield but not more than from the 400-lb N rate.

In the second residual year (1981), conditions were so dry in the beginning of the season that germination and emergence were uneven and weed control was poor. These conditions led to a very high CV (18%) for yield. Thus, even though a 30.6 bu/A advantage was obtained with carryover NO_3-N, the grain yields were not significantly different from the check. Yields from the 6-row strip where N was applied during 1981 averaged 121.5 bu/A.

Table 1. Soil NO_3-N in the 0-10' profile in the fall of 1979 as influenced by seven consecutive years of N application at Lamberton.

Profile depth	Annual N rate (lb/A) 18	100	200	400	200 org.
feet	ppm				
0-1	1.0	1.8	5.7	29.4	4.2
1-2	0.2	1.0	4.8	40.0	1.7
2-3	0.3	2.3	10.7	39.9	9.0
3-4	0.7	5.6	18.5	61.6	12.2
4-5	0.9	8.1	18.9	56.2	13.0
5-6	1.3	4.4	12.6	34.3	9.4
6-7	1.4	2.9	7.5	20.9	4.9
7-8	1.6	2.2	4.9	9.7	2.8
8-9	1.8	1.7	3.3	5.4	1.7
9-10	1.7	1.7	3.5	3.4	1.3
Total (lb NO_3-N in 10-foot profile)	44.	127.	362.	1203.	241.

Table 2. Corn grain yields as influenced by residual NO_3-N at Lamberton in 1980 and 1981.

Annual[1/] N rate	Total N Applied	Year 1980	1981
lb N/A		Yield (bu/A)	
18	126	39.7	68.2
100	700	65.9	83.3
200	1400	83.2	90.6
400	2800	91.4	98.8
Signif. Level(%):		99	80
BLSD(.05) :		11.6	
CV (%) :		8.7	18.
0[2/]	0	51.5	50.5
200 org.	1400 org.	96.0	91.7

[1/] Seven-year period (1973-1979).

[2/] True check = no N, herbicide or insecticide.

Residual NO_3-N levels after the 1981 season indicate about 2x, 4x, and 14x as much NO_3-N in the 0-10' profile from the 100, 200 and 400-lb rates, respectively, as from the 18-lb treatment (Table 3). The nitrate-N level following the 200-lb organic N treatment was slightly less than with the 200-lb treatment as urea. Little NO_3-N was found above the 3-foot depth with the 100 and 200-lb N treatments (< 11% of that in the 10-foot profile). With the 400-lb rate most of the NO_3-N (78%) was found between 2' and 7'. Nitrates were found at the 10' depth with only the 400-lb treatment.

Results from 1982 show significant differences in leaf N, silage yield, N uptake in the silage, grain yield, grain N and N removal in the grain due to carryover from the previous 200 and 400-lb N rates (Table 4). Leaf N and silage yield were increased by the carryover from the 200-lb rate, but additional increases were not significant (95% level) with the 400-lb rate. Silage N uptake, grain yield, grain N, and N removal in the grain were increased significantly over the 200-lb rate by the carryover from the 400-lb N rate. Apparently, the greater total amount of NO_3-N and the fact that significantly more was found in the 2-3' zone at the beginning of the season led to this response. Even though the amount of residual NO_3-N with the 100-lb treatment at the beginning of the 1982 season was similar to that at the beginning of the 1980 season (Table 1), this amount was not sufficient to sustain high yields in 1982 when growing conditions were good. Differences in silage and grain yield were not observed between the fertilizer and organic N sources applied at the 200-lb rate.

Grain yield and grain N taken from the 6-row strip where N was applied in 1982 averaged 162.7 bu/A and 1.37% N. These were only slightly more than with the 400-lb rate.

Table 3. Residual NO_3-N in the 0-10' soil profile in the fall of 1981 as influenced by previous N application at Lamberton.

Profile depth	Annual N rate (lb/A)[1/] 18	100	200	400	200 org.
feet	ppm				
0-1	2.1	2.8	2.6	9.5	5.5
1-2	0.7	0.9	1.3	5.4	2.2
2-3	0.4	0.8	4.7	23.2	3.2
3-4	0.4	4.5	16.0	54.6	10.5
4-5	1.4	6.6	19.5	54.2	12.3
5-6	1.6	5.7	16.2	42.5	10.8
6-7	2.0	4.6	7.7	26.4	8.4
7-8	2.3	3.7	4.8	18.4	4.3
8-9	3.2	2.8	3.8	11.5	3.4
9-10	3.7	3.4	3.2	10.8	2.5
Total lb NO_3-N in 10-foot profile	71.	143.	319.	1026.	252.

1/ Annual application over 7-year period (1973-1979).

Table 4. Corn production and N utilization in 1982 as influenced by residual NO_3-N from annual N applications from 1973-1979 at Lamberton.

Annual N rate	Final popl'n.	Leaf N	Silage Yield	Silage N uptake	Grain Yield	Grain N	Grain N removal
lb N/A	ppA x 10^{-3}	%	T DM/A	lb N/A	bu/A	%	lb N/A
18	22.0	1.57	4.23	59.0	84.0	1.04	41.2
100	21.3	1.82	4.24	61.2	86.1	1.07	43.6
200	21.6	2.16	6.06	107.4	130.7	1.17	72.2
400	21.6	2.35	6.86	139.4	155.3	1.31	96.5
Signif:[1/]	56	99	99	99	99	99	99
BLSD(.05):		.38	.81	20.0	16.6	.05	10.3
CV (%):	2.2	9.4	7.7	11.	7.5	2.3	8.4
0[2/]	21.7	1.52	3.96	51.5	78.2	1.04	38.5
200 org.	21.6	1.87	5.93	98.7	125.7	1.15	68.4

1/ Probability level that a difference among the four means listed above is significant.

2/ True check = no N, herbicide or insecticide.

The tile lines flowed during May, June, July, October, November and December in 1982. Total flow averaged 5.24 acre-inches with slight differences among rates (Table 5). Flow-weighted NO_3-N concentrations ranged from 9.3 with the 18-lb N treatment to 114.9 mg/L with the 400-lb treatment. Even the 100-lb treatment which did not contain enough residual NO_3-N to sustain yields resulted in an average NO_3-N concentration of 22.8 mg/L. Nitrate-N losses thru the tile lines were quite high and on a relative basis compared very closely to the amount of residual N found in the soil (Table 3). The 200-lb organic N treatment showed much lower NO_3-N concentrations and losses than did the 200-lb N treatment as urea.

Table 5. Tile line flow, average NO_3-N concentration and total NO_3-N losses into the tile lines in 1982 as related to annual N application rates from 1973-1979 at Lamberton.

Annual N rate	Total tile flow	Nitrate-N Avg. Concentration	Nitrate-N Losses
lb N/A	acre-inches	mg/L	lb/A
18	5.52	9.3	11.6
100	5.77	22.8	29.8
200	4.28	55.6	53.9
400	6.04	114.9	157.1
200 org.	4.57	26.6	27.5

Nitrate-N concentrations in the tile water decreased throughout the 1982 season (data not shown). Concentrations slipped from 13 in May to 8 mg/L in December with the annual 18-lb N treatment, from 30 to 16 mg/L with the 100-lb rate, from 66 to 53 with the 200-lb rate, from 136 to 93 with the 400-lb rate, and from 40 to 17 with the 200-lb rate as organic N.

Even though corn yields were not improved over the 18-lb treatment by the carryover N from the 100-lb rate, significantly higher NO_3-N concentrations and losses in the tile water were found. Apparently, the nitrates in the vicinity of the tile lines (3-5' zone) were not available to the corn crop but were susceptible to loss via tile drainage.

WEST CENTRAL EXPERIMENT STATION - MORRIS

WEATHER SUMMARY - 1982

Month	Period	Precipitation 1982	Precipitation 94-yr. av.	Precipitation Dev. from av.	Air Temperature 1982	Air Temperature 94-yr. av.	Air Temperature Dev. from av.	Soil Temperature (10 cm depth) 1982	Soil Temperature (10 cm depth) 10-yr. av.
January	1-31	1.31	.68	+ .63	-5.7	8.0	-13.7	19.0	20.7
February	1-28	.27	.67	- .40	9.5	12.6	- 3.1	20.3	23.9
March	1-31	2.07	1.09	+ .98	24.5	26.7	- 2.2	28.4	29.2
April	1-10	1.42	.58	+ .84	27.5	37.9	-10.4	34.0	
	11-20	.07	.65	- .58	44.2	44.4	- 0.2	42.1	
	21-30	.07	1.08	-1.01	49.4	48.2	+ 1.2	49.2	
Total or av.		1.56	2.31	- .75	40.4	43.5	- 3.1	41.7	41.4
May	1-10	.26	.78	- .52	57.1	51.9	+ 5.2	58.2	
	11-20	1.46	.95	+ .51	59.0	55.8	+ 3.2	60.1	
	21-31	.51	1.25	- .74	59.2	60.1	- 0.9	63.1	
Total or av.		2.23	2.98	- .75	58.5	56.1	+ 2.4	60.5	57.1
June	1-10	.47	1.26	- .79	56.2	63.1	- 6.9	63.0	
	11-20	.31	1.27	- .96	60.9	66.5	- 5.6	69.4	
	21-30	1.14	1.38	- .24	64.2	68.2	- 4.0	73.4	
Total or av.		1.92	3.91	-1.99	60.4	66.0	- 5.6	68.6	69.3
July	1-10	3.23	1.48	+1.75	70.5	70.0	+ 0.5	77.0	
	11-20	.63	1.03	- .40	70.2	71.3	- 1.1	75.6	
	21-31	.50	1.03	- .53	71.2	71.5	- 0.3	83.1	
Total or av.		4.36	3.54	+ .82	70.8	71.0	- 0.2	78.7	76.7
August	1-10	.65	1.05	- .40	72.5	70.3	+ 2.2	75.4	
	11-20	1.93	.90	+1.03	69.0	69.2	- 0.2	75.0	
	21-31	1.12	.98	+ .14	61.9	66.9	- 5.0	69.4	
Total or av.		3.70	2.93	+ .77	67.5	68.7	- 1.2	73.1	73.9
September	1-30	4.10	2.19	+1.91	56.4	59.1	- 2.7	60.1	61.5
October	1-31	4.22	1.62	+2.60	45.3	47.3	- 2.0	47.4	47.8
November	1-30	1.37	.96	+ .41	25.7	29.7	- 4.0	31.4	33.6
December	1-31	.65	.68	- .03	21.8	15.5	+ 6.3	26.3	23.4
April-August Growing Season		13.77	15.67	-1.90	59.6	61.1	- 1.5	65.1	63.8
January-December Annual		27.76	23.56	+4.20	39.7	42.0	- 2.3	46.7	46.7

MANURE RATE STUDY

West Central Experiment Station - Morris

S. D. Evans, P. R. Goodrich and R. C. Munter

Solid and liquid beef manures were applied at three rates and the effects were compared against check plots. Treatments and results from previous years are given in Soil Series 91, 95, 97, 99, 103, 105, 107, 109, and Misc. Publ. 2-1982. The last manure applications were made in the fall of 1978, but fertilizer has been applied to the fertilized check each year. The plots were severely damaged by hail on August 31, 1982.

I. Planting Information

The plots were planted to Pioneer 3901 on May 4, 1982. Counter @ 8.8 lbs/acre (1 lb/acre active ingredient) was applied in the row to the entire area at planting. Starter fertilizer consisting of 154 lbs/acre of 10-26-26 was applied to the fertilized treatment. Nitrogen in the form of urea was applied to the fertilized plots to provide 110 lbs/acre of N on October 28, 1981. Lasso (2.5 lbs/acre) and Bladex (2.2 lbs/acre) were broadcast on May 5, 1982.

II. Soil Sampling and Analysis

A. 1981 Measurements

NO_3-N was the only variable measured in the fall of 1981. The values shown in Table 1 indicate some changes from those values one year earlier. In general the NO_3-N in the 0-4' zone increased slightly in the manure treated plots (except LB3) and decreased slightly in the fertilized treatment.

B. 1982 Measurements

The soils were sampled again to a depth of 4 feet for NO_3-N analysis but the results are not yet available.

III. Plant Tissue Analysis (Table 2)

There were significant effects on all elements except iron, copper, and boron. There were some significant effects of solid beef manure on increasing leaf levels of N, P, and K and decreasing leaf levels of Ca, Mg and Zn as compared to the fertilized check. The effects of liquid beef manure were similar to those of solid beef manure but the effects were reduced.

IV. Growth and Yield Measurements (Table 3)

A. Early plant height and dry matter - Plants on the manure treated plots were taller (except for LB1) and weighed more (except for LB1) than on the fertilized check.

B. Grain - Yields were smaller than in recent years due to the hail damage, but SB1, SB3, LB3 yielded significantly more than the fertilized check.

C. Silage - There were no significant differences between manure treated and fertilized plots.

V. Summary

The 1982 season was the fourth since manure had been applied. It appears that even the lowest rates of each manure were sufficient for grain yields equal to or higher than the fertilized check.

Table 1. Effect of two types of beef cattle manure and commercial fertilizer on the NO_3-N level of a Tara soil profile - Fall 1981.

Depth - ft -	Treatment CK	FE	SB1	SB2	SB3	LB1	LB2	LB3
	NO_3-N, ppm							
0-1	6.4	8.7	15.5	38.1	78.1	7.3	19.5	26.2
1-2	2.7	60.6	88.8	154.3	199.7	33.6	118.3	107.4
2-3	1.9	55.9	94.3	196.3	183.3	56.5	104.0	150.3
3-4	3.2	39.9	47.4	146.0	145.0	42.1	72.7	143.0

Table 2. Summary of analysis of corn leaves at silking - 1982.

Treatment	N	P	K	Ca	Mg	Fe	Zn	Cu	Mn	B
	%					ppm				
CK	2.16	.23	1.67	.44	.41	145	17.3	4.4	68	5.2
FE	2.74	.25	1.65	.51	.44	142	22.6	4.4	102	5.2
SB1	2.71	.34	2.14	.45	.29	144	18.1	5.8	87	5.6
SB2	2.73	.51	2.43	.42	.24	140	18.6	4.0	70	5.4
SB3	2.84	.52	2.52	.40	.22	139	21.1	3.9	59	5.5
LB1	2.88	.29	1.80	.48	.39	144	17.1	5.3	93	5.0
LB2	2.70	.31	1.90	.47	.36	134	16.9	5.2	86	5.2
LB3	2.86	.38	2.09	.46	.33	155	15.1	4.2	87	5.4
Significance	**	**	**	*	**	NS	**	NS	*	NS
BLSD(.05)	.18	.07	.20	.06	.07	--	3.0	--	28	--
CV(%)	3.8	11.4	6.0	6.8	12.8	6.5	9.2	22.5	17.1	10.3

Table 3. Summary of plant measurements - 1982.

Treatment	Early plant height inches	Early plants (10) dry wt. grams	Grain: Moisture at harvest %	Grain: Yield at 15.5% M. Bu/A	Grain: Nitrogen %	Silage: Dry matter at harvest %	Silage: Silage yield (D.M.) lbs/A	Silage: Ear wt. ÷ silage wt. %
CK	16.4	28.7	29.8	55.9	1.11	37.8	7652	44.8
FE	21.4	43.7	27.5	68.3	1.38	30.3	10697	41.4
SB1	26.6	89.3	24.3	94.9	1.47	28.5	11717	42.7
SB2	28.5	88.0	27.3	75.2	1.63	24.8	10564	36.4
SB3	28.3	98.7	25.1	96.5	1.54	23.7	12156	37.8
LB1	20.7	40.0	25.6	82.6	1.37	34.6	10467	45.8
LB2	25.4	64.7	23.8	89.2	1.43	30.6	12398	43.8
LB3	27.6	83.0	26.7	95.2	1.44	22.1	9945	36.4
Significance	**	**	**	*	**	**	**	**
BLSD(.05)	2.2	13.3	2.2	24.4	0.07	4.1	1854	3.4
CV(%)	5.7	12.2	4.8	15.6	3.0	8.5	9.7	4.9

RESIDUAL EFFECT OF HEAVY APPLICATIONS OF ANIMAL MANURES ON CORN GROWTH AND YIELD AND ON SOIL PROPERTIES

West Central Experiment Station - Morris
S. D. Evans, P. R. Goodrich and R. C. Munter

The experiment initiated in 1970 was continued. Treatments and results from previous years are given in Soil Series 88, 89, 91, 95, 97, 99, 103, 105, 107, 109, and Misc. Publ. 2-1982. Manure was applied in 1970 and 1971 only. Fertilizer has been applied to the fertilized checks each year. The plots were severely damaged by hail on August 31, 1982.

I. Planting Information

Twenty-four rows of corn (var. Pioneer 3901) were planted in each plot on May 4, 1982. Counter at 8.8 lbs/acre (1 lb/acre active ingredient) was applied in the row at planting to all plots. Starter fertilizer consisting of 154 lbs/acre of 10-26-26 was applied to the fertilized treatment only. Nitrogen in the form of urea was applied to the fertilized plots to provide 110 lbs/acre of N on October 28, 1981. Lasso (2.5 lbs/acre) and Bladex (2.2 lbs/acre) were applied broadcast on May 5, 1982.

II. Soil Sampling and Analysis

A. 1981 Measurements

NO_3-N was the only variable measured in the fall of 1980. The values shown in Table 1 indicate that levels in most soil zones changed little in the past year. The total NO_3-N in the 0-4' profile was greater on all manure treatments than on the fertilized check.

B. 1982 Measurements

The soils were sampled again to a depth of 4 feet for NO_3-N analysis but the results are not yet available.

III. Plant Tissue Analysis

The nutrient concentrations in the ear leaves at silking in 1982 are given in Table 2. There were significant effects on most elements. The concentrations of N, P and K were higher and Mg lower in all manure treatments than in the fertilized treatment. There were significant differences between at least one manure treatment and the fertilized treatment for Zn.

IV. Growth and Yield Measurements (Table 3)

A. Early plant height and dry matter - Plants on the SB and LB manure treated plots were taller than those on the fertilized treatment. Dry matter differences were identical to those of plant height.

B. Grain - There were no significant differences in grain yield. The grain N content of the LH treatment was significantly lower than that of the fertilized check.

C. Silage - There were no significant differences between the manure treatments and the fertilized treatment in silage yield.

V. Summary

The effects of the manure treatments applied in 1970 and 1971 still show up in most plant and soil measurements. Plant and soil analysis show that the liquid hog manure treatment is starting to lose some of its effect as compared to the other two manure treatments, but grain yield is still not significantly lower than the fertilized check.

Table 1. Effect of high rates of manure and commercial fertilizer eleven years (fall 1981) after application of the NO_3-N level of a Tara soil profile.

Depth - ft -	Treatment CH	FE	SB	LB	LH
	NO_3-N, ppm				
0-1	5.0	7.8	8.7	10.4	28.4
1-2	3.4	69.5	40.4	58.1	13.5
2-3	1.1	73.9	76.2	116.8	55.0
3-4	4.0	46.9	67.8	132.5	44.9

Table 2. Summary of analysis of corn leaves at silking - 1982.

Treatment	N	P	K	Ca	Mg	Fe	Zn	Cu	Mn	B
	%					ppm				
CK	2.10	.19	1.49	.47	.42	136	16.0	3.9	84	5.9
FE	2.97	.28	1.61	.46	.42	139	22.7	3.4	72	4.7
SB	2.63	.33	2.03	.45	.25	140	16.0	4.6	78	5.1
LB	2.73	.39	2.06	.45	.25	148	16.9	4.2	62	4.6
LH	2.42	.31	1.92	.46	.27	137	22.3	4.9	66	5.0
Significance	**	**	**	NS	**	NS	**	NS	+	+
BLSD(.05)	0.24	.05	0.24	--	0.08	--	2.5	--	18	0.9
CV(%)	5.0	8.7	7.0	7.4	14.0	7.1	7.3	16.7	12.0	9.0

Table 3. Summary of plant measurements - 1982.

Treatment	Early plant height inches	Early plants (10) dry wt. grams	Grain: Ear moisture at harvest %	Grain: Yield at 15.5% M. Bu/A	Grain: Nitrogen %	Silage: Dry matter at harvest %	Silage: Silage yield (D.M.) lbs/A	Silage: Ear wt. ÷ silage wt. %
CH	15.5	25.0	32.2	45.1	1.11	36.9	6690	43.6
FE	22.6	51.7	27.9	81.7	1.42	30.8	11136	42.7
SB	26.5	77.3	25.3	80.5	1.39	30.4	11804	44.0
LB	27.3	88.3	26.1	84.1	1.40	27.5	11276	41.0
LH	23.8	59.3	26.5	74.7	1.32	32.0	10077	45.1
Significance	**	**	*	*	**	+	**	NS
BLSD(.05)	1.7	20.3	4.6	25.0	0.08	7.1	1380	--
CV(%)	4.2	18.2	8.2	17.1	3.5	10.7	7.4	6.3

NITROGEN FERTILIZATION AND NITROGEN UTILIZATION BY TWELVE SMALL GRAIN VARIETIES - MORRIS, MN - 1982

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The semi-dwarf varieties of hard red spring wheat account for a major portion of the acreage planted to hard red spring wheat in Minnesota. These short statured varieties not only provided improved physical characteristics, but also provide the potential for a system which might be capable of responding to higher rates of nitrogen application without lodging. The differences that exist between wheat varieties in their ability to utilize soil and fertilizer nitrogen is not well understood. A portion of the differences which exist may be due to the genetic ability of the plant because of some favorable plant characteristic either above or below the soil surface. If selection of plant genotypes can be made for more effective nitrogen uptake and utilization, advancements may be made in increasing present yield levels as well as improving the overall protein content of the grain. Experiments were established in 1982 to examine some of the differences which exist between wheat varieties in their response to fertilizer nitrogen and their ability to utilize existing soil nitrogen. Existing popular varieties as well as older varieties and experimental varieties were included for comparison. Similar trials were conducted at Crookston as well as Morris, MN.

EXPERIMENTAL PROCEDURE

Twelve varieties of hard red spring wheat were compared at nitrogen application rates of 0, 60 and 120 # N/A at the West Central Experiment Station at Morris, MN. Nitrogen was applied as spring application of ammonium nitrate broadcast and incorporated. The treatments were arranged in a split plot design with nitrogen as the main effect and the twelve varieties planted within a uniformly fertilized area. All treatments were replicated four times. Experimental plots were planted into areas 5' x 20' on April 23 utilizing a cone seeder.

Total plant dry matter was measured at approximately the "soft dough" stage of growth (July 22) and samples were collected for nitrogen content and calculation of nitrogen uptake. Yield grain was harvested on August 5 by harvesting 14 ft^2 of the plot area. The above ground growth (straw and grain) was removed from the experimental plot area, allowed to air dry in a forced air dryer. The samples were then weighed, thrashed and the grain reweighed for yield determination. Straw weights were determined by difference. Samples of straw and grain were collected and analyzed for nitrogen content and determination of nitrogen removal.

GENERAL RESULTS

Grain yields at the Morris location were excellent in 1982. Grain yields were influenced by both nitrogen rate and variety. A significant nitrogen rate x variety interaction suggests that all varieties did not respond in a similar manner to nitrogen fertilization. A number of interesting observations can be made in evaluating the yield data: 1) varieties which produced more than 40 bu/A with no fertilizer N applied; 2) those varieties which produced more than 50 bu/A when 60 # N/A was applied and 3) those varieties which responded in yield by more than 5 bu/A when the nitrogen rate was increased from 60 to 120 # N/A. In assessing these three groupings, Era, Thatcher, and MN 7357 fit into group 1; Butte, Marshall, Olaf, MN 7357 and MN 73167 fit into group 2; and Coteau, Era, MN 7125, MN 7122 and MN 73168 fit into group 3. One interesting aspect of these groupings, which might be considered favorable yielding traits, is that no one variety appears in all three groups, and that very few varieties appear twice. This then tends to complex the issue of what varieties are the most efficient and most responsive to N fertilization.

Nitrogen content of the grain (protein) was influenced by both nitrogen rate and variety. Grain N was increased when going from 60-120 # N/A but was not increased when going from 0-60 # N/A. Total N uptake was substantially increased in going from 0-60 # N/A so the lack of a protein increase was due to a dilution effect caused by the increased grain yield. Grain N content due to varieties was highly significant and spanned a considerable range. The varieties Coteau, Olaf and James proved to have the highest overall protein content. This was especially true at the zero N rate, but when 120 # N/A was applied, many other varieties produced comparable protein concentration.

Total nitrogen removal was highly influenced by nitrogen rate, but a significant N rate x variety interaction suggested that not all varieties responded in a similar manner. With zero N fertilization Era and Thatcher proved to be the most effective in N removal. When 120 # N/A was applied Butte, Coteau, Olaf and MN 7222 and MN 73167 were the most effective in total N removal.

Table 1. Influence of nitrogen fertilizer and variety on yield, N content and test weight of 12 hard red spring wheat varieties from Morris, MN - 1982.

Nitrogen Rate	Variety	Grain Yield	Grain N Content	Grain Test wt.	Forage Total Dry Matter	Forage N Content
#/A		bu/A	%	#/bu	T/A	%
0		34.8	2.66	58.0	1.99	0.97
60		48.7	2.63	58.3	2.85	1.14
120		54.4	2.80	57.5	3.32	1.36
Significance			*	NS	**	
BLSD (.05)			0.04	--	0.12	
-	Butte	49.8	2.69	60.3	2.95	1.04
-	Coteau	45.0	3.02	59.1	2.72	1.18
-	Era	44.8	2.68	57.1	2.70	1.20
-	Marshall	43.3	2.64	58.7	2.41	1.22
-	MN 7125	43.4	2.52	58.0	2.81	1.15
-	MN 7222	44.2	2.62	57.1	2.62	1.17
-	Olaf	45.9	2.90	57.6	2.66	1.20
-	Thatcher	42.9	2.67	55.6	2.70	1.09
-	MN 7357	50.2	2.58	58.2	2.67	1.18
-	MN 73167	50.6	2.61	58.2	2.77	1.17
-	MN 73168	46.5	2.64	57.2	2.77	1.25
-	James	45.1	2.78	58.4	2.87	1.07
Significance			**	**	*	
BLSD (.05)			0.01	1.0	0.35	
Interaction - N Rate x Variety						
0	Butte	33.8	2.71	59.3	2.05	0.91
0	Coteau	29.8	3.13	57.7	2.11	1.11
0	Era	41.5	2.64	58.5	2.16	0.96
0	Marshall	30.0	2.63	58.9	1.78	0.99
0	MN 7125	33.2	2.47	58.4	2.03	0.89
0	MN 7222	26.4	2.54	57.5	1.71	0.92
0	Olaf	33.3	2.91	58.5	1.80	1.03
0	Thatcher	40.4	2.65	55.3	2.05	0.93
0	MN 7357	40.1	2.47	58.5	1.84	0.99
0	MN 73167	36.1	2.49	57.7	2.15	0.94
0	MN 73168	36.3	2.54	57.6	2.01	1.04
0	James	36.4	2.78	58.0	2.17	0.98
60	Butte	56.4	2.59	60.8	3.14	1.00
60	Coteau	49.3	2.94	59.3	2.78	1.11
60	Era	41.8	2.60	56.7	2.72	1.20
60	Marshall	50.1	2.51	59.9	2.71	1.20
60	MN 7125	42.8	2.54	58.3	3.02	1.14
60	MN 7122	44.9	2.57	57.4	2.72	1.10
60	Olaf	51.3	2.82	58.3	3.00	1.20
60	Thatcher	42.7	2.52	56.0	2.66	1.08
60	MN 7357	55.1	2.50	58.3	2.91	1.18
60	MN 73167	55.9	2.59	58.7	2.80	1.17
60	MN 73168	47.3	2.57	56.7	2.74	1.27
60	James	47.0	2.73	59.4	2.97	1.06

Table 1 continued on page after next

Table 2. Influence of nitrogen fertilization and variety on straw production and nitrogen uptake by forage, straw, and grain by 12 hard red spring wheat varieties from Morris, MN - 1982.

Nitrogen Rate	Variety	Harvest Straw Dry Matter	Harvest Straw N Content	Nitrogen Removal Forage	Nitrogen Removal Straw	Nitrogen Removal Grain	Grain α Straw
#/A		T/A	%	#/A			
0		1.21	0.47	38.9	11.2	48.2	59.4
60		1.70	0.54	65.1	18.2	66.8	85.0
120		1.94	0.70	89.7	27.0	79.6	106.6
Significance		**		**	**		
BLSD (.05)		0.08		3.4	1.6		
-	Butte	1.78	0.47	62.6	17.6	69.8	87.4
-	Coteau	1.81	0.51	64.7	18.8	70.9	89.7
-	Era	1.59	0.63	66.8	20.5	62.8	83.3
-	Marshall	1.37	0.61	60.1	17.1	59.6	76.7
-	MN 7125	1.61	0.58	66.8	19.0	57.5	76.5
-	MN 7222	1.39	0.64	64.6	19.0	61.1	80.1
-	Olaf	1.80	0.57	65.1	21.3	69.5	90.8
-	Thatcher	1.94	0.49	60.0	19.0	59.9	78.9
-	MN 7357	1.54	0.61	64.5	19.2	67.9	87.1
-	MN 73167	1.48	0.62	66.4	18.8	69.5	88.3
-	MN 73168	1.39	0.57	71.5	16.5	64.7	81.2
-	James	1.68	0.53	61.9	18.5	65.5	84.0
Significance		**		NS	NS		
BLSD (.05)		0.17		--	--		
Interaction - N-Rate x Variety							
0	Butte	1.19	0.38	37.3	9.0	47.7	56.7
0	Coteau	1.32	0.55	47.2	14.6	48.6	63.2
0	Era	1.13	0.53	41.9	11.9	57.7	69.6
0	Marshall	1.05	0.49	35.1	10.1	40.8	50.9
0	MN 7125	1.23	0.48	36.4	12.0	42.8	54.8
0	MN 7222	0.90	0.42	31.7	7.6	35.1	42.7
0	Olaf	1.26	0.46	36.7	11.6	50.6	62.2
0	Thatcher	1.68	0.43	38.4	14.3	55.4	69.7
0	MN 7357	1.26	0.50	36.4	12.5	51.6	64.1
0	MN 73167	1.17	0.49	40.6	11.4	47.2	58.6
0	MN 73168	1.04	0.44	41.8	9.0	48.0	57.0
0	James	1.24	0.42	42.7	10.2	53.0	63.2
60	Butte	2.01	0.45	63.2	18.2	76.4	94.6
60	Coteau	1.89	0.42	61.2	16.0	76.4	92.4
60	Era	1.76	0.59	65.5	20.5	56.6	77.1
60	Marshall	1.49	0.63	65.5	18.8	65.6	84.4
60	MN 7125	1.90	0.49	68.7	18.7	56.8	75.5
60	MN 7222	1.41	0.74	60.6	21.4	60.3	81.7
60	Olaf	1.88	0.48	71.7	17.8	75.6	93.4
60	Thatcher	1.84	0.47	58.0	17.1	56.0	73.1
60	MN 7357	1.64	0.56	68.7	18.4	72.3	90.7
60	MN 73167	1.46	0.64	65.1	18.9	75.7	94.6
60	MN 73168	1.40	0.60	69.2	16.9	63.9	80.8
60	James	1.77	0.44	63.4	15.4	67.1	82.5

Table 2 continued on next page

Table 1. Influence of nitrogen fertilizer and variety on yield, N content and test weight of 12 hard red spring wheat varieties from Morris, MN - 1982. (cont.)

Nitrogen Rate	Variety	Grain Yield	Grain N Content	Grain Test wt.	Forage Total Dry Matter	Forage N Content
#/A		bu/A	%	#/bu	T/A	%
120	Butte	59.3	2.75	60.7	3.66	1.19
120	Coteau	55.9	2.99	60.2	3.27	1.33
120	Era	50.9	2.79	56.0	3.22	1.44
120	Marshall	49.7	2.79	57.2	2.74	1.47
120	MN 7125	54.3	2.57	57.3	3.38	1.42
120	MN 7222	61.2	2.76	56.3	3.41	1.50
120	Olaf	53.0	2.97	56.0	3.18	1.37
120	Thatcher	45.7	2.86	55.5	3.38	1.24
120	MN 7357	55.4	2.75	57.8	3.26	1.36
120	MN 73167	59.8	2.75	58.4	3.36	1.40
120	MN 73168	55.9	2.82	57.1	3.55	1.46
120	James	51.9	2.83	58.0	3.48	1.15
Signfiicance		**	NS	NS	NS	*

Table 2. (Cont.) Influence of nitrogen fertilization and variety on straw production and nitrogen uptake by forage, straw, and grain by 12 hard red spring wheat varieties from Morris, MN - 1982.

Nitrogen Rate	Variety	Harvest Straw Dry Matter	Harvest Straw N Content	Nitrogen Removal Forage	Nitrogen Removal Straw	Nitrogen Removal Grain	Grain α Straw
#/A		T/A	%	#/A			
120	Butte	2.14	0.59	87.3	25.4	85.3	110.7
120	Coteau	2.23	0.56	85.7	25.8	87.6	113.4
120	Era	1.90	0.77	92.9	29.3	74.0	103.3
120	Marshall	1.57	0.71	79.7	22.4	72.3	94.7
120	MN 7125	1.71	0.77	95.3	26.3	73.1	99.4
120	MN 7222	1.85	0.76	101.5	28.0	88.0	116.0
120	Olaf	2.27	0.77	86.7	34.6	82.4	117.0
120	Thatcher	2.30	0.56	83.4	25.6	68.0	93.6
120	MN 7357	1.72	0.77	88.4	26.7	79.7	106.4
120	MN 73167	1.79	0.73	93.4	26.0	85.6	111.6
120	MN 73168	1.74	0.68	103.4	23.7	82.2	105.9
120	James	2.04	0.73	79.6	29.8	76.6	106.4
Significance		NS	*	NS	NS	**	**

EFFECTS OF NITROGEN AND PHOSPHORUS APPLICATION METHODS ON SPRING WHEAT - 1982

West Central Experiment Station - Morris
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The objective of this study was to compare nitrogen and phosphorus application methods on spring wheat. This is the second year of this study initiated to determine if dual banding of nitrogen and phosphorus is more effective than broadcast or drill applications on spring wheat growth and yield.

Experimental Procedures

Soil sample results prior to plowing in November are given in Table 1. In the spring the plots were sampled by rep prior to fertilizer application and the results are given in Table 2. The entire area was field cultivated and drug on April 26. The anhydrous ammonia and 10-34-0 were applied with a dual applicator on April 29. The material was placed at about an 8-inch depth with a knife spacing of 12 inches. The broadcast 0-46-0 was applied by hand on April 30. The area was then dragged to level the seedbed and seeded to Era wheat @ 1 3/4 Bu/A. The drill applied fertilizers were made up from urea and 0-46-0. All treatment combinations are given in Table 4. The fertilizer bands were marked by red flags in reps 1, 3 and 5 of treatments 3 and 11 so that the bands could be located after harvest.

Whole plant samples were collected on July 20 and were used to calculate forage yield and N and P uptake. The plots were harvested on August 9 with a plot combine. On selected treatments soil samples after harvest were taken on September 3 and the results are given in Table 3.

Yield and Nutrient Uptake

The nutrient uptake and yield results are given in Table 4. Dry matter yield was significantly affected by N application but there were no significant differences between application methods. The highest D.M. yield was when all the P was drill applied.

The phosphorus concentration in the tissue at the soft dough stage decreased when N decreased and when no P was drill applied. When some P was drill applied, the % P increased slightly. There was no significant difference between application methods.

Phosphorus uptake did not increase with increased N except when some P was drill applied. At the 50 N rate there were no differences between placement method; whereas, at the 100 N rate the treatment with all P drill applied was significantly higher in P uptake than all other treatments.

The N concentration in the tissue at soft dough stage was closely related to N application rate, but there were no differences between placement methods.

Nitrogen uptake was significantly affected by N application rate. At the low N rate there were no significant differences. At the high N rate there were again no significant differences, but the maximum difference (18.4 lb/A) was between all P broadcast and all P drill applied.

Grain yield was closely related to N rate. At the low N rate there was a significant difference between all P with a knife (55.5 Bu/A) and all P drill applied (61.0 Bu/A). At the high N rate there was a significant difference between all P drilled applied (63.6 Bu/A) and only 25% of the P drill applied (58.2 Bu/A).

Grain protein levels were somewhat related to N rate. There were no significant differences in grain protein at either N rate, but the highest protein was where all P was drill applied.

The 1982 study on placement methods shows very little effect of placement on any of the variables measured. In most cases the best uptake and yield resulted from drill application of all the P. In no cases were there any differences between the deep band treatments (2 and 3) and the broadcast treatments (4 and 5).

Soil Sampling of the Deep Bands

One problem associated with deep banding of P is the method of obtaining accurate soil samples of the area banded. An attempt was made in 1982 to see if the P level in the bands was different than the P level between the bands after harvest. Results in Table 3 compare the band and between band

P levels with the check treatment (no P) and the broadcast P treatment. The P soil test level was determined by three methods.

There was a definite difference of the P soil test in the band compared to between the bands. The difference varied with soil test method. In all cases we could not detect the broadcast P by soil test (comparing the check P level with the broadcast P level). The between band P levels appeared to be slightly lower than the check and broadcast levels.

Table 1. Soil test results on November 3, 1981.

Soil Texture	Organic Matter	pH	Bray P 1:10	Exch. K	NO_3-N(lb/A) 0-1'	1-2'	2-3'	3-4'	4-5'
Cl	H	7.7	13 lb/A	224 lb/A	7	6	6	6	8

Table 2. Soil test results in April, 1982.

Rep	P Soil Test Olson	Bray 1:10	Bray 1:50	Exch. K	Soil pH
	lb/A			- lb/A -	
1	13	23	55	283	7.9
2	15	21	50	294	7.8
3	12	20	50	242	7.8
4	12	20	45	270	8.0
5	14	21	50	235	7.9
6	13	24	50	257	7.8

Table 3. The effect of P application methods on P soil test (September 1982).

Trt. No.	P Placement Method	Sample Location	P_2O_5	P Soil Test Method[1] Olson	Bray 1:10	Bray 1:50
			- lb/A -	lb/A		
1	Check	-	0	9	18	40
3	Deep Band	In Band	40	16	27	52
		Between Bands	40	6	14	37
11	Deep Band	In Band	30	14	19	40
		Between Bands	30	6	16	34
5	Broadcast	-	40	8	17	39
Significance:				*	**	*
BLSD(.05):				7	6	10
CV (%):				36.4	16.1	12.7

[1] Average of three replications, 4 subsamples per plot 0-10" deep.

Table 4. The effect of N and P application methods on spring wheat.

Trt. No.	Treatment Description: Placement	Fertilizer Treatment: Source[1]	N	P_2O_5	Whole Plants @ Soft Dough Stage: D.M. Yield	Phosphorus	Phosphorus Uptake	Nitrogen	Nitrogen Uptake	Grain Yield	Grain Protein
			- lb/A -		lb/A	%	lb/A	%	lb/A	Bu/A	%
1	Check	-	0	0	2345	.237	5.53	0.93	21.7	27.2	12.5
2	Dual NP, Knife	AA,APP	50	40	6109	.208	12.73	1.08	66.5	55.5	12.6
3	Dual NP, Knife	AA,APP	100	40	6936	.182	12.61	1.43	98.9	62.3	13.5
4	N Knife, P BCST	AA,TSP	50	40	6273	.209	13.16	1.07	66.7	58.7	13.1
5	N Knife, P BCST	AA,TSP	100	40	6719	.199	13.35	1.39	93.1	60.2	13.7
6	N Knife, NP1 DRILL[2]	AA,UR,TSP	50	40	6216	.199	12.35	1.15	70.6	59.4	12.2
7	N Knife, NP1 DRILL[2]	AA,UR,TSP	100	40	7506	.206	15.47	1.48	111.5	63.6	14.6
8	N Knife	AA	50	0	6181	.203	12.47	1.08	66.8	61.0	12.9
9	N Knife	AA	100	0	6573	.194	12.72	1.44	94.5	61.7	13.8
10	NP Knife, NP2 DRILL[3]	AA,APP,UR,TSP	50	40	6053	.190	11.55	1.01	61.1	55.2	12.1
11	NP Knife, NP2 DRILL[3]	AA,APP,UR,TSP	100	40	6559	.204	13.10	1.44	97.4	58.2	13.2
Significance:					**	*	**	**	**	**	**
BLSD(.05):					743	.031	2.08	0.15	15.1	5.2	1.4
CV (%):					11.5	10.9	15.6	11.7	18.5	8.8	8.2

[1] AA = Anhydrous Ammonia (82-0-0), APP = Ammonium Polyphosphate (10-34-0), TSP = Triple Super-Phosphate (0-46-0), UR = Urea (46-0-0).

[2] NP1 DRILL = 10 N + 40 P_2O_5 at seeding with drill.

[3] NP2 DRILL = 10 N + 10 P_2O_5 at seeding with drill.

EFFECT OF FERTILIZER ON CORN GRAIN YIELD AND N CONTENT OF THE EAR LEAVES

West Central Experiment Station - Morris

S. D. Evans and Greg Buzicky

Plot areas were established in the fall of 1972 on a Doland silt loam at the West Central Experiment Station to study the effect of fertilizer treatments on corn yield and nutrient content and on chemical elements added to soils. Reported below are some of the observations during the ten years of the experiment.

A 95-day hybrid was planted each year at about 22,000 seeds/A during the first three weeks in May. Corn rootworm and weed control chemicals were used. A starter fertilizer (6-24-24) was applied along the row at 143 lb/A at planting time. Nitrogen in addition to the starter was applied broadcast as urea, at the times indicated in Table 1. An organic source of N was applied as soybean oil meal, which supplied some P and K as well. The 80-lb rate of meal supplied 8 and 25 lb/A of P and K, respectively; the 120-lb rate of meal, 12 and 39 lb/A of P and K, respectively. An overall application of 100 lb/A of P_2O_5 and 100 lb/A of K_2O was made in the spring of 1981. All materials were incorporated soon after application. The treatments were replicated 4 times. In 1982 the plots were severely damaged by hail on August 31.

Grain yield was determined on mature corn. Sixth corn leaf samples were collected for analysis at silking.

Corn Grain Yield

Yields for each of the ten years and the averages are given in Table 1. Significant yield differences occurred in 1974, 1979, 1980, 1981, and 1982. In no case was more than 80 lb N/A needed for maximum yield. In fact, in some years lesser amounts of N were adequate--1976 - 40 lb/A, 1977 - starter only, 1978 - 40 lb/A, and 1982 - 40 lb/A. The ten-year average shows maximum yield at 80 lb N/A.

In most years there was little difference between fall and spring applications of N. In 1975 and 1978 some fall treatments yielded slightly more than corresponding spring treatments. The ten-year average shows no difference between fall and spring applications.

Treatments receiving the organic N source, soybean oil meal, were not significantly different from the corresponding urea treatments 4 and 5. However, there was some year-to-year variation. In 1973 the 80-lb organic treatment was lower yielding than the 80-lb urea treatment, possibly due to inadequate mineralization. In 1975 the 120-lb organic treatment yielded more than the 120-lb urea treatment and in 1979 the 80-lb organic treatment yielded more than the 80-lb urea treatment. The ten-year average again shows no difference between organic and urea N sources.

The extra 30 lb P/A (treatment 12) did not yield significantly better than treatment 4, but in 1976 the yield difference was 11.3 bu/A. There was no significant effect on the ten-year average. Soil tests in the fall of 1980 showed Bray exchangeable P levels averaging 13 on treatment 4 and 43 on treatment 12. For this reason additional P was applied in the spring of 1981.

Results of the first ten years of this trial show that (1) 80 lb N/A were needed for maximum yield, (2) there was no difference between fall and spring urea applications, (3) there was no difference between urea and soybean oil meal as N sources, and (4) the amount of P supplied in the starter was adequate, but soil test levels had decreased to 13 lb/A.

N Content of Sixth Leaf

All the values for ear leaf N are given in Table 2. Significant differences occurred in all years except 1977. There was considerable year-to-year variation in N contents within a specific treatment. For example, the 80-lb spring applied urea (treatment 4) varied from a low of 2.53% in 1973 to a high of 3.37% in 1974. In all years there was an increase in the leaf N content as urea rates increased to the 120-lb rate, even though yields reached a maximum at the 80-lb rate. In 1973, 1975, 1976, 1979, and 1982 treatments 1 and 2 (starter only) had values in the deficient range (<2.45% N). The 40-lb urea treatment had N contents in the deficient range in 1973 and 1979, in the low range (2.46%-2.75%) in 1975, 1976, and 1982, and in the sufficient range (2.76%-3.50%) in 1974, 1977, 1978, 1979, and 1980. In all years except 1974 and 1976, leaf N levels were a good indicator of the

adequacy of N for maximum yields. In 1974 all N levels were high even though it took 80 lb N/A for maximum yields. In 1976 yields were very low due to the extreme drouth and maximum yield was at the 40-lb N/A rate.

Table 1. Effect of fertilizer treatments on corn grain yield.

Fertilizer Treatments		In addition to starter		Grain Yield										
No.		N[2]	P	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	10-year average
		— lb/A —		— bu/A —										
1	Starter[1]	0	0	112.5	77.3	99.4	19.9	101.8	117.9	79.6	67.4	87.6	57.9	82.1
2	"	0	0	116.3	70.7	104.5	20.1	100.6	117.4	75.0	67.9	78.8	52.5	80.4
3	"	40	0	122.1	81.7	104.7	24.2	101.4	128.2	107.9	95.8	104.0	74.8	94.5
4	"	80	0	129.8	94.0	110.9	24.4	103.3	129.3	112.2	104.0	111.4	74.3	99.4
5	"	120	0	128.2	91.2	112.5	21.2	102.5	126.7	111.0	103.6	113.2	75.2	98.5
6	"	120(SD)	0	126.5	90.4	119.8	19.6	103.1	126.4	116.3	112.0	111.2	79.6	100.5
7	"	160(SD)	0	128.9	91.9	110.7	25.6	99.3	125.7	105.8	103.2	107.6	71.8	97.0
8	"	80(F)	0	118.2	92.8	119.0	23.2	99.6	135.7	115.7	113.6	108.3	84.8	101.1
9	"	120(F)	0	128.9	90.2	125.7	21.2	103.4	128.6	115.8	106.1	112.7	77.2	101.0
10	"	80(ORG)	8	122.2	87.8	114.7	25.4	99.4	129.0	121.9	102.6	107.5	80.9	99.1
11	"	120(ORG)	12	127.7	96.9	119.2	22.0	101.0	130.7	113.1	109.6	100.2	76.2	99.7
12	"	80	30	123.6	91.8	108.9	24.7	104.2	127.8	123.5	105.4	109.2	80.0	99.9
Significance				NS	**	NS	NS	NS	NS	**	**	**	**	
BLSD(.05)				-	16.9	-	-	-	-	12.0	9.8	11.2	15.4	

[1] Starter (6-24-24) was applied along the row at planting time at 143 lb/A.

[2] Nitrogen sources were urea except for treatments 10 and 11 which were soybean oil meal. All treatments were spring applied except 8 and 9 which were applied in the fall. Two treatments received split applications of nitrogen: Treatment 6 received 80 lb at planting and 40 lb sidedressed and treatment 7 received 80 lb at planting and 80 lb sidedressed.

Table 2. Effect of fertilizer treatments on the nitrogen content of the sixth leaf at silking.

Fertilizer treatments		In addition to starter		N content of sixth leaves										
No.		N[2]	P	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	10-year average
		— lb/A —		— % —										
1	Starter[1]	0	0	2.20	2.96	2.26	2.25	3.11	2.64	1.85	2.46	2.88	2.24	2.48
2	"	0	0	2.18	3.04	2.27	2.09	3.00	2.65	1.71	2.41	2.81	2.12	2.43
3	"	40	0	2.40	3.26	2.59	2.57	3.07	3.00	1.98	3.00	3.22	2.70	2.78
4	"	80	0	2.53	3.37	2.85	2.62	3.13	3.13	2.86	2.90	3.28	2.88	2.96
5	"	120	0	2.74	3.50	2.90	2.79	3.16	3.24	2.99	3.06	3.39	3.04	3.08
6	"	120(SD)	0	2.55	3.46	2.88	2.53	3.12	3.24	2.96	3.02	3.23	3.01	3.00
7	"	160(SD)	0	2.62	3.45	2.85	2.67	3.04	3.22	2.68	3.08	3.11	3.04	2.98
8	"	80(F)	0	2.50	3.32	2.82	2.64	3.14	3.12	2.86	2.72	3.19	2.93	2.92
9	"	120(F)	0	2.48	3.46	2.80	2.62	3.23	3.11	2.88	2.86	3.32	2.98	2.97
10	"	80(ORG)	8	2.52	3.42	2.84	2.54	3.23	3.16	3.00	2.95	3.29	2.89	2.98
11	"	120(ORG)	12	2.61	3.42	2.93	2.67	2.98	3.20	2.62	3.16	3.37	3.02	3.00
12	"	80	30	2.49	3.36	2.60	2.64	3.09	3.13	2.40	2.85	3.14	2.92	2.86
Significance				**	**	**	**	NS	**	**	**	**	**	
BLSD(.05)				.22	.19	.23	.16	-	.13	.59	.32	.29	.15	

[1] Starter (6-24-24) was applied along the row at planting time at 143 lb/A.

[2] Nitrogen sources were urea except for treatments 10 and 11 which were soybean oil meal. All treatments were spring applied except 8 and 9 which were applied in the fall. Two treatments received split applications of nitrogen: Treatment 6 received 80 lb at planting and 40 lb sidedressed and treatment 7 received 80 lb at planting and 80 lb sidedressed.

CONTINUOUS CORN SILAGE

West Central Experiment Station - Morris

S. D. Evans

I. Experimental Description

In 1965 an experiment was initiated on McIntosh silt loam to determine the effect of removal of continuous corn silage and fertilizer on corn grain and corn silage yields and on soil properties. Rates of fertilizer used were 74 + 48 + 48 ($N + P_2O_5 + K_2O$) and 148 + 96 + 96. All plots received a broadcast application of 10 lbs/acre of zinc as zinc sulfate in the fall of 1965.

II. 1982 Operations

In 1982 the variety was Trojan TXS99. Counter was applied at 1 lb/acre (active ingredient) at planting on April 29. Lasso @ 2.5 lbs/acre plus Bladex @ 2.2 lbs/acre were applied broadcast on April 30. AAtrex 9-0 @ 3/4 lb/acre + 1 qt oil/acre was applied on June 9. The plots were severely damaged by hail in August 31. Silage yields were taken on September 21 and grain yields on October 15.

III. Silage Yields - Dry matter; tons/acre

Treatment	1982 yield	1966-82 yield
Silage, low fertility	5.06	5.64
Silage, high fertility	5.87	6.07
Grain, low fertility	5.34	5.64
Grain, high fertility	5.65	5.90

IV. Grain Yields - Bushels/acre @ 15.5% M.

	1982 yield	1966-82 yield
Grain, low fertility	60.02	89.64
Grain, high fertility	69.20	92.88

V. Check Yields

Yields on an additional unfertilized, unreplicated check adjacent to the experimental area:

	1982 yield	1966-82 yield
Grain (0 + 0 + 0)	27.96	48.95
Silage (0 + 0 + 0)	3.07	3.73

VI. Discussion

A. In 1982 there were no significant differences in silage yields but the silage high fertility plots yielded slightly more than the low fertility plots.

B. The 17-year average yields show very little difference between silage and grain plots, but there is still a slight advantage for the higher fertility level.

EFFECT OF IRON ON THE CORRECTION OF SOYBEAN CHLOROSIS

West Central Experiment Station - Morris
S. D. Evans and H. L. Meredith

The primary objective of this study was to determine the effectiveness of a low pH iron containing urea-phosphate fertilizer on iron chlorosis in soybeans.

Experimental Procedures

Treatments used in this study are shown in Table 1. The urea phosphate (17-44-0) had a pH of 1.5. The same material was co-granulated with iron sulfate to give a material with an analysis of 15-39-0 also containing 4% iron. A foliar application of iron chelate applied at the 2nd trifoliate stage was also included in the study. Both studies were carried out on the Kermit Stahn farm in Section 11, Synnes Township, Stevens County. Two soybean varieties were included each year. One variety was Evans which is fairly tolerant of iron chlorosis. The other two varieties, II-74-15 and II-75-15, had many of the same characteristics as Evans but were fairly susceptible to iron chlorosis.

Results

The results for both years are shown in Table 2. In 1981 there was no chlorosis visible in the plot area. The only significant effect was a difference between Evans and II-74-15. There was no significant effect of any of the fertilizer treatments.

In 1982 chlorosis was quite evident. The chlorosis score shows a big difference between Evans and II-75-15. There was no significant effect of the urea phosphate + iron or iron chelate in correcting the visual symptoms. Yield figures for 1982 again show a variety difference but no effect of the fertilizer treatments. However, there seems to be some effect of the urea phosphate in increasing yields over the check in both varieties. The urea phosphate + iron also appeared to increase yields over the urea phosphate alone on the variety II-75-15.

Table 1. Plot information for 1981 and 1982.

Varieties	1981 Evans and II-74-15	1982 Evans and II-75-15
Planting date	May 14	May 24
Row spacing	30 inches	30 inches
Iron chelate	Fe 330	Fe 138
Date applied	June 24	June 29
Soil type	Hamerly clay loam	Nutley-Hattie clay

Table 2. Effect of urea phosphate + iron and iron chelate on soybean yield and chlorosis score, 1981-82.

Fertilizer Treatment	1981			1982			1982		
	Evans	II-74-15	Av.	Evans	II-75-15	Av.	Evans	II-75-15	Av.
	Bu/A			Bu/A			Chlorosis Score[1]		
Check	40.7	32.3	36.5	33.3	30.0	31.7	1.8	3.5	2.7
Urea phosphate 17-44-0 @ 100 lb/A	39.2	34.8	37.0	35.6	31.6	33.6	1.7	3.3	2.5
Urea phosphate + 4% iron sulfate @ 113 lb/A	35.5	32.0	33.7	35.7	33.6	34.7	1.7	4.0	2.8
Iron chelate to provide 0.15 Fe/A at 2nd trifoliate stage	38.7	32.8	35.8	36.0	30.1	33.1	1.3	2.8	2.1
Average	38.5	33.0		35.2	31.3		1.6	3.4	
Significance -									
Fertilizer Treatment:	NS			NS			NS		
Variety:	**			**			**		
Interaction:	NS			NS			NS		

[1] Chlorosis score, 1 = normal, 2 = slight chlorosis, 3 = 50% plants in row chlorotic, 4 = 75% plants in row chlorotic, 5 = most plants in row chlorotic.

SOIL TEST LAB COMPARISON

West Central Experiment Station - Morris

S. D. Evans and C. A. Schrader

In the past few years the number of commercial laboratories testing soils in west central Minnesota has increased. In many cases the commercial laboratory recommendations differ greatly from those of the University of Minnesota Soil Testing Laboratory. In order to develop educational material for use by the extension soils specialists, trials were started at the West Central Experiment Station in 1980 on a corn-wheat rotation. Results from the 1980 and 1981 trials were summarized previously (Soil Series 109 and Misc. Publ. 2).

In the fall of 1981 soil samples of the plow layer and the 0-2 foot zone (corn only) were taken from each plot except the check. The soil from the four replications was combined to make two samples (plow layer and 0-2 foot) from each treatment. The samples were dried thoroughly, mixed and subdivided and sent to the same laboratory as that treatment in 1980. Recommendations were requested for corn at a yield goal of 130 Bu/A and spring wheat at a yield goal of 65 Bu/A. Analyses requested were (1) a complete analysis on the plow layer samples and (2) a nitrate-N analysis and recommendation on the 0-2 foot samples on the treatments to be planted to wheat. After receiving the soil tests and recommendations (Tables 1 and 2), the fertilizer treatments were calculated with an adjustment for soil buildup with Lab C. With Lab C there was no indication that the 0-2 foot sample was used for the nitrogen recommendation on wheat.

General

The experiment was set up as a randomized complete block with four replications on each crop. Two blocks, each with 24 plots, are adjacent to one another and alternate between wheat and corn. The plot size is 15 feet by 40 feet. Row spacing on the corn is 30 inches. A hail storm on August 31 caused severe lodging in the corn and lowered the yield potential.

Wheat

Copper and zinc treatments were dissolved in water and sprayed on the plots on November 3, 1981. The P, K, and S were applied by hand on November 4 and the N on November 10. The plots were then plowed. In the spring the plots were worked with a field cultivator and dragged. On April 23 the area was seeded to Era wheat @ 1 3/4 Bu/A. On May 24 the wheat area was sprayed with Hoelon @ 3 1/3 pts/A. The plots were sprayed again on June 3 with MPCA @ 1 pt/A. The upper two leaves were sampled prior to flowering on June 23 for nutrient analysis. On July 20 the soft dough stage whole plant samples were taken for nutrient analysis. The plots were harvested with a plot combine on August 9. Samples of grain were saved for protein analysis.

Corn

Copper and zinc were dissolved in water and sprayed on the plots on November 3, 1981. N, P, K, and S were hand spread on November 4. The area was plowed on November 5. On May 4 the plots were dug with a field cultivator, dragged and planted to Trojan TXS 99 @ 23,000 seeds/A. No starter fertilizer or insecticide was used. The herbicides Lasso (2.5 lb/A) and Bladex (2.2 lb/A) were applied on May 5. Early plant heights and samples were collected on June 23. Leaf samples at mid-silk were collected on July 28. The plots were hand harvested on September 28. Samples of grain were saved for protein analysis.

Results and Discussion of the Wheat Trial

As shown in Table 1, the soil tests and fertilizer recommendations varied greatly with laboratory. Two labs recommended sulfur and zinc and one copper. The N and K recommendations had wide variations.

Upper leaf nutrient concentration differences among the laboratories were found for Ca, Mg, Fe, Cu, and Mn. Lab B or C generally had the highest concentrations. Lab D usually had the lowest concentration. Soft dough nutrient concentration differences between laboratories were found for N, K, Ca, Mg, Fe, and B. There were significant differences in lodging, grain yield and grain moisture. Lab D had a significantly lower grain yield than all other labs.

Table 1. Soil test results and the suggested fertilizer program for wheat in 1982.

	Soil Test Results[1]				
Test	Lab A	Lab B	Lab C	Lab D	Lab E (UM)
pH	7.9	7.6	8.0	7.9	7.9
Phosphorus (Bray 1)		16-M		19-M	21
($NaHCO_3$)	22-M	48-H	18	- -	
Potassium	216-H	175-H	170	220-H	198
Organic Matter	3.4	2.9-M	3.1	M	M
Calcium	8800	2970-H	5169	3600-H	- -
Magnesium	920	420-VH	623	630-H	903
Sodium	45	- -	17	- -	- -
Sulfur	3-L	7-L	26	10-MH	5
Iron	15.3-VH	14-M	25.0	10-H	- -
Manganese	8.26-VH	11-M	11.0	5.5-H	- -
Zinc	1.50-H	1.5-M	1.8	1.6-M	1.4
Copper	.89-H	.8-L	.8	.6-H	.6
Boron	- -	1.0-M	.8	2.6-H	- -
ENR (lb/A)	- -	88	- -	- -	- -
Nitrate N (lb/A)	124	80	10	108	68
C.E.C. (meq/100 g)	26.2	18.8	31.5	- -	- -
Soluble salts	.29	- -	.30	- -	- -

	Suggested Fertilizer Program[2]				
Nutrient	Lab A	Lab B	Lab C	Lab D	Lab E (UM)
Nitrogen	28	110	85	22	50
Phosphorus (P_2O_5)	45	45	45	41	30
Potassium (K_2O)	63	65	160[3]	100	60
Sulfur	- -	10	- -	20	- -
Zinc	- -	2	- -	6	- -
Manganese	- -	- -	- -	- -	- -
Copper	- -	.5	- -	- -	- -
Boron	- -	- -	- -	- -	- -

[1] All soil test results are stated in ppm unless otherwise noted.

[2] All values indicate pounds of nutrient suggested per acre for a yield goal of 65 bushels of wheat per acre.

[3] Values include maintenance plus 1/2 of suggested buildup.

Table 2. Soil test results and the suggested fertilizer program for corn in 1982.

	Soil Test Results[1]				
Test	Lab A	Lab B	Lab C	Lab D	Lab E (UM)
pH	7.9	7.6	7.7	7.9	7.6
Phosphorus (Bray 1)	- -	18-M	- -	23-M	25
($NaHCO_3$)	20-M	44-H	18	- -	- -
Potassium	202-H	202-H	228	261-H	222
Organic Matter	3.9	2.8-M	3.6	M	H
Calcium	7000	2790-H	4128	3600-M	- -
Magnesium	1050	521-VH	634	520-M	898
Sodium	43	- -	22	- -	- -
Sulfur	4-L	6-L	25	11-MH	5
Iron	16.5-VH	19-H	26.6	10-H	- -
Manganese	13.25-VH	16-H	17.6	11-H	- -
Zinc	1.62-H	1.8-M	2.7	1.9-M	1.7
Copper	.92-H	.9-M	1.1	1-H	.6
Boron	- -	1.1-M	.8	2.5-H	- -
ENR (lb/A)	- -	86	- -	- -	- -
Nitrate N (lb/A)	- -	- -	1	26	- -
C.E.C. (meq/100 g)	22.2	18.8	26.5	- -	- -
Soluble salts	.35	- -	.35	- -	- -

	Suggested Fertilizer Program[2]				
Nutrient	Lab A	Lab B	Lab C	Lab D	Lab E (UM)
Nitrogen	132	150	135	111	90
Phosphorus (P_2O_5)	92	55	80	101	70
Potassium (K_2O)	68	65	95[3]	122	40
Sulfur	0	15	- -	20	- -
Zinc	0	1.5	- -	3	- -
Manganese	0	- -	- -	- -	- -
Copper	0	1	- -	- -	- -
Boron	- -	- -	- -	- -	- -

[1] All soil test results are stated in ppm unless otherwise noted.

[2] All values indicate pounds of nutrient suggested per acre for a yield goal of 65 bushels of wheat per acre.

[3] Values include maintenance plus 1/2 of suggested buildup.

The fertilizer cost and economic returns are given in Table 8. The fertilizer cost differed by $18 between Lab C and Lab E. The return over fertilizer ranged from $232.40 (Lab E) to $162.83 (Lab D). The check had the lowest returns.

Results and Discussion of the Corn Trial

Soil tests varied widely, as shown in Table 2. Recommendations for N, P, and K were different, but the range was not as great as for the wheat. Two laboratories recommended both sulfur and zinc and one also recommended copper.

Small whole plant nutrient concentration differences among the laboratories were significant only for K and Cu.

Ear leaf nutrient concentration among laboratories was significant for N, P, K, Zn, and Cu. The copper level was highest in the two labs which have received Cu in the past three years.

Corn grain yields did not vary significantly between laboratories. None of the other plant measurements varied significantly. Variation in the plots was high due to the hail damage.

Fertilizer costs are given in Table 8. The costs ranged from $62.75 (Lab D) to $35.80 (Lab E). The economic return over fertilizer varied about $19/acre between labs.

Three-Year Summary

The combined data for 1980, 1981, and 1982 (Table 9) shows quite a range in the return over check. For wheat Labs C and D show the smallest return while Lab E shows the greatest return. For corn all results are negative because of reduced corn prices but Labs C and D show the most negative results while Lab D Shows the least negative results. The combined wheat and corn results averaged over years shows the same ranking of labs. After three years of testing, it appears that the recommendations by some labs of sulfur, micronutrients and high rates of P and K are not resulting in significantly higher yields than the University of Minnesota recommendations. On the other hand, some labs give recommendations that are close to the University of Minnesota.

Table 3. Effect of suggested fertilizer applications on the leaf[1] nutrient concentration of wheat.

	Nutrient								
Lab	P	K	Ca	Mg	Fe	Zn	Cu	Mn	B
	%				ppm				
A	.307	2.59	.533	.315	95	29.4	4.4	75	5.9
B	.304	2.73	.548	.310	96	35.7	5.9	82	7.2
C	.310	2.63	.536	.340	95	31.1	4.3	86	6.0
D	.310	2.48	.419	.269	82	26.1	3.2	62	7.6
E (UM)	.306	2.61	.479	.302	87	29.9	5.1	70	6.3
Check	.314	2.48	.331	.204	77	37.3	2.9	47	4.5
Significance	NS	NS	**	**	*	NS	**	**	NS
BLSD (.05)	- -	- -	.086	.057	10	- -	1.5	7	- -
CV (%)	3.8	6.5	12.2	12.9	9.9	31.1	21.8	7.2	42.4

[1] Upper 2 leaves prior to flowering.

Table 4. Effect of suggested fertilizer applications on the nutrient concentrations of whole plants at the soft dough stage of wheat.

Lab	Nutrient									
	N	P	K	Ca	Mg	Fe	Zn	Cu	Mn	B
	%					ppm				
A	1.38	.213	1.11	.200	.179	57	22.8	1.2	46	1.9
B	1.42	.196	1.29	.245	.188	62	24.6	1.2	46	2.3
C	1.33	.193	1.31	.206	.184	62	21.2	1.4	46	2.1
D	1.08	.197	1.14	.159	.156	46	19.9	1.0	45	1.8
E (UM)	1.30	.205	1.13	.185	.169	53	22.7	1.0	45	1.7
Check	1.06	.201	0.98	.143	.129	53	22.9	0.9	40	1.4
Significance	*	NS	*	**	**	*	NS	NS	NS	**
BLSD (.05)	0.24	- -	.24	.048	.024	10	- -	- -	8	0.3
CV (%)	11.8	9.8	12.3	16.2	9.5	11.4	9.8	33.2	7.5	11.2

Table 5. Effect of suggested fertilizer applications on the nutrient concentration in young whole plants of corn.

Lab	Nutrient								
	P	K	Ca	Mg	Fe	Zn	Cu	Mn	B
	%				ppm				
A	.328	3.03	.563	.475	183	38.1	6.1	53.7	5.2
B	.319	3.42	.533	.427	197	38.5	6.3	47.9	5.1
C	.328	3.59	.504	.391	196	39.4	5.8	50.7	5.3
D	.315	3.30	.562	.419	195	40.0	6.4	53.2	5.2
E (UM)	.326	3.10	.544	.471	185	37.4	6.4	52.4	5.2
Check	.324	2.76	.574	.451	203	38.7	6.8	53.0	5.6
Significance	NS	*	NS	NS	NS	NS	+	NS	NS
BLSD (.05)	- -	0.57	- -	- -	- -	- -	- -	- -	- -
CV (%)	6.9	10.6	8.6	11.2	8.0	8.0	7.2	6.5	7.2

Table 6. Effect of suggested fertilizer applications on the leaf concentrations in corn.

Lab	Nutrient									
	N	P	K	Ca	Mg	Fe	Zn	Cu	Mn	B
	%					ppm				
A	2.95	.315	1.87	.554	.455	122	16.5	4.6	69	4.6
B	3.18	.322	1.93	.556	.421	130	18.7	5.6	66	4.9
C	3.08	.318	2.00	.580	.407	129	18.1	5.1	67	4.9
D	3.06	.314	1.98	.544	.307	126	18.3	5.3	65	4.7
E (UM)	3.01	.311	1.87	.541	.420	126	16.4	4.7	65	4.5
Check	2.67	.272	1.69	.550	.383	125	16.5	4.2	56	4.4
Significance	**	**	**	NS	NS	NS	**	**	NS	+
BLSD (.05)	0.15	.020	.15	- -	- -	- -	1.2	0.7	- -	- -
CV (%)	3.5	4.3	5.1	6.5	12.0	3.93	4.6	9.1	10.9	5.4

Table 7. Effect of fertilizer recommendations on various plant measurements.

Lab	Corn				Wheat				
	Early Plant Height	Early Plants (10) Dry Weight	Corn Grain Yield	Grain Moisture	Plant Height at Harvest	Lodging at Harvest	Grain Yield	Grain Moisture	Grain Protein
	- in -	- grams -	-Bu/A-	- % -	- in -	Score[1]	-Bu/A-	- % -	- % -
A	21.2	38	107.3	34.0	27.0	1.8	57.3	14.6	13.8
B	20.9	44	108.3	34.0	29.0	1.8	62.8	14.5	14.3
C	20.4	38	105.3	34.9	28.5	2.0	66.7	14.4	14.0
D	31.3	41	106.0	35.0	28.2	1.2	49.0	14.6	12.4
E (UM)	20.9	42	106.6	34.2	29.5	2.0	64.4	14.6	13.5
Check	21.6	38	91.4	35.0	26.8	1.0	35.1	14.8	12.2
Significance	NS	NS	+	NS	+	**	**	**	*
BLSD (.05)	-	-	-	-	-	.5	9.30	0.2	1.4
CV (%)	6.2	19.5	7.3	4.3	5.1	21.2	11.6	.75	6.6

[1] Lodging score: 1 = No lodging, 9 = flat.

Table 8. Economic return over fertilizer costs - 1982.

Lab	Wheat			Corn		
	Value of Crop @ $4/Bu	Fertilizer Cost*	Return over Fertilizer	Value of Crop @ $2/Bu	Fertilizer Cost	Return over Fertilizer
	$/A					
A	229.20	34.56	194.64	214.60	50.96	163.64
B	251.20	40.29	210.91	216.60	48.36	168.24
C	266.80	43.20	223.60	210.60	51.65	158.95
D	196.00	33.17	162.83	212.00	62.75	149.25
E (UM)	257.60	25.20	232.40	213.20	35.80	177.40
Check	140.40	0	140.40	182.80	0	182.80

* Values used ($/lb) were as follows: N = $0.15, P_2O_5 = $0.25, K_2O = $0.12, S = $0.24, Zn = $0.47, Cu = $2.80.

Table 9. Three-year summary of yields and economic returns.

Lab	Wheat*				Corn**				Average Return per Year
	Total 3-year Yield	Total 3-year Fertilizer cost	Economic Return over Fertilizer	Return over Check	Total 3-year Yield	Total 3-year Fertilizer Cost	Economic Return over Fertilizer	Return over Check	
	Bu/A	$/A			Bu/A	$/A			$/A
A	166.5	71.73	594.27	+57.47	340.3	145.64	699.50	-31.64	+8.61
B	176.0	114.97	589.03	+52.23	348.1	166.22	695.98	-35.16	+5.59
C	175.8	152.65	550.55	+13.75	348.9	197.96	669.52	-61.62	-15.96
D	158.4	83.53	550.07	+13.27	342.5	179.50	671.32	-59.82	-15.52
E (UM)	170.9	62.11	621.49	+84.69	340.6	122.25	721.97	-9.17	+25.17
Check	134.2	-	536.80	-	292.9	-	731.14	-	-

* Wheat valued at $4/Bu, 1980-82.

** Corn valued at $3.00, $2.40 and $2.00/Bu in 1980, 1981 and 1982, respectively.

PROBLEMS WITH IRRIGATED CORN 1982

W. E. Fenster and C. J. Overdahl

County Agricultural Agents and irrigator farmers in recent years have reported corn production problems where corn yields appear to be on the decline. In 1979 two farmers in Morrison County complained that yields dropped by two-thirds from the year before. In 1980 and 1981 the Wadena County Agricultural Agent reported similar problems.

In 1982 field experiments were initiated at 2 irrigated sites, the CMIDRF at Staples and Roth farm northeast of Staples. Both areas had sandy textured soils.

The design of the experiment used at both sites is shown in table 1 along with 1982 corn yields.

Yield data from the Roth farm indicates a significant response to nitrogen, and a significant benefit from the use of the inhibitor "N-Serve". There appears to be no benefit from boron even though plant analysis of the corn leaf at silking time showed below sufficient levels of boron. There appears to be benefit from split applications of nitrogen at the 160 pound rate when N-Serve is not used.

Data from the Staples farm shows a significant response to nitrogen. There appeared to be no benefit from the inhibitor, the sulfur, the boron, or from split applications of nitrogen.

The efforts on this research project of Mike O'Leary, Greg Buzicky, Todd King, Gene Peters, Negussie Berihun and Mel Wiens are acknowledged.

Table 1. Nutrient treatments and various growth stages at Roth and Staples farms and corn yields. 1982

Trt	Total #N/A	Amount and Time of N Application ppl[1]	8 leaf	12 leaf	Tassel	Sulfur[2]	Boron[3]	Yield Bu/A @ 15.5% moist. Roth	Staples
1	0	-	-	-	-	+	+	72	100
2	80		80+			+	+	156	155
3	160	160				+	+	128	160
4	160	160+				+	+	166	161
5	160		160+			+	+	168	153
6	160	80+	80			+	+	163	165
7	160		80	40	40	+	+	167	156
8	160		80+	40	40	+	+	167	163
9	200	200				+	+	151	166
10	200	200+				+	+	171	150
11	200		80	80	40	+	+	166	160
12	200		80+	80	40	+	+	165	160
13	200		80+	80	40	+[4]	+	168	163
14	200		80+	80	40	+	-	173	167
15	200		80+	80	40	-	+	152	163
16	200		80+	80	40	-	-	165	162

Original Soil Test 0 - 6"

	Staples Rep 1	Staples Rep 2
pH	6.4	6.7
P	44	29
K	210	204
Mg	254	208
S	3	3
Zn	0.7	0.6
	Roth	
pH	5.6	6.0
P	105	140
K	168	266
Mg	173	238
S	2	3
Zn	1.5	3.0

Trts.	1-12	12-16	1-12	12-16
Signif.	**	**	**	ns
BLSD (.05)	14.3	5.3	13.4	-
C.V.	7.1	2.8	6.5	2.8

1/ Plus sign indicates use of N-Serve (½ lb/A a.i.) ppl = preplant

2/ Sulfur - 25 lbs/A (applied as starter)

3/ Boron - 2 lbs/A (Bdcst)

4/ Sulfur - 25# additional S at 12 leaf stage

Starter fertilizer results in additional 20 lbs N/A

Table 2. Plant analysis of corn at 2 stages of growth, Staples 1982.

Trt		% N	% P	% K	% S	% Mg	ppm B
			Whole plant 8-leaf stage (4 reps avg)				
1	Zero N, + S, + B	3.97	.46	4.76	.26	.26	36
9	ppl 200 #N, + S, + B	3.95	.44	4.62	.26	.24	48
15	ppl 200 #N, - S, + B	3.50	.35	3.92	.27	.23	50
16	ppl 200 #N, - S, - B	3.43	.35	4.17	.27	.21	9
	adequate levels	3.50	.40	3.00	-	.30	7
			6th leaf stage (2 reps avg)				
13	220 #N$^+$, + S, + B	(See table 3)	.30	3.29	.25	.17	8
14	220 #N$^+$, + S, - B		.31	3.24	.20	.18	4
15	220 #N$^+$, - S, + B		.31	3.16	.22	.18	10
16	220 #N$^+$, - S, - B		.31	3.29	.24	.17	4
	adequate levels	2.70	.25	1.75	.20	.16	6

Table 3. Plant analysis of corn at 2 stages of growth, Roth farm. 1982.

Trt		% N	% P	% K	% S	% Mg	ppm B
			Whole plant, 8 leaf stage (4 reps avg)				
1	Zero N, + S, + B	3.66	.46	4.73	.23	.24	32
9	200 #N, + S, + B	3.96	.46	4.81	.23	.24	45
15	200 #N, - S, + B	3.78	.44	4.63	.26	.25	48
16	200 #N, - S, - B	3.72	.40	4.54	.24	.24	9
	adequate levels	3.50	.40	3.00	-	-	6
			6th leaf stage (2 reps)				
13	220 #N, + S, + B		.24	3.04	.16	.16	7
14	220 #N, + S, - B		.29	3.26	.22	.20	4
15	220 #N, - S, + B		.31	3.20	.23	.18	8
16	220 #N, - S, - B		.31	3.17	.23	.22	4
	adequate levels		.25	1.75	.20	.16	6

		% N	
		Roth	Staples
1	0	2.31	2.08
2	80 N	2.84	2.48
3	160 N	2.80	2.93
5	160 (8th) N	3.26	2.97
6	80 + 80 N	2.96	3.29
7	80 + 40 + 40 N	2.98	3.03
10	200+ N	3.00	3.39
	adequate	2.70	2.70

CORN-BEAN ROTATION

Harvey Meredith, Melvin Wiens and Greg Buzicky

An experiment was initiated in 1981 at the Staples Station to evaluate corn yields under a regime of continuous corn versus corn following soybeans or edible beans.

The study contains two single cross maturity hybrids: Pioneer 3978 (85-day) and 3906 (95-day).

No significant differences in corn yields were noted in 1981 between the two maturity hybrids. The average yield was 151 bushels/A.

Purpose of Study: Yield of corn from a continuous corn monoculture has not met the expectation of many growers on the irrigated sand plain. Many factors have been advanced as probable cause-effect. The potential for consistently high yields rests with the best combination of weather and management. Perhaps the two most critical factors identified with top management focus around moisture and nitrogen. Excess moisture from rainfall or irrigation (or both) result in an extremely deleterious effect on the soil nitrogen regime.

This study represents an application of research coupled with the best known management. The study contains no fertility variable but nutrition requirements have been assured.

1982 Corn Yield Staples Station

Treatment	Bu/A	Shelling %	% Moisture
C-C 3978	168	90	36
C-C 3906	166	88	44
SB-C 3978	170	90	35
EB-C 3978	168	89	37

C-C: Continuous corn
SB-C: Corn following soybeans (Clay - ave. yield, 47 bu/A)
EB-C: Corn following edible beans (Seafarer - ave. yield, 1813 Lb/A)

Fertility: 210-60-210 plus 1 lb. B, 10 lb. Zn, and 12 lb. S.
Nitrogen applied at three equal increments at 7th leaf stage, 12th leaf stage, and at silking.
Starter fertilizer included 150 lb/A of 25-10-20.

Rainfall growing season - 14.6 in. plus 11 in. irrigation water. The suggested CB water use was 20.7 in.

SOUTHERN EXPERIMENT STATION - WASECA

WEATHER DATA - 1982

Month	Period	Precipitation 1982	Precipitation Normal	Avg. Air Temp. 1982	Avg. Air Temp. Normal	Growing Degree Days 1982	Growing Degree Days Normal
		-----inches------		-------°F--------			
January	1-31	2.38	.73	0.6	12.9		
February	1-28	0.57	.96	12.6	17.5		
March	1-31	1.86	1.94	27.7	28.5		
April	1-30	2.78	2.48	40.4	45.6		
May	1-10	1.58		57.4		100.5	
	11-20	2.44		63.6		135.5	
	21-31	2.43		58.7		102.0	
	Total	6.45	3.86	59.8	57.7	338.0	319
June	1-10	0.21		58.6		102.0	
	11-20	0.64		62.2		131.5	
	21-30	0.93		65.6		160.0	
	Total	1.78	4.75	62.2	67.1	393.5	519
July	1-10	0.93		71.4		203.0	
	11-20	0.45		72.4		223.5	
	21-31	0.08		73.0		252.0	
	Total	1.46	4.02	72.4	71.4	678.5	646
August	1-10	0.90		72.8		222.5	
	11-20	0.29		69.0		192.0	
	21-31	3.42		63.5		153.0	
	Total	4.61	3.60	68.2	69.7	567.5	604
September	1-30	4.27	3.45	58.8	60.3	242.0	337
October	1-31	3.72	1.89	49.3	50.3	0.0	35
November	1-30	2.82	1.25	30.0	32.9		
December	1-31	3.48	1.02	24.6	19.0		
Year	Jan-Dec	36.18	29.95	42.2	44.4	2220.0	2460
Growing Season	May-Sep	18.57	19.68	64.3	65.3	2220.0	2425

Notes:

1) Highest temp. on July 5 -- 96°
2) Highest 24-hour precipitation on November 10 -- 1.35"
3) Growing degree days were 10% below normal
4) Available soil moisture in 0-5' profile was below 30% of field capacity in August
5) Last spring frost -- April 22
6) Frost on September 21
7) Second driest June-July period in 67-year record

ROTATION NITROGEN STUDY

Waseca, 1982

G. W. Randall

Increasing the efficiency of fertilizer N along with reducing fertilizer N recommendations by improved diagnostic techniques, symbiotic N fixation, crop rotation, etc. are goals which are gaining widespread research support throughout the United States. The adoption of crop rotations or sequences may play a vital role in the conservation of N. The purpose of this study is to determine the N needs of continuous corn (removed for grain), corn removed for silage, second year corn following soybeans, corn following soybeans and corn following wheat.

EXPERIMENTAL PROCEDURES

Four crop sequences (continuous corn, corn-soybean, corn-wheat and corn-wheat + alfalfa) were begun in 1974 on a Webster clay loam. Each N plot within each crop sequence is 15' wide (6 rows) by 50' long. Rates of N (0, 40, 80, 120, 160 and 200 lb N/A) have been applied annually to corn.

The corn-wheat + alfalfa sequence was dropped in 1981 in favor of a continuous corn system where all of the corn was removed as silage the preceding year. This gives us a comparison of the N needs between grain removal only compared to total above-ground biomass removal. In 1982, a C-C-Sb rotation was introduced to examine the N needs of second-year corn following soybeans.

In 1982, anhydrous ammonia was applied on April 27 to all corn plots. Wheat received 50 lb N/A as urea before planting. Broadcast P, K and Zn of 50 + 150 + 10 lb P_2O_5, K_2O, and Zn as $ZnSO_4$/A were applied in the fall of 1981 before moldboard plowing all plots. Starter fertilizer was not applied.

Each corn plot was split lengthwise and two corn hybrids (Pioneer 3732 and Pioneer 3901) were planted in 30" rows at 29900 ppA on April 29. Amaze was applied to all corn plots at 1 lb/A to control rootworms. Era wheat was planted on May 10. Corsoy-79 soybeans were planted on June 3.

Weeds were chemically controlled along with one cultivation of the corn. A combination of 3½ qt Lasso plus 3 lb Bladex/A was applied preemergence to corn. Soybeans received 3½ qt Lasso plus 5½ qt Amiben/A applied preemergence.

Corn leaf samples were taken at silking from rows 2 and 3 (Hybrid A) and from rows 4 and 5 (Hybrid B) of each 6-row plot. Corn yields were taken by mechanically harvesting the same rows. Grain moisture and grain N data were obtained on the harvested samples.

After the 1981 harvest, soil samples were taken in the fall to a 5' depth from the 0 and 160-lb N treatments which were applied to the corn grown in each crop sequence. For the continuous corn sequences (grain and silage) this means that samples were taken where the N was applied in 1981 whereas in the soybean and wheat sequences the N was applied to the corn in 1980. Two cores were taken/plot, divided into 1-foot increments, composited/rep, dried, crushed and analyzed for NO_3-N by the Soil Testing Laboratory.

RESULTS

Nitrate-N remaining in the soil profile after the 1981 crop, which was available to the 1982 corn, is shown in Table 1. When no fertilizer N was applied in 1981 (except the blanket 50-lb rate to wheat) very little difference in residual NO_3-N appeared among the four crop sequences. Highest residual NO_3-N followed soybeans while the lowest followed corn removed as silage. When 160 lb of N was applied some carryover of that N was found with continuous corn (both grain and silage). The 160-lb N rate applied to corn in 1980 did not appear to carryover following soybeans or wheat in 1981. In summary, these data indicate little difference in residual N among the crop sequences when no N was applied, but that residual NO_3-N following corn which received a standard 160-lb N rate was markedly higher than following soybeans which received no N or wheat which received 50 lb N/A.