PLANT AND GRAIN YIELD AND NITROGEN CONTENT OF FERTILIZED CORN UNDER IRRIGATION (CMDIR STATION, STAPLES, MINNESOTA, 1976)

A.C. Caldwell, L. Goodroad, J. Gerwing, M. Wiens, H. Werner

An experiment was established on an Estherville loamy sand at the CMDIR Station at Staples, Minnesota, in the spring of 1974 to study the effects of time and rate of application of fertilizers on corn yield and to account for those essential nutrients and other elements added to soils by analysis of plant, soil, and materials applied. The results reported below are some observations from the third cropping year, 1976.

A 90-day hybrid was planted at 26,000 seeds per acre in middle May in 30-inch rows. Herbicides were used to control weeds. Irrigation water was applied as needed. Fertilizer treatments and rates are given in the following table. The nitrogen was not applied at one time but at 2 or 3 intervals up to tasseling time depending upon the rate required. For example, the 80 pound rate of nitrogen (treatment 2) was split into 18 (starter), 22 and 40 pound allotments of nitrogen; the 160 pound rate (treatments 4, 7, 8) was split into 18 (starter), 42, 50, and 50 pound allotments of nitrogen as urea. The soybean meal (treatment 9) was applied all at one time prior to planting. The treatments were replicated four times.

Total plant yield was obtained by sampling the corn when it had reached physiological maturity. Grain yield was determined on mature corn. Grain and plant tissue were analyzed for nitrogen.

Total plant yields increased with increasing nitrogen rates up to 240 pounds N/A (see accompanying table). An additional 150 pounds of K/A seemed to depress whole plant yields slightly. An additional 30 pounds P/A gave about the same yield as the basic application.

Grain yields increased with increasing nitrogen rates to 160 pounds N/A. Additional applications of P and K over the basic application had little effect on grain yields.

Pounds per acre of N in the tissue and grain show the amounts required to produce the dry matter and yields obtained. For example, treatment 4 (160 lbs N/A) gave maximum yield of 142 bu/A which contained 108 pounds of nitrogen.

Total Plant and Grain Yield and Nitrogen Content of Corn Under Irrigation (CMDIR, Staples, 1976)

Treatment Number	Fertilizer Treatments[1] N	P	K	Total Plant Yield	Nitrogen in tissue %	Nitrogen in tissue	Grain Yield	Nitrogen in Grain %	Nitrogen in Grain
	lbs/A			tons/A		lbs/A	bu/A		lbs/A
1	18	10	150	4.28	0.77	66	73	1.18	41
2	80	10	150	6.11	0.87	106	113	1.42	76
3	120	10	150	6.82	1.13	154	130	1.62	100
4	160	10	150	6.99	1.07	150	142	1.61	108
5	200	10	150	6.92	1.13	157	137	1.69	110
6	240	10	150	7.26	1.13	164	141	1.62	108
7	160	40	150	7.08	1.13	160	136	1.60	103
8	160	10	300	6.62	1.10	146	139	1.66	109
9	160	24	194	7.09	1.07	152	135	1.59	102

[1] All plots received 18, 10, and 56 lbs/A of N, P, and K, respectively, as starter along the row, plus an additional broadcast application of 94 lbs of K/A (as KCl). Treatment 7 got an extra 30 lbs P/A (as superphosphate), and treatment 8 an additional 150 lbs K/A (as KCl). The soybean meal application, treatment 9, contributed another 14 lbs P and 44 lbs K per acre. Sulfur was applied to all plots at 20 lbs S/A as gypsum.

NITROGEN TRIALS ON SPRING WHEAT UNDER IRRIGATION AT STAPLES IN 1976

A.C. Caldwell, R. Schoper, J. Lensing, M. Wiens

As a continuation of a trial initiated in 1974, a time and rate of nitrogen experiment on wheat was conducted under irrigation on a sandy loam soil at Staples in 1976. In 1976, as in the previous two years, Kitt and Era were the two semi-dwarf wheat varities grown. A randomized complete block design was used with six nitrogen treatments, applied as ammonium nitrate, replicated four times.

Nitrogen Treatment	Time and Rate of Application
lbs N/A	lbs N/A
0	--
50	50 preplant
75	50 preplant, 25 early boot
100	50 preplant, 50 early boot
125	75 preplant, 50 early boot
175	75 preplant, 50 stooling, 50 early boot

In addition to the nitrogen treatments, 20 lbs. P_2O_5/A was applied with the seed and 60 lbs. K_2O/A was broadcast over the experimental area.

Grain yield for the two varieties was better than average ranging from 32-77 bu/A. (Table 1) as compared to a range of 19-62 bu/A. in 1974 and 11-26 bu/A. in 1975. This dramatic improvement in yield is probably due to not only an earlier seeding date, April 6 versus May 2 in 1975, but also to an improved irrigation schedule.

Forage yields for both varieties were collected at the soft dough stage to determine total dry matter yield, percent nitrogen and total nitrogen removal for the various rates of nitrogen. In addition, grain protein was measured following harvest. The results of these measurements are reported in Tables 2 and 3.

Table 1. Yield of Era and Kitt wheat as affected by nitrogen fertilizer rates under irrigation at Staples in 1976.

Fertilizer Treatments	Variety	
	Era	Kitt
lbs N/A	- - - - -Bu/A- - - - -	
0	32	39
50	60	68
75	69	69
100	72	73
125	77	74
175	70	71
Significance	**	**
BLSD (.05)	7	7
CV, %	7.2	7.6

Table 2. The grain protein, dry matter yield, percent N in the tissue and total N removal by the forage for Era wheat as affected by nitrogen fertilizer at Staples in 1976.

Fertilizer Treatment	Grain Protein	Forage Yield	Forage N	Forage N Removed
lbs N/A	%	Tons/A	%	lbs/A
0	10.3	2.24	0.92	41
50	10.3	3.37	1.13	76
75	12.2	3.94	1.45	115
100	13.2	3.82	1.52	116
125	15.7	4.07	1.52	123
175	15.7	4.36	1.86	162
Significance	**	**	**	**
BLSD (.05)	0.6	0.31	0.24	21
CV, %	3.7	6.3	12.3	14.5

Table 3. The grain protein, dry matter yield, percent N in the tissue and total N removal by the forage for Kitt wheat as affected by nitrogen fertilizer at Staples in 1976.

Fertilizer Treatment	Grain Protein	Forage Yield	Forage N	Forage N Removed
lbs N/A	%	Tons/A	%	lbs/A
0	11.7	2.52	1.06	54
50	12.4	3.99	1.32	106
75	13.2	4.39	1.46	129
100	13.4	4.16	1.58	132
125	15.2	4.28	1.76	151
175	15.9	4.43	1.93	169
Significance	**	**	**	**
BLSD (.05)	1.3	0.36	0.37	32
CV, %	9.2	6.8	16.2	18.7

N RATE STUDIES OF IRRIGATED WHEAT AND OATS WITH AND WITHOUT LEGUME UNDERSEEDING, STAPLES, 1976

H. Meredith, M. Wiens, R. Schoper, J. Lensing
H. Werner and J. O. Jacobson

1976 was the second crop year of a study initiated in 1975 to:

a) determine optimum economic N rates for continuous cropping to oats and wheat

b) determine optimum economic N rates for continuous cropping to oats and wheat with red clover underseeding

c) determine optimum N rates for wheat following plowdown of an established stand of red clover.

Stout oats, Era wheat and Lakeland red clover represented the varieties of the respective crops. The experiment consists of a randomized complete block design with four replications and four N rates. Urea was used as the N source. N rates for oats were 0, 40, 80 and 120 pounds of N per acre. Wheat received 0, 60, 120 and 180 pounds of N per acre. N on the oats was applied at two intervals, one-half at seeding and the remaining N applied just prior to boot formation.

Wheat received one-third of the N at seeding, one-third at stooling and one-third prior to boot formation.

All plots received a broadcast application of 300 pounds K per acre in early April. Urea was broadcast and incorporated by harrowing prior to seeding. Seeding rate in pounds per acre was: wheat, 120; oats, 96; and red clover, 16.

Plots were moldboard plowed, disced, and harrowed in early April. Seeding was accomplished on April 7.

Table 1. Grain Yield from Irrigated Wheat, Staples, 1975 and 1976.

	1975			1976		
Lbs. N/Ac	Wheat 1/	Wheat 2/	Lbs.N/Ac	Wheat 1/	Wheat 2/	Wheat 3/
0	7.3	5.0	0	24.3	53.0	59.1
40	18.0	13.0	60	53.0	58.3	70.0
80	21.3	16.5	120	66.4	55.2	69.2
120	24.0	17.0	180	68.0	56.7	66.7
Treatments	**	**		**	NS	*
BLSD (.05)	5.8	4.1		8.1	-	7.6
C.V.	21.1	20.8		10.2	12.6	6.8

1/ Chemical weed control

2/ Seeded with a red clover companion crop

3/ Seeded following plowdown of established stand of red clover and chemical weed control.

Table 2. Grain Yield from Irrigated Oats, Staples, 1975 and 1976.

	1975		1976	
Lbs N/Ac	Oats 1/	Oats 2/	Oats 1/	Oats 2/
0	24.0	24.0	54.4	85.7
40	35.8	44.8	84.0	87.7
80	40.8	51.8	100.9	90.2
120	34.8	41.0	111.2	93.2
Treatments	*	NS	**	NS
BLSD (.05)	4.3	--	28.5	--
C.V.	17.3	29.9	20.1	15.9

1/ Chemical weed control

2/ Seeded with a red clover companion crop

Table 3. Protein in Irrigated Wheat Grain, Staples, 1975 and 1976.

Percent Protein						
1975			1976			
Lbs. N/Ac	Wheat 1/	Wheat 2/	Lbs. N/Ac	Wheat 1/	Wheat 2/	Wheat 3/
0	12.4	12.3	0	12.1	12.1	12.5
40	11.8	11.1	60	12.9	11.2	13.7
80	13.0	12.4	120	15.2	13.2	15.2
120	15.7	13.4	180	15.4	15.6	15.3
Treatments	**	**		**	**	**
BLSD (.05)	.58	.44		1.4	1.5	1.0
C.V.	6.2	4.9		6.6	7.5	4.6

1/ Chemical weed control

2/ Seeded with red clover companion crop

3/ Seeded following plowdown of established stand of red clover and chemical weed control.

Table 4. Protein in Irrigated Oat Grain, Staples, 1975 and 1976.

	Percent Protein			
	1975		1976	
Lbs. N/Ac	Oats 1/	Oats 2/	Oats 1/	Oats 2/
0	14.4	11.9	14.3	13.0
40	13.6	12.0	14.9	13.5
80	15.1	12.4	16.5	15.1
120	15.7	14.0	16.5	15.6
Treatments	NS	NS	*	**
BLSD (.05)	--	--	1.8	1.4
C.V.	12.4	10.9	6.8	5.9

1/ Chemical weed control

2/ Seeded with red clover companion crop

Table 5. Approximate Nutrient Removal in Wheat and Oats Grain and Straw 1/

	N	P_2O_5	K_2O
Wheat			
Grain/bu	1.2	.6	.4
Straw: 75 lbs/bu	.6	.2	1.0
Oats			
Grain/bu	.7	.25	.2
Straw: 50 lbs/bu	.3	.15	1.0

1/Source: Soil Fertility Notes, Univ. of Minn., No. 58, Sept. 1976

Table 6. Nutrient Removal From Intensively Irrigated Wheat Plots - Grain and Straw, Staples, 1976.

Lbs N/A	Yield Bu/A	Actual N	Estimated[1/] N	Estimated[1/] P_2O_5	Estimated[1/] K_2O
		Lbs/A	Lbs/A	Lbs/A	Lbs/A
0	24.3	47	44	19.4	34.0
60	53.0	87	102	42.4	65.7
120	66.4	120	128	53.1	82.3
180	68.0	142	139	54.4	84.3
0	59.0	87.6	106.2	47.2	73.2
60	70.0	114.8	126.0	56.0	86.8
120	69.2	125.6	124.5	55.3	85.8
180	66.7	133.6	120.0	53.3	82.7

1/ Based on Soil Fertility Notes, No. 58, Sept. 1976, University of Minnesota

Table 7. Nutrient Removal From Intensively Irrigated Oat Plots - Grain and Straw, Staples, 1976.

Lbs N/Ac	Yield Bu/A	Actual N	Estimated[1/] N	Estimated[1/] P_2O_5	Estimated[1/] K_2O
		Lbs/A	Lbs/A	Lbs/A	Lbs/A
0	54.4	43.2	54.4	21.8	65.3
40	84.0	74.3	84.0	33.6	100.8
80	100.9	114.0	100.9	40.3	121.1
120	111.2	127.8	111.2	44.5	133.4

1/ Based on Soil Fertility Notes, No. 58, Sept. 1976, Univ. of Minnesota

Table 8. Wheat Forage Yields under Intensive Irrigation, Staples, 1976 1/

Lbs N/Ac	Tons D.M./A	Percent Protein in forage	Lbs Protein per acre in forage	Lbs N per acre in forage
0	1.77	8.34	292.6	46.8
60	3.28	8.30	543.7	87.0
120	3.98	9.44	749.6	119.9
180	3.76	11.80	889.3	142.3
Treatments	**	**	**	**
BLSD (.05)	.38	1.64	102.1	17.4
C.V.	7.5	10.3	11.0	11.0

1/ Chemical weed control

Table 9. Wheat-Red Clover Forage Yields Under Intensive Irrigation, Staples, 1976 1/

Lbs N/Ac	Tons D.M./A	Percent Protein in forage	Lbs Protein per acre in forage	Lbs N per acre in forage
0	3.34	8.69	582.9	93.3
60	3.83	8.52	649.9	104.0
120	3.81	10.66	811.0	129.8
180	3.74	10.72	796.9	127.5
Treatments	NS	*	**	*
BLSD (.05)	-	1.64	169.1	27.1
C.V.	10.3	10.3	14.2	14.2

1/ Seeded with red clover companion crop

Table 10. Wheat Forage Yield under Intensive Irrigation, Staples, 1976 1/.

Lbs N/Ac	Tons D.M./A	Percent Protein in forage	Lbs. Protein per acre in forage	Lbs. N per acre in forage
0	3.17	8.63	547.8	87.6
60	3.75	9.56	717.4	114.8
120	3.58	10.93	784.9	125.6
180	3.56	11.78	835.1	133.6
Treatments	NS	**	**	**
BLSD (.05)	-	1.13	103.2	19.0
C.V.	11.1	6.7	9.9	9.9

1/ Seeded following plowdown of established red clover and chemical weed control.

Table 11. Oat Forage Yield under Intensive Irrigation, Staples, 1976 1/.

Lbs N/Ac	Tons D.M./A	Percent Protein in forage	Lbs Protein per acre in forage	Lbs N per acre in forage
0	2.05	6.58	270.0	43.2
40	2.98	7.83	464.1	74.3
80	3.84	9.34	712.4	114.0
120	4.26	9.41	798.7	127.8
Treatments	**	**	**	**
BLSD (.05)	.78	1.25	118.9	20.4
C.V.	14.5	9.0	14.1	14.1

1/ Chemical weed control

Table 12. Oat-Red Clover Forage Yields under Intensive Irrigation, Staples, 1976 1/.

Lbs N/Ac	Tons D.M./A	Percent Protein in forage	Lbs Protein per acre in forage	Lbs N per acre in forage
0	3.30	7.95	527.3	84.4
40	3.58	8.02	569.2	91.1
80	3.89	9.94	769.4	123.1
120	4.09	9.69	792.9	126.9
Treatments	NS	*	**	**
BLSD (.05)	--	1.67	109.2	19.9
C.V.	9.8	11.1	11.2	11.2

1/ Seeded with red clover companion crop

Table 13. Oat, Straw, and Oat Grain-Straw Ratios under Intensive Irrigation, Staples, 1976 1/.

Lbs N/A	Lbs Straw per acre	Lbs Straw per Bu	Straw	Grain
			- - - - Percent - - - - -	
0	2360	43.4	58	42
40	3272	39.0	55	45
80	4451	44.1	58	42
120	4962	44.6	58	42
Ave.		42.8	57.2	42.8

1/ Chemical Weed Control

Table 14. Wheat Straw and Wheat Grain-Straw Ratios under Intensive Irrigation, Staples, 1976[1/].

	1976			
Lbs N/Ac	Lbs Straw per acre	Lbs Straw per bu	Straw	Grain
			- - - Percent - -	- - -
0	3760	63.6	51.5	48.5
60	4340	62.0	50.8	49.2
120	4240	61.3	50.5	49.5
180	4380	65.7	52.2	47.8
Ave.		63.2	51.2	48.8

1/ Seeded following plowdown of established red clover and chemical weed control

Table 15. Wheat Straw and Wheat Grain-Ratios under Intensive Irrigation, Staples, 1976[1/].

Lbs N/Ac	Lbs Straw per acre	Lbs Straw per bu	Straw	Grain
			- - - Percent -	- - -
0	2060	84.8	58.6	41.4
60	3460	65.3	52.1	47.9
120	3740	56.3	48.4	51.6
180	4260	62.6	51.0	49.0
Ave.		67.2	52.5	47.5

1/ Chemical Weed Control

Table 16. Soil Test Results Following Two Years Intensive Irrigation, Staples, 1976.

Lbs N/A/Yr	pH 1/	P 1/	K 1/
0	6.25	48	248
40	6.18	41	200
80	6.10	36	195
120	6.00	36	185

Irrigation 1975: 13.5 acre inches; rainfall 9.9 inches, in season.

Irrigation 1976: 25 acre inches; rainfall 7.3 inches in season.

Samples: August, 1976.

Crop: Wheat, 1975; oats, 1976.

1/ Average of four replications

Table 17. Soil pH following two years Intensive Irrigation, Staples, 1976.

Lbs N/Ac 1/	April 76 Sampling 2/	August 76 Sampling 3/
0	5.89	6.32
60	5.91	6.18
120	5.85	6.15
180	5.79	6.05

1/ Received 0, 40, 80, 120 Lbs N/Ac in 1975.

2/ Average of eight replications

3/ Average of four replications.

Irrigation and rainfall data same as Table 19.

Table 18. Two-Inch Soil Temperature Maximums 1/.

June					
Days Over 75°F		Days Over 85°F		Days Over 95°F	
1975	1976	1975	1976	1975	1976
23	26	12	17	2	8

July					
Days Over 75°F		Days Over 85°F		Days Over 95°F	
1975	1976	1975	1976	1975	1976
31	31	27	30	14	26

1/ Temperatures recorded under vegetation-free area.

Table 19. Rainfall, Irrigation and Pan Evaporation Data by Month for 1975 and 1976.

	1975			1976		
	Inches Rainfall	Inches Irrigation	Ave. Pan Evap/day	Inches Rainfall	Inches Irrigation	Ave. Pan Evap/day
April 1/	--	--	--	0.7	3.2	.14
May	1.6	3.6	.23	.3	7.9	.27
June	6.0	1.7	.24	5.0	6.6	.33
July	2.3	6.8	.33	1.3	6.4	.32
Total	9.9	12.1	24.5	7.2	24.1	29.5

Ratio $\frac{\text{Rainfall + Irrigation}}{\text{Pan Evaporation}}$: 1975: $\frac{22.0}{24.5} = 0.9$ 1976: $\frac{31.3}{29.5} = 1.1$

1/ Seeded May 2, 1975
Seeded April 7, 1976

Water Quality Studies - 1976

H. Meredith, M. Wiens and R. C. Munter

Water samples were analyzed several times during the irrigation season to gain a better understanding of water quality. Samples are from the Staples Irrigation Farm and adjacent area.

Table 1. Water Hardness from North well, Staples Irrigation Center, 1975 and 1976.

1975		1976		
Date	$mg/CaCO_3/L$ [1]	Date	pH	$mg/CaCO_3/L$ [1]
5/12 (1)	144	4/28 [2]	8.1	216
5/12 (2)	148	4/28	8.6	118
5/24	167	5/29	7.8	206
6/24	169	6/10	8.7	68
7/24	188	7/8	8.3	136
8/2 (1)	159	7/17	8.1	146
8/2 (2)	153	7/17	8.9	133
9/24 (1)	242	8/10	8.3	99
9/24 (2)	240	9/6	8.2	151
Average	179			141 [3]

1/ $CaCO_3$ equivalent based on total hardness

2/ Not pumped

3/ 32 Lbs. $CaCO_3$/A Inch water

Table 2. Water Analyses of North well, Staples Irrigation Center, 1976.

Date	Spec. Conductance [1]	SO_4-S	Cl	B
		- - - - - -	PPM	- - - - - -
4/28	241	2.3	4.6	--
4/28	279	--	4.8	.12
5/29	503	2.6	8.1	.15
6/10	87	< 2.0	1.3	.04
7/8	291	< 2.0	7.0	.06
7/17	369	2.9	8.9	.09
7/17	403	2.6	8.4	.07
8/10	200	4.5	1.4	.12
9/6	338	< 2.0	4.7	.06

[1] Micromhos/cm @25°C

Table 3. Water Hardness from Center well, Staples Irrigation Center 1975 and 1976.

1975		1976		
Date	$mg/CaCO_3/L$ [1]	Date	pH	$mgCaCO_3/L$ [1]
5/27	164	4/28	8.1 [2]	175
6/24 (1)	148	4/28	8.7	136
6/24 (2)	132			
7/12 (1)	155			
7/12 (2)	182	5/15	8.2	172
8/2 (1)	157	7/3	8.0	--
8/2 (2)	141	7/7	8.2	113
		7/17	8.0	149
		7/27	7.9	133
		9/6	8.2	261

[1] $CaCO_3$ equivalent based on total hardness

[2] Not pumped

Table 4. Water Analyses of Center Well, Staples Irrigation Center, 1976.

Date	Spec. Conductance 1/	SO_4-S	Cl	B
		- - - - - - - PPM	- - - - - - -	
4/28 (1)	402	2.6	6.6	.06
4/28 (2)	337	3.1	6.8	.03
5/15	418	2.7	6.8	.04
7/3	187	--	1.1	--
7/7	304	3.0	6.2	.02
7/17	348	2.3	5.3	.49
7/27	137	--	.8	.12
9/6	565	<2.0	7.3	.09

1/ Micromhos/cm @ 25°C

Table 5. Water Analyses of Farmer Wells in Staples Area, 1976.

Farmer Name	pH	S.C. 1/	S	Cl	B	$CaCO_3$ 2/ Equivalent
			- - - - PPM	- - - - - - - - -		
B. Cedar	7.9	371	6.1	4.6	.16	125
"	7.9	303	8.1	3.4	.15	97
S. Roth	8.0	325	4.8	4.3	.11	131
"	8.1	369	7.6	4.9	.07	149
"	8.1	347	6.4	4.4	.08	157
M. Roth	8.1	280	3.0	4.1	.05	131
"	8.2	392	4.5	3.4	.04	193
L. Wallace	8.2	361	3.3	2.4	.06	185
C.M. Wilkins	8.1	368	3.0	4.9	.05	165
Plagon (?)	8.2	216	5.9	8.0	--	341
B. Sommars	8.2	412	3.7	10.6	.04	175
H. Kramer	8.2	424	5.0	6.7	.07	203
C. Olson-Pond	8.2	435	4.0	22.3	.11	139
C.Olson-C. Pivot	8.2	351	5.1	8.7	.05	66

1/ Specific Conductance, micromhos/cm @ 25°C

2/ $CaCO_3$ equivalent based on total hardness

SOUTHERN EXPERIMENT STATION - WASECA
WEATHER DATA - 1976

Month	Period	Precipitation 1976	Precipitation Normal	Avg. Air Temp. 1976	Avg. Air Temp. Normal	Growing Degree Days 1976	Growing Degree Days Normal
		inches		°F			
January	1-31	.35	.73	12.3	12.9		
February	1-28	.47	.96	26.6	17.5		
March	1-31	2.66	1.94	30.6	28.5		
April	1-30	1.79	2.48	49.8	45.6		
May	1-10	.01		49.6		69.5	
	11-20	.58		58.8		111.5	
	21-31	1.67		60.8		128.5	
	Total	2.26	3.86	56.5	57.7	309.5	323
June	1-10	.36		70.8		201.0	
	11-20	.76		67.6		174.0	
	21-30	1.43		66.4		163.5	
	Total	2.55	4.75	68.3	67.1	538.5	521
July	1-10	.00		71.4		208.0	
	11-20	1.24		73.2		217.5	
	21-31	1.41		73.5		253.0	
	Total	2.65	4.02	72.7	71.4	678.5	637
August	1-10	.87		66.3		163.5	
	11-20	.33		70.2		196.0	
	21-31	.20		72.0		236.5	
	Total	1.40	3.60	69.6	69.7	596.0	583
September	1-30	2.11	3.45	59.0	60.3	324.0	310
October	1-31	.89	1.89	42.8	50.3		44
November	1-30	.06	1.25	26.2	32.9		
December	1-31	.24	1.02	9.8	19.0		
Year	Jan-Dec	17.43	29.95	44.4	44.4	2446.0	2418
Growing Season	May-Sept	10.97	19.68	65.3	65.3	2446.0	2374

Notes:

1) Highest temp. on July 11 - 98°

2) Highest 24-hour precipitation on July 15 - 1.15"

3) Frost on September 28

4) Record low rainfall for growing season and for year

NITROGEN FERTILIZATION OF CORN

Waseca, 1976

G. W. Randall and W. E. Lueschen

To evaluate various sources of N fertilizer, an experiment involving four sources of N applied at two rates in both the fall and the spring was established at the Southern Experiment Station on a Cordova silty clay loam in 1971. The experimental design was a randomized complete-block, replicated four times.

Because P and K had not been applied since 1972, P and K (100 lb P_2O_5+150 lb K_2O/A) were broadcast and plowed under in the fall of 1975. Starter fertilizer was not used. Ammonium nitrate, urea and 28% N solution were fall-applied on 10/28/75 and plowed down immediately. Anhydrous ammonia was applied on 11/17/75. Ammonium nitrate, urea and UAN (urea-ammonium nitrate solution, 28% N) were spring-applied on 4/26/76 and disked in. The anhydrous ammonia was applied on 4/20/76. Fall and spring soil conditions were considered to be fair and excellent, respectively, for N application. Beginning in 1974, UAN was substituted for aqua ammonia (20% N) because of the unavailability of the latter material.

Corn (Pioneer 3780) was planted at 26,000 ppA in 30" rows on April 29. An insecticide (Counter at 1 lb/A) was applied at planting. Weeds were controlled with 3 lb/A of Lasso and 2½ lb/A of Bladex applied preemergence. Soil nitrate samples were taken to a depth of 2 feet from all 150-lb treatments on July 1. The leaf opposite and below the ear was sampled at silking and was submitted for Kjeldahl analysis. Yields were taken by combine harvesting the center two rows from each plot.

RESULTS

Only leaf and grain N (protein) were affected by the N treatments in 1976 (Table 1). Grain moisture, yield and N removal in the grain were not influenced in this dry year in which CV's were quite high.

In comparing N sources, leaf N was significantly lower with UAN (2.07%) than with either anhydrous ammonia, urea or ammonium nitrate (2.23, 2.17 and 2.20%, respectively). Grain N was significantly higher with anhydrous ammonia than with the other sources.

Significant increases in leaf and grain N, yield and N removal were associated with the 150-lb rate over the 75-lb N rate.

Denitrifying conditions did not exist at any time during this dry year. Therefore, time of N application had no effect on any of the parameters measured in 1976.

Table 1. Continuous corn parameters as influenced by source, rate and time of application of N at Waseca in 1976.

Treatment			Leaf	Grain			
Source	Rate	Time	N	Moisture	Yield	N	N Removal
	lb N/A		%	%	bu/A	%	lb N/A
Anhyd. Am.	75	F	2.20	18.8	62.7	1.88	55.4
"	75	S	2.13	19.8	70.4	1.86	61.2
"	150	F	2.39	19.5	66.4	1.94	60.2
"	150	S	2.18	18.7	78.2	1.88	69.5
Urea	75	F	2.01	18.7	61.0	1.74	49.8
"	75	S	2.04	19.1	63.6	1.84	54.3
"	150	F	2.24	20.5	65.6	1.80	55.5
"	150	S	2.38	18.6	72.5	1.84	63.1
Am. Nitrate	75	F	2.12	19.8	63.8	1.78	52.8
"	75	S	2.02	19.8	68.6	1.61	52.4
"	150	F	2.26	19.8	69.4	1.84	59.0
"	150	S	2.40	19.3	72.5	1.82	62.4
UAN[1/]	75	F	2.00	20.5	53.8	1.76	44.9
"	75	S	1.91	19.8	57.3	1.68	45.2
"	150	F	2.23	18.6	75.4	1.86	65.6
"	150	S	2.16	19.7	67.5	1.86	58.0
Significance:			**	NS	NS	*	NS
CV (%) :			4.8	6.0	21.3	6.1	20.0
BLSD (.05) :			.14			.20	
Individual Factors							
Source							
Anhydrous Am.			2.23	19.2	69.4	1.89	61.6
Urea			2.17	19.2	65.7	1.80	55.7
Am. Nitrate			2.20	19.6	68.6	1.76	56.6
UAN			2.07	19.6	63.5	1.79	53.4
Significance:			**	NS	NS	*	NS
BLSD (.05) :			.07			.08	
Rate							
75 lb N			2.05	19.5	62.6	1.77	52.0
150 lb N			2.28	19.3	70.9	1.86	61.7
Significance:			**	NS	*	**	**
Time							
Fall			2.18	19.5	64.7	1.82	55.4
Spring			2.15	19.3	68.8	1.80	58.2
Significance:			NS	NS	NS	NS	NS
Interaction							
Source X Rate			NS	NS	NS	NS	NS
Source X Time			*	NS	NS	NS	NS
Rate X Time			NS	NS	NS	NS	NS
Source X Rate X Time			+	+	NS	NS	NS

1/ Urea-ammonium nitrate solution (28% N)

With the exception of the S x T interaction for leaf N, other interactions did not exist at the 95% probability level. Spring application of the dry materials (33 and 45%) resulted in increased leaf N over fall applications whereas the opposite was true for 28 and 82% N.

Soil NO_3-N analyses showed marked differences among the treatments (Table 2). Spring application resulted in NO_3-N levels being approximately double fall application, except for UAN. No reason can be given for the low values with spring-applied UAN, however, the same pattern occurred in 1975. Soil NO_3-N was equal from all four N sources when fall-applied.

Table 2. Effect of N source and time of application on soil NO_3-N on July 1, 1976.

Treatment[1/]		
Source	Time	NO_3-N (0-24")
		lb/A
Anhyd. Am.	F	98
"	S	216
Urea	F	98
"	S	139
Am. Nitrate	F	94
"	S	175
UAN	F	95
"	S	73

1/ 150 lb N/A

FIVE-YEAR YIELD RESULTS

Yields show no significant differences among the treatments in 1972 and 1976 (Table 3). In both years spring rainfall (April-June) was below average (-2.55" in 1972 and -4.49" in 1976). Consequently, denitrifying conditions apparently did not exist. Rainfall from July thru September was above normal in 1972, resulting in excellent yields. In 1976 dry conditions continued throughout the summer and yields were quite low.

Yields were affected significantly in 1973, 1974 and 1975. Spring rainfall in each of these years totaled 3.20, 0.11 and 2.35 inches above normal, respectively. Fall applications of the ammonium forms of N resulted in yields equal to those from spring applications. The nitrate forms, however, provided a vastly different picture. Spring application of both UAN and ammonium nitrate were far superior to the fall applications. Average yields over that period show approximately a 15 bushel annual advantage for spring application. Equal yields were obtained from all N sources when applied in the spring at the 150-pound rate.

Table 3. Continuous corn yields as influenced by source, rate and time of application of N at Waseca in 1972-1976.

Treatment			Grain Yield						
Source	Rate	Time	1972	1973	1974	1975	1976	1972-76 Avg.	1974-76 Avg.
	lb N/A		bu/A						
Anhyd. Am.	75	F	144.8	145.4	103.3	52.1	62.7	101.7	72.7
(82%)	75	S	142.4	143.2	100.6	53.4	70.4	102.0	74.8
"	150	F	149.7	145.8	111.1	64.1	66.4	107.4	80.5
"	150	S	149.9	146.8	112.3	57.3	78.2	108.9	82.6
Urea	75	F	154.0	136.8	80.4	51.9	61.0	96.8	64.4
(45%)	75	S	160.1	126.8	95.1	52.8	63.6	99.7	70.5
"	150	F	151.9	145.3	112.9	71.7	65.6	109.5	83.4
"	150	S	150.0	144.3	113.0	69.8	72.5	109.9	85.1
Am. Nit.	75	F	153.7	122.7	75.6	34.8	63.8	90.1	58.1
(33%)	75	S	153.2	128.7	96.0	51.4	68.6	99.6	72.0
"	150	F	140.8	137.3	96.8	46.5	69.4	98.2	70.9
"	150	S	147.7	146.0	108.9	64.4	72.5	107.9	81.9
UAN	75	F	--	--	84.0	33.0	53.8	--	56.9
(28%)	75	S	--	--	103.0	51.3	57.3	--	70.5
"	150	F	--	--	103.7	47.8	75.4	--	75.6
"	150	S	--	--	113.0	60.9	67.5	--	80.5
Significance:			NS	*	**	*	NS		
CV (%)		:	6.0	7.3	9.3	25.4	21.3		
BLSD (.05)		:		17.1	13.1	23.3			

CONCLUSION

The proper source and time of N application for greatest N efficiency is highly dependent on the moisture conditions during the early part of the growing season. In years of average to above average spring rainfall, it is apparent that denitrification conditions and subsequent losses of N exist in south-central Minnesota. Therefore, fall applications of nitrate forms (28 and 33%) should not be attempted. Fall application of ammonium forms of N after soil temperatures are below 50°F will minimize losses and improve fertilizer efficiency as well as yields. Equal efficiency among all sources was shown with spring application.

N-SERVE ON CORN

Waseca, 1976

G. W. Randall, G. L. Malzer and H. G. Johnson

Increasing the efficiency of fertilizer N has gained strong support within the last few years due to environmental concern, crop production economics and shortages of natural gas supplies for ammonia production. One of the methods to increase efficiency is to inhibit temporarily the nitrification reaction that converts NH_4^+ (a stable form) to NO_3^- (a mobile form). N-Serve (nitrapyrin), a nitrification inhibitor produced by Dow Chemical Co., is perhaps the most commonly available product at this time. The objective of this study was to evaluate the effect of fall and spring applications of N and N-Serve on soil N fractions and corn production in Southern Minnesota.

EXPERIMENTAL PROCEDURES

The experimental site consisted of a Webster clay loam which is tiled at a 75-foot spacing perpendicular to the plots. Spring wheat had been the previous crop.

Anhydrous ammonia with and without N-Serve was applied with a 6-row tool-bar applicator on September 25, October 25, 1975 and April 27, 1976. The application depth was 6 inches. Nitrogen rates were 90, 120 and 150 lb N/A. The design was a randomized, complete-block with four replications.

Following the October application the site was chisel plowed perpendicular to the plots. The area was field cultivated following the spring application and before planting (May 3). Corn (Dekalb XL-43A) was planted at 26,100 ppa with 140 lb 0-23-30/A applied as a starter. Weeds were controlled with a preemergence application of Lasso (3 qts) plus Bladex (2½ lb).

Soil samples were taken periodically (Table 2) in 0-1 and 1-2' increments from the 0 and 150 lb treatments. The 10/24/75 sampling consisted of taking three 2" cores from 5 to 7 inches to the side of the anhydrous band in each plot. Because the tillage operations obliterated the anhydrous tracks, 8 random cores were taken and composited per plot on the other dates. All replications were sampled.

The leaf opposite and below the ear was sampled at silking and analyzed for N. Barren stalk, lodging and stalk rot readings were taken just prior to harvest. Stalk rot was determined by splitting open 20 stalks per plot. The six internodes and the node above them starting at the soil line were evaluated individually. A scale from 0 (no rot) to 5 (all nodes and internodes severely rotted) was used.

Yields were taken by combine harvesting the center two rows from each plot with a modified JD 3300 combine. Moisture and grain protein were determined on subsamples of harvested grain.

RESULTS

Climatic conditions during the course of this experiment could be summarized as warm and dry (Table 1). Soil and air temperatures were above normal from 9/21 thru 11/10/75. These temperatures should have induced rapid nitrification; however, it was very dry during this period (0.35") and nitrification was probably curtailed somewhat. A total of 4.39" of rain fell in November, but most of it occurred after soil temperatures fell below 50°F.

Table 1. Weather data from late September 1975 thru July 1976 at Waseca.

Period	Avg. Air Temp.	Precip.	Avg. 4 & 8" Soil Temp.	1965-74 Avg. 4 & 8" Soil Temp.
	°F	in.	---------- °F	----------
9/21 - 9/30/75	50.7	.14	58.1	55.3
10/1 - 10	54.9	.09	59.9	52.2
11 - 20	51.0	.00	58.9	46.4
21 - 31	46.0	.12	52.1	42.5
11/1 - 10	50.6	1.77	52.4	35.7
11 - 20	39.0	1.27	42.4	
21 - 30	19.4	1.35	35.8	
4/1 - 4/10/76	46.1	.16	40.8	
11 - 20	56.1	.98	51.3	
21 - 31	47.3	.65	49.5	
5/1 - 10	49.6	.01	52.8	
11 - 20	58.8	.58	59.6	
21 - 31	60.8	1.67	64.1	
6/1 - 10	70.8	.36	71.3	
11 - 20	67.6	.76	72.9	
21 - 30	66.4	1.43	71.3	
7/1 - 10	71.4	.00		
11 - 20	73.2	1.24		
21 - 31	73.5	1.41		

Dry conditions prevailed throughout the 1976 growing season. Consequently, conditions for large denitrification losses of N did not exist. Soil temperatures warmed above 50°F about May 1.

Soil NH_4-and NO_3-N values were quite inconsistent (Table 2). This may have been due primarily to the random sampling technique used. Samples taken from the top foot on 10/24 indicated that N-Serve was stabilizing the N applied one month earlier (9/25) as NH_4 (26.3 ppm compared to 12.3 ppm without N-Serve). By April 26 the NH_4-N values were almost identical, which would indicate that the early fall-applied ammonia had nitrified by this time. On the other hand, soil NO_3-N was lower with N-Serve indicating incomplete nitrification. Samples taken on May 20 and June 16 from this early fall treatment again show N stabilization with N-Serve (27.0 and 14.3 ppm with and 12.6 and 6.6 without N-Serve, respectively).

Table 2. Effect of N-Serve on soil NH_4-and NO_3-N at Waseca in 1976.

Treatment[1/]				Sampling date			
Applc'n date	N-Serve	Depth	10/24/75	4/26/76	5/20/76	6/16/76	7/13/76
				NH_4-N (ppm)			
Check		0-1'	13.2	3.8	3.8	6.4	5.1
9/25/75	-	"	12.3	13.3	12.6	6.6	7.7
"	+	"	26.3	14.2	27.0	14.3	7.4
10/25/75	-	"		10.6	8.2	6.9	6.3
"	+	"		9.4	9.1	7.4	7.0
4/27/76	-	"			68.0	17.4	8.7
"	+	"			81.7	27.7	12.7
Check		1-2'	8.2	2.5	2.6		
9/25/76	-	"	10.2	3.1	2.6		
"	+	"	11.2	2.9	3.0		
10/25/76	-	"		3.1	3.0		
"	+	"		2.5	2.9		
4/27/76	-	"			2.9		
"	+	"			7.3		
				NO_3-N (ppm)			
Check		0-1'	7.0	9.0	11.6	7.1	2.6
9/25/75	-	"	11.0	40.7	60.2	37.3	27.8
"	+	"	9.2	26.7	48.4	48.4	15.5
10/25/75	-	"		30.9	44.8	48.3	14.5
"	+	"		20.6	38.6	33.0	8.9
4/27/76	-	"			28.7	65.0	48.9
"	+	"			34.3	53.0	30.1
Check		1-2'	1.0	3.9	4.0	4.5	2.2
9/25/75	-	"	1.4	13.0	14.8	12.5	8.8
"	+	"	1.0	10.2	11.3	13.6	11.2
10/25/75	-	"		9.0	6.9	8.3	9.8
"	+	"		6.2	6.3	8.3	3.4
4/27/76	-	"			4.1	7.5	3.6
"	+	"			5.0	6.1	5.6

1/ 150 lb N/A as anhydrous ammonia; 0.5 lb (ai) N-Serve/A

Soil N data from the October 25 application show little effect of N-Serve. No detectable differences can be seen in the NH_4-N data; whereas, soil NO_3-N was lower throughout the 1976 season with N-Serve.

Spring-applied ammonia with N-Serve resulted in consistently higher soil NH_4-N levels and lower soil NO_3-N in June and July than without N-Serve. This would indicate that with the dry conditions complete nitrification was delayed well into the growing season.

Samples taken from the 1-2' depth indicates very little movement of NH_4^+ or NO_3^- from the surface layer. No detectable differences between the N-Serve treatments can be found in samples from this depth.

The inconsistencies described above make accurate interpretation of the soil N data almost impossible. It points out the need for more detailed, spatial sampling at shorter time intervals in future studies.

Leaf and grain N, yield and moisture, were affected by the treatments in 1976 (Table 3). Leaf N was significantly increased by N-Serve. Application date and rate had no effect on leaf N. Grain N (protein) was increased significantly over the check by all the N treatments. Highest protein was associated with 150 lb N rate and the spring application. N-Serve did not influence protein. No explanation can be given for the lower values associated with the October 25 application.

Grain yield differences among the treatments were significant; however, the main effects of application date, rate and N-Serve were not significant. A date X rate interaction was shown and is partially attributed to the low yields with the 150-lb rate with N-Serve in April. Early growth of these plants was stunted and showed effects of ammonium toxicity. Plants on the 150-lb spring applied treatment without N-Serve did not show the toxicity effect. Grain moisture was reduced by the high N rates.

Table 3. Effect of N-Serve on corn production at Waseca in 1976.

Treatment			Leaf	Grain		
Date	Rate	N-Serve[1/]	N	N	Moisture	Yield
	lb N/A			------%-------		bu/A
	Control		1.69	1.28	22.2	109.3
9/25/75	90	-	2.00	1.59	21.0	126.0
	"	+	2.27	1.61	20.3	112.9
	120	-	2.39	1.58	20.0	129.8
	"	+	2.34	1.58	20.4	135.9
	150	-	2.10	1.70	18.4	102.0
	"	+	2.42	1.63	19.3	128.4
10/25/75	90	-	2.02	1.52	21.1	127.0
	"	+	2.26	1.49	20.2	116.9
	120	-	2.08	1.59	19.8	114.4
	"	+	2.19	1.59	19.0	109.1
	150	-	2.26	1.53	19.4	127.2
	"	+	2.26	1.60	20.2	125.8
4/27/76	90	-	2.10	1.62	20.6	120.3
	"	+	2.53	1.54	19.8	127.4
	120	-	2.35	1.65	19.9	117.8
	"	+	2.34	1.61	20.4	140.0
	150	-	2.21	1.66	20.1	122.4
	"	+	2.20	1.70	19.2	107.8
	Signif:		+	**	**	*
	CV (%):		13.1	5.3	4.2	11.3
	BLSD(.10):		0.48	-	1.1	20.4
	(.05):			0.12	1.3	24.4
Individual Factors						
Date						
9/75			2.26	1.61	19.9	122.5
10/75			2.18	1.55	19.9	120.1
4/76			2.27	1.63	20.0	122.6
Signif:			NS	**	NS	NS
BLSD(.05):				0.05		
Rate						
90			2.20	1.56	20.5	121.7
120			2.28	1.60	19.9	124.5
150			2.24	1.63	19.4	118.9
Signif:			NS	**	**	NS
BLSD(.05):				0.05	0.5	
N-Serve						
-			2.17	1.60	20.0	120.8
+			2.31	1.59	19.8	122.7
Signif:			*	NS	NS	NS
Interactions						
Date X Rate			NS	NS	*	*
Date X N-Serve			NS	NS	NS	NS
Rate X N-Serve			NS	NS	+	NS
Date X Rate X N-Serve			NS	NS	NS	*
Signif (DxR) and (DxRxN-S):		.05 =			0.9	15.3

[1/] N-Serve applied at 0.5 lb ai/acre

Table 4. Effect of N-Serve on corn plant characteristics and plant population at Waseca in 1976.

Date	Treatment Rate	N-Serve[1/]	Barren stalks	Lodging	Stalk rot[2/] reading	Pop'ln
	lb N/A		-------%--------			ppa X 1000
	Control		0.5	0.8	0.68	25.0
9/25/75	90	-	0.2	3.0	1.09	25.0
	"	+	0.0	4.6	1.20	26.3
	120	-	0.2	1.3		24.7
	"	+	0.0	1.8		24.5
	150	-	0.0	6.0		25.9
	"	+	0.8	4.0		25.2
10/25/75	90	-	0.0	3.5	0.87	25.1
	"	+	0.2	4.5	1.25	25.0
	120	-	0.2	5.8		26.2
	"	+	0.5	6.1		25.0
	150	-	0.5	4.6		25.3
	"	+	0.2	2.8		25.5
4/27/76	90	-	0.2	3.8	1.10	25.0
	"	+	0.2	2.4	1.27	25.8
	120	-	0.8	3.1		25.0
	"	+	0.2	2.0		25.0
	150	-	0.2	4.5		25.2
	"	+	0.2	6.8		25.7
	Signif:		NS	NS	NS	NS
	CV (%):		209.	75.	35.8	3.1

1/ N-Serve applied at 0.5 lb ai/acre

2/ 0 = no rot, 5 = severe rot in nodes and internodes

Barren stalks, lodging, stalk rot and final plant population were not affected by the treatments (Table 4). The incidence of stalk rot was very low especially on the check plots.

SUMMARY

Even though the soil N data was inconsistent it was apparent that N-Serve did inhibit nitrification under these conditions. Additional, spatial sampling would have been necessary to determine the length of the inhibitory effect.

In this dry year when denitrification conditions did not exist, N-Serve did not influence grain yield, protein or stalk rot.

NITRIFICATION INHIBITOR (TERRAZOLE) APPLICATION FOR CORN PRODUCTION IN SOUTHERN MINNESOTA

G. L. Malzer and G. W. Randall

Field experiments were conducted in 1975 and 1976 to investigate the potential of an experimental chemical (Terrazole - Registered trademark of the Olin corporation) for use as a nitrification inhibitor. The objectives were to measure the influence of different levels of terrazole at several nitrogen rates and acertain with the use of soil analysis, plant tissue analysis, and crop response (corn) the effectiveness of Terrazole as a nitrification inhibitor.

EXPERIMENTAL PROCEDURES

Thirteen treatments including a check, three rates of nitrogen (60, 120, and 180 #N/A as urea), and four levels of Terrazole (0, .25, .50) and 1.0% by weight of fertilizer) were applied in all combinations. The thirteen treatments were established in a randomized complete block design with five replications. Poor geographic position forced a shifting in the plot layout. Due to this, three replications had a previous cropping history of corn and two replications had a previous cropping history of soybeans. Considerable variation in crop growth was found in 1976 due to cropping history so data included in this report will make reference to both cropping histories as well as overall observations. The experimental area was on a recently tiled Nicollet loam on the Southern Experiment station at Waseca, MN.

All nitrogen fertilizer treatments were applied as spring applications of urea preplant and incorporated (4/25/76). Corn (Pioneer 3780) was planted on May 4 at a population of 26,000 ppa. Starter fertilizer was applied at the rate of 180 #/A of 0-23-30. Good weed control was accomplished with the use of preemergence applications of Lasso (3 lbs/A) and Atrazine (2 1/2 lbs/A). Insecticide was also applied as 1 lb. of Furadan/A.

Tissue samples including the leaf opposite and below the ear at silking, as well as silage samples were analyzed for Kjeldahl nitrogen content. Silage dry matter yields were determined by harvesting 10 ft. of row from each plot and grain yields determined by harvesting two 20 ft. rows. Measurements concerning various other growth parameters such as smut, barren stalks, and lodging were also recorded. The effectiveness of the nitrification inhibitor in slowing the nitrification reaction was evaluated by the analysis of soil samples for ammonium-N and nitrate-N at two different times during the

season. Soil samples were taken from each plot on 8/10/76 (silking) and 10/18/76 (after harvest) to a depth of 24 inches. The samples were divided into increments 0-6" and 6-24" with all samples being analyzed for nitrate-N and the 0-6" sample being analyzed for ammonium-N.

RESULTS

The nitrogen content of the leaf opposite and below the ear at silking and the grain yields are presented in Table 1. Nitrogen rate significantly increased nitrogen content of the leaf under both previous cropping histories as well as overall. Nitrogen content in the leaves on the corn following corn area was substantially lower than on the corn following soybean area. The highest level (1.0%) of Terrazole did reduce the leaf nitrogen content on the corn following soybeans but had no influence on the corn following corn or overall.

Considerable grain yield differentials were observed on the corn following corn vs. the corn following soybeans. Across all treatments their was a 72 bu/A reduction in yield with corn following corn as compared to corn following soybeans. Most of this differential does not appear to be treatment related. Nitrogen rate regardless of cropping history had no influence on grain yield. The highest Terrazole level did significantly reduce yields on the corn following soybeans and this was also reflected overall.

Silage dry matter yields (Table 2) were also markedly affected by previous cropping history with dry matter yields averaging 2.3 T/A less on the corn following corn area. Aside from one treatment there was no influence due to nitrogen rate or Terrazole level. The silage nitrogen content was also not significantly influenced by treatments other than the control comparisons. Even with the substantial differences between the previous corn and soybean areas as far as yield and dry matter production there was very little difference in nitrogen content between silage treatments.

Other growth parameters such as smut, barren stalks, and lodging in most cases were not influenced by treatments. Here again previous crop did appear to have an influence.

Soil ammonium and soil nitrate concentrations (Table 4) in the surface 6 inches when collected on 8/10/76 were significantly influenced by the treatments. Increasing nitrogen rates significantly increased both ammonium and nitrate concentration in the surface 6 inches. Increasing Terrazole concentrations significantly increased soil ammonium concentration and at

the same time significantly decreased the soil nitrate concentration within the same layer. Therefore, suggesting that the Terrazole was effective in inhibiting the nitrification reaction.

Soil ammonium and soil nitrate concentrations measured on 10/18/76 (Table 5) also detected significant influences due to the treatments. The inhibitor was still effective in delaying the nitrification reaction late into the season (6 months). The effectiveness of the inhibitor coupled with the dry weather experienced in 1976 might suggest that much of the ammonium nitrogen and possibly nitrate nitrogen was positionally unavailable to the plant rooting system.

Soil nitrate concentration in the 6-24 inch depth (Table 6) were low suggesting that the plants were effective in the removal of NO^{-3}-N from this depth. The interaction of nitrification inhibitors with dry soil and environmental conditions and its implications on nitrogen availability remain to be investigated.

Table 1. Leaf N content and corn grain yields (15.5% moisture) as influenced by rate of nitrogen application (urea) and nitrification inhibitor coating (Terrazole) following corn and soybeans.

Treatment		Leaf N			Grain Yield		
N Rate	Terrazole Coating	f/soybeans	f/corn	overall	f/soybeans	f/corn	overall
lbs N/A	%	%-			bu/A-		
control		1.62	1.61	1.61	105.0	27.3	58.4
60	0	2.05	1.84	1.92	119.6	32.8	67.5
60	.25	2.08	1.79	1.91	94.6	29.9	55.8
60	.50	2.24	1.76	1.96	113.4	32.3	64.7
60	1.00	2.03	1.83	1.91	105.9	28.3	59.3
120	0	2.23	1.98	2.08	117.8	34.1	67.6
120	.25	2.18	1.95	2.04	118.4	28.7	64.6
120	.50	2.06	1.97	2.01	90.3	19.6	47.9
120	1.00	1.97	1.83	1.89	80.8	34.7	53.1
180	0	2.30	1.99	2.11	131.2	41.5	77.4
180	.25	2.25	2.04	2.13	102.5	45.7	68.4
180	.50	2.20	1.92	2.03	111.1	34.7	65.4
180	1.00	2.10	2.00	2.04	73.9	33.3	49.5
	Signif.	**	*	**	+	NS	NS
	BLSD (.05)	.23	.20	.14	30.8 (.10)	-	-
	C.V.	4.9	5.8	5.7	14.7	44.0	25.1

Factorial - Excludes checks

N Rate	60 #N/A	2.10	1.81	1.92	108.4	30.9	61.9
	120	2.11	1.93	2.00	101.8	29.3	58.3
	180	2.21	1.99	2.08	104.7	38.8	65.1
	Signif.	+	*	**	NS	NS	NS
	BLSD	0.21 (.10)	0.09	.07	-	-	-
Terrazole level	0%	2.19	1.93	2.04	122.9	36.2	70.8
	.25	2.17	1.93	2.03	105.1	34.8	62.9
	.50	2.17	1.89	2.00	104.9	28.9	59.3
	1.00	2.03	1.89	1.95	86.8	32.1	54.0
	Signif.	+	NS	NS	*	NS	*
	BLSD	0.12 (.10)	-	-	20.6	-	12.7
NXT	Signif.	NS	NS	NS	NS	NS	NS
	BLSD	-	-	-	-	-	-
	C.V.	4.8	5.7	5.4	15.0	44.3	25.7

Table 2. Silage yields and nitrogen content of silage as influenced by rate of nitrogen application (urea) and nitrification inhibitor coating (Terrazole) following corn and soybeans.

Treatment		Silage Yield			Silage N Content		
N Rate	Terrazole Coating	f/soybeans	f/corn	overall	f/soybeans	f/corn	overall
lbs N/A	%	Ton/A			%		
control		6.56	3.83	4.92	1.00	.69	.81
60	0	4.94	4.47	4.66	1.02	.97	.99
60	.25	6.30	4.33	5.12	.89	.95	.92
60	.50	6.98	4.19	5.31	.92	.92	.92
120	1.00	7.64	4.22	5.58	1.02	1.22	1.14
120	0	7.23	4.74	5.73	.92	1.07	1.01
120	.25	6.80	4.00	5.12	.97	1.05	1.02
120	.50	6.74	3.90	5.04	1.09	1.16	1.13
180	1.00	4.34	4.01	4.14	1.07	1.00	1.03
180	0	8.01	4.57	5.94	1.01	1.06	1.04
180	.25	7.29	4.70	5.73	1.09	1.10	1.10
180	.50	6.33	4.35	5.14	1.09	1.06	1.07
180	1.00	5.94	4.33	4.97	1.13	1.11	1.12
	Signif.	+	NS	+	NS	NS	**
	BLSD	2.41 (.10)	-	1.15 (.10)	-	-	0.21
	C.V.	14.6	12.1	15.6	13.7	20.1	17.3
Factional - Excludes Checks							
N Rate	60 #N/A	6.46	4.30	5.17	.96	1.01	.99
	120	6.28	4.16	5.01	1.01	1.07	1.05
	180	6.89	4.49	5.45	1.08	1.08	1.08
	Signif.	NS	NS	NS	NS	NS	NS
	BLSD	-	-	-	-	-	-
Terrazole Level	0%	6.73	4.59	5.45	.98	1.03	1.01
	.25	6.79	4.34	5.32	.98	1.03	1.01
	.50	6.68	4.15	5.16	1.03	1.05	1.04
	1.00	5.97	4.19	4.90	1.07	1.11	1.09
	Signif.	NS	NS	NS	NS	NS	NS
	BLSD	-	-	-	-	-	-
NXT	Signif.	*	NS	*	NS	NS	NS
	BLSD	2.43	-	1.28	-	-	-
	C.V.	15.2	12.2	16.0	11.1	20.6	16.4

Table 3. Various growth parameters related to the rate of nitrogen application and nitrification inhibitor coating (Terrazole) following corn and soybeans.

Treatment		Smut			Barren stalks			
N Rate	Coating	f/soybeans	f/corn	overall	f/soybeans	f/corn	overall	Lodging
lbs N/A	%			%				
Control		4.6	20.4	15.5	1.7	5.0	4.1	0.2
60	0	8.0	28.9	20.6	0.5	4.9	3.2	0.4
60	.25	10.2	25.1	19.1	1.0	4.3	3.0	0.0
60	.50	1.4	25.9	16.1	1.4	5.2	3.7	0.6
60	1.00	2.8	27.3	17.5	2.8	4.6	3.9	0.4
120	0	5.4	26.0	17.8	0.5	6.9	4.4	0.2
120	.25	2.9	32.6	20.7	2.0	8.3	5.8	1.0
120	.50	14.5	32.5	25.3	3.4	7.6	5.9	0.2
120	1.00	17.5	29.6	27.2	0.0	6.4	5.1	0.8
180	0	3.5	33.6	21.6	1.0	7.9	4.9	0.6
180	.25	9.6	22.7	17.5	1.9	3.3	2.7	0.8
180	.50	7.5	24.4	17.6	1.0	5.4	3.6	0.6
180	1.00	17.2	26.2	22.6	2.0	4.5	3.5	0.4
	Signif.	NS	NS	NS	NS	NS	NS	NS
	BLSD (.05)	-	-	-	-	-	-	-
	C.V.	77.3	26.5	37.6	82.0	35.9	45.9	151.9
Factorial - Excludes Check								
N Rate	60 #N/A	5.7	26.8	18.3	1.6	4.8	3.5	0.4
	120	12.2	29.8	22.8	2.2	7.4	5.3	0.6
	180	9.5	26.7	19.8	1.4	5.3	3.7	0.6
	Signif.	NS	NS	NS	NS	*	**	NS
	BLSD (.05)	-	-	-	-	1.6	1.2	-
Terrazole Level	0%	5.7	29.5	20.0	0.5	6.6	4.2	.4
	.25	7.6	26.8	19.1	1.6	5.3	3.8	.6
	.50	7.8	27.6	19.7	2.1	6.1	4.5	.5
	1.00	15.3	27.2	22.4	2.5	5.3	4.2	.5
	Signif.	NS	NS	NS	NS	NS	NS	NS
	BLSD (.05)	-	-	-	-	-	-	-
N X T	Signif.	NS	NS	NS	NS	NS	NS	NS
	BLSD	-	-	-	-	-	-	-
	C.V.	76.5	58.7	38.3	85.0	36.3	46.3	14.8

Table 4. Influence of nitrogen rate and nitrification inhibitor concentration (Terrazole) on soil ammonium and soil nitrate concentration in the 0-6" depth taken 8/10/76

Treatment

N Rate	Terrazole Coating	Soil Ammonium 0-6" f/soybeans	f/corn	overall	Soil Nitrates 0-6" f/soybean	f/corn	overall
lbs N/A	%	ppm			ppm		
control		6.9	6.9	6.9	5.4	4.2	4.7
60	0	9.0	9.2	9.1	20.5	14.6	16.9
60	.25	8.6	10.7	9.9	19.7	5.6	11.2
60	.50	13.2	13.8	13.6	14.5	5.5	9.1
60	1.00	10.7	11.1	10.9	9.4	3.5	5.8
120	0	9.8	15.2	13.0	24.9	46.2	37.7
120	.25	14.9	15.5	15.3	21.4	8.7	13.8
120	.50	12.0	21.9	17.9	14.3	8.5	10.8
120	1.00	20.5	21.0	20.8	9.8	5.8	7.4
180	0	13.8	7.8	10.2	54.4	63.1	59.6
180	.25	16.7	27.5	23.2	24.4	18.6	20.9
180	.50	22.1	34.1	29.3	14.1	15.8	15.1
180	1.00	49.5	47.4	48.2	21.0	8.6	13.5
	Signif.	*	+	**	**	**	**
	BLSD (.05)	22.7	25.3 (.10)	14.6	18.7	16.3	11.5
	C.V.	56.3	76.0	64.7	41.1	62.7	56.1

Factorial - Excludes Checks

N Rate	60 #N/A	10.4	11.2	10.9	16.0	7.3	10.8
	120	14.3	18.4	16.8	17.6	17.3	17.4
	180	25.5	29.2	27.7	28.4	26.5	27.3
	Signif.	*	*	**	*	**	**
	BLSD	10.6	8.9	7.1	9.5	8.6	6.0
Terrazole Level	0%	10.8	10.7	10.8	33.2	41.3	38.1
	.25	13.4	17.9	16.1	21.8	11.0	15.3
	.50	15.8	23.3	20.3	14.3	10.0	11.7
	1.00	26.9	26.5	26.6	13.4	5.9	8.9
	Signif.	+	NS	**	**	**	**
	BLSD	11.0 (.10)	-	8.8	10.6	9.5	6.8
NXT	Signif.	NS	NS	*	NS	*	**
	BLSD	-	-	18.0	-	11.8	13.8
	C.V.	56.2	75.4	64.4	40.2	62.2	55.1

Table 5. Influence of N Rate and nitrification inhibitor concentration (Terrazole) on soil ammonium and soil nitrate concentration in the 0-6" depth on 10/18/76

Treatment		Soil Ammonium 0-6"			Soil Nitrates 0-6"		
N Rate	Terrazole Coating	f/soybeans	f/corn	overall	f/soybeans	f/corn	overall
lbs N/A	%						
control		9.6	12.9	11.6	8.3	6.5	7.2
60	0	13.2	11.1	11.9	23.7	21.1	22.2
60	.25	12.5	12.5	12.5	14.6	13.5	13.9
60	.50	15.1	12.7	13.6	23.8	10.9	16.0
60	1.00	14.1	15.5	15.0	17.5	9.8	12.8
120	0	13.1	11.2	11.9	23.3	25.3	24.5
120	.25	13.0	18.2	16.1	35.7	20.6	26.6
120	.50	14.9	15.1	15.0	35.0	20.8	26.5
120	1.00	27.2	21.3	23.6	10.7	12.8	12.0
180	0	13.8	19.3	17.1	21.1	43.4	34.5
180	.25	31.5	18.5	23.7	50.8	23.6	34.5
180	.50	35.7	15.5	23.6	20.6	15.2	17.3
180	1.00	30.0	26.3	27.8	21.6	13.7	16.7
	Signif.	*	**	**	*	*	**
	BLSD (.05)	15.5	7.5	7.8	22.9	22.6	15.6
	C.V.	36.6	25.2	34.8	38.8	59.4	53.8

Factorial - Excludes Checks

N Rate	60 #N/A	13.7	12.9	13.3	19.9	13.8	16.2
	120	17.0	16.4	16.7	26.2	19.9	22.4
	180	27.8	19.9	23.0	28.4	24.0	25.8
	Signif.	**	**	**	NS	NS	*
	BLSD	7.8	3.1	3.6	-	-	7.7
Terrazole Level	0%	13.4	13.9	13.7	22.7	29.9	27.0
	.25	19.0	16.4	17.4	33.7	19.2	25.0
	.50	21.9	14.4	17.4	26.4	15.6	20.0
	1.00	23.8	21.0	22.1	16.5	12.1	13.9
	Signif.	NS	**	**	+	*	*
	BLSD	-	3.7	4.5	11.1 (.10)	11.5	8.7
NXT	Signif.	NS	NS	NS	*	NS	NS
	BLSD	-	-	-	20.3	-	-
	C.V.	36.7	23.6	34.1	38.0	58.5	53.0