CONTINUOUS CORN SILAGE

West Central Experiment Station - Morris

Samuel 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 application 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. 1976 Soil Measurements

In the fall of 1976 samples were taken to plow depth in all plots. The results are given in Table 1.

A. Organic matter - No significant differences.

B. Organic carbon - No significant differences.

C. Bray #1 P - Much higher where more fertilizer used.

D. Potassium - Much higher where more fertilizer used; measureably higher where grain only removed.

E. $(NO_3 + NO_2)$-N - Much higher where more fertilizer used.

F. Zinc - Slightly lower where silage harvested at a high fertility level.

G. pH - No significant differences.

Table 1. Effect of 11 years of continuous corn silage on soil properties.

Treatment	Organic matter %	Organic carbon %	Bray #1 P ppm	K ppm	(NO_3+NO_2)-N ppm	Zn ppm	pH
Silage-low fertility	5.590	3.250	14.0	158	30	4.1	7.8
Silage-high fertility	5.494	3.194	32.7	179	76	3.8	7.8
Grain-low fertility	5.145	2.991	16.6	170	22	4.3	7.9
Grain-high fertility	5.237	3.045	33.4	189	66	4.4	7.7
Significance:	NS	NS	**	**	**	*	NS
BLSD(.05)	-	-	5.8	11	28	0.3	-

III. 1977 Operations

In 1977 the variety was Trojan TXS99. Furadan was applied at 1 lb./acre (active ingredient) at planting on April 29. Lasso at 2 lbs./acre and Bladex at 2 lbs./acre were applied broadcast on April 29. A hail storm on May 29 severely damaged the plots and they never fully recovered. Silage yields were taken on September 16 and grain yields on September 29.

IV. Silage Yields - Dry matter; tons/acre.

Treatment	1977 yield	1966-77 yield
Silage, low fertility	4.89	5.24
Silage, high fertility	4.97	5.62
Grain, low fertility	4.70	5.38
Grain, high fertility	5.47	5.81

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

	1977 yield	1966-77 yield
Grain, low fertility	84.66	86.35
Grain, high fertility	81.99	90.36

VI. Check Yields

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

	1977 yield	1966-77 yield
Grain (0 + 0 + 0)	76.17 Bu/A	51.16 Bu/A
Silage (0 + 0 + 0)	4.17 Tons/A	3.75 Tons/A

VII. Discussion

A. The 11 years of continuous corn silage had no detrimental effect on any of the soil properties measured.

B. In 1977 there were no significant treatment effects. Yields on the check plots were substantially lower than on the fertilized plots.

C. The 12-year average yields again show no reduction in silage yields from growing continuous corn silage and show a response to fertilizer.

SULFUR FERTILIZATION OF ALFALFA

A.C. Caldwell and J.N. Lensing

Sulfur is an essential element for plant growth and is required in relatively large amounts by some crops such as alfalfa. Since there are areas in Minnesota where S deficiency does occur, investigations on S needs by crops in this state were conducted quite a few years ago, and then more recently by the Department of Soil Science. However, continuing research to a greater or lesser degree on most of the nutrient elements is necessary because of greater crop production (which means greater nutrient removal), the use of purer chemicals as fertilizers, cleaner air, and because of the introduction of fertilizer chemicals that may differ in characteristics (form, analysis, etc.).

In 1974 studies were begun on the response of some crops in Minnesota to a new granulated gypsum product from U.S. Gypsum. The soil on the experimental field located at Park Rapids, Minnesota is a Dorset sandy loam, testing 7 ppm available S, which would place it in the low to medium range in S supply for crops.

RESULTS

Alfalfa yields--The trial established in 1974 consisted of rates of either elemental or gypsum applied in a single application at the initiation of the experiment. The results shown in Table 1 reflect a substantial increase in yields due to sulfur. Four years after application, elemental S has emerged as a better source of S than gypsum when applied at equivalent rates as shown in Table 2. It seems likely that the more readily available SO_4 in gypsum has been taken up more rapidly than the less slowly available S in elemental S. Since SO_4 will move downward in the soil water, it is possible also that some S has been moved beyond the reach of the plants.

Sulfur content of alfalfa--The S content of 4-year old irrigated alfalfa as affected by rates and source of S is shown in Table 3. The S content of untreated alfalfa is below the critical level of 0.25% S. Also below this level is alfalfa from plots treated with 25 lbs S/A as gypsum. Sulfur in the plant has increased with increasing rate of S applied. As with yield, response to S has persisted longer when elemental S was used as the original S source rather than gypsum.

Table 1. Yields of 4-year old irrigated alfalfa as affected by sources and rates of sulfur at Park Rapids, MN in 1977.

S Treatment*		Cutting			
		First	Second	Third	Total
lbs S/A	Source	Tons/A			
0	-	1.12	1.29	1.07	3.48
25	gypsum	1.34	1.44	1.15	3.93
50	gypsum	1.74	1.53	1.09	4.36
100	gypsum	1.87	1.90	1.30	5.07
25	elemental	1.02	1.60	1.15	4.37
50	elemental	1.88	1.93	1.38	5.19
100	elemental	2.00	2.08	1.44	5.52

* S applied prior to planting in 1974.

Table 2. Yields of irrigated alfalfa during 3 years as affected by sources and rates of sulfur at Park Rapids, MN. (Total of cuttings).

S Treatment*		1975[1]	1976[2]	1977[2]
lbs S/A	Source	----------Tons/A----------		
0	-	2.25	4.25	3.48
25	gypsum	3.00	5.35	3.93
50	gypsum	3.08	5.54	4.36
100	gypsum	3.08	5.75	5.07
25	elemental	2.80	4.76	4.37
50	elemental	2.65	5.23	5.19
100	elemental	3.03	5.67	5.52

* S applied prior to planting 1974

1 Two cuttings

2 Three cuttings

Table 3. S content of 4-year old irrigated alfalfa as affected by source and rate of sulfur at Park Rapids, MN in 1977.

S Treatment*		First	Second	Third	Ave.
lbs S/A	Source	----------% S----------			
0	-	0.236	0.214	0.226	0.225
25	gypsum	0.254	0.216	0.222	0.231
50	gypsum	0.286	0.246	0.228	0.253
100	gypsum	0.321	0.300	0.275	0.299
25	elemental	0.295	0.252	0.232	0.260
50	elemental	0.316	0.280	0.283	0.293
100	elemental	0.364	0.340	0.326	0.343

* S applied prior to planting in 1974.

PESTICIDE INTERACTION PLOTS AT ROSEMOUNT

Russell S. Adams, Jr.

An experiment studying the effects of combinations of the insecticide Furadan, the herbicide, Atrazine, and soil pH in continuous corn was established for the fifth year in 1977. Treatments included five residual lime treatments, Furadan at 0, 1/2, and 2 pounds per acre; Atrazine at 0, 2, 4, and 8 pounds per acre and their combinations. Each treatment has been replicated four times. The plots have been managed so as to maximize both weed and corn root worm infestation.

The 1977 season was a year of adequate moisture. However, some nitrogen deficiency developed in late season and supressed yield. Cultivation gave excellent weed control and their was little insect infestation until late season. Consequently, chemical treatments did not give as pronounced increase in yields as in previous years.

Corn yields in 1976 (Table 1) generally reflected chemical treatments, but not as pronounced as in previous years. Yields in the no chemical treatments ranged from 100 to 112 bushels per acre. Whereas near normal Furadan (1/2 lb/A) and Atrazine (4 lb/A) yielded from 109 to 150 bu/A/ Most pronounced effects were in the high lime soils. The average increase was 21%. Five year averages (Table 2) ranged from 58 to 69 bu/A in the no chemical treatments and 80 to 98 bu/A in the more normal chemical applications or an increase of 30%.

No significant lodging occurred in any treatments in 1977. A study of corn root worms present could find few. However, the data in Table 3 show that viable corn root worms were shown to confirm the observations made in 1975 and 1976, i.e., Furadan was apparently not controlling the corn root worm in high lime treatments as lodging was heavy. Note in Table 3 that Furadan markedly reduced corn root worm counts in soils receiving no lime, gave less control in moderately limed soils and no control in heavily limed soils. Work is being conducted in the laboratory to determine if differential microbial decay may be a factor.

In the 1976 report we observed that velvet leaf was increasing relative to giant foxtail. In 1977 there was a recession. The Broadleat Giant Foxtail ratio averaged 0.15 in the no chemical treatments, with broadleaf weeds (excepting one treatment) accounting for 10% or less of the total weed population. Apparently velvet leaf is either favored by drought or we are experiencing a cyclic fluctuation.

Table 1. The amount of lodging, weed growth, and corn yields in Atrazine-Furadan-soil pH studies at Rosemount, Minnesota, 1977.

Rate of Furadan and lime status	No Atrazine			2 lbs/A Atrazine			4 lbs/A Atrazine			8 lbs/A Atrazine		
	Lodging %	Weeds tons/A	Corn bu/A	Lodging %	Weeds tons/A	Corn bu/A	Lodging %	Weeds tons/A	Corn bu/A	Lodging %	Weeds tons/A	Corn bu/A
No lime--somewhat acid (~pH 5.4)												
Furadan 0 lbs/A	10	1.21	103	0	0.10	110	2	0.01	99	0	.00	100
1/2	0	0.10	110	0	0.10	107	2	0.04	109	0	.00	113
2	10	0.77	107	2	0.04	117	0	0.11	135	2	.00	138
Moderate lime, slightly acid (~pH 6.3)												
Furadan 0 lbs/A	4	0.66	100	0	0.44	102	8	0.01	129	10	.00	118
1/2	2	0.44	102	0	0.20	119	0	0.01	133	0	0.02	106
2	0	0.62	115	0	0.10	110	0	0.02	128	0	.00	130
Well limed, near neutral (~pH 6.8)												
Furadan 0 lbs/A	8	0.70	112	0	0.23	115	0	0.04	111	0	0.01	115
1/2	0	0.44	120	0	0.10	132	0	0.02	136	0	.00	115
2	2	0.35	116	2	0.17	122	0	0.02	113	0	.00	111
Heavily limed--slightly alkaline (~pH 7.2)												
Furadan 0 lbs/A	0	0.89	100	7	0.08	104	0	0.01	112	0	.00	121
1/2	2	0.40	119	0	0.14	124	8	0.11	125	2	0.04	106
2	0	0.31	115	2	0.02	125	0	0.02	150	2	.00	127

Table 2. The amount of lodging, weed growth and corn yields in Atrazine-Furadan-soil pH studies at Rosemount, Minnesota, 5 year average.

Rate of Furadan and lime status	No Atrazine			2 lbs/A Atrazine			4 lbs/A Atrazine			8 lbs/A Atrazine		
	Lodging %	Weeds tons/A	Corn bu/A	Lodging %	Weeds tons/A	Corn bu/A	Lodging %	Weeds tons/A	Corn bu/A	Lodging %	Weeds tons/A	Corn bu/A
No lime--somewhat acid (~pH 5.4)												
Furadan 0 lbs/A	45	1.44	58	41	0.80	77	44	0.36	80	31	0.20	83
1/2	20	1.47	68	26	0.54	84	27	0.53	80	26	0.17	91
2	16	1.09	77	32	0.65	86	12	0.55	87	29	0.13	95
Moderate lime--slightly acid (~pH 6.3)												
Furadan 0 lbs/A	35	1.64	69	41	0.65	74	35	0.27	90	44	0.06	92
1/2	37	1.18	64	29	0.57	85	21	0.43	98	32	0.16	88
2	19	1.41	75	18	0.72	82	13	0.25	92	17	0.18	95
Well limed, near neutral (~pH 6.8)												
Furadan 0 lbs/A	40	1.16	66	30	0.71	77	36	0.20	85	35	0.08	96
1/2	32	1.09	82	27	0.72	83	30	0.39	94	38	0.07	95
2	20	.87	77	16	0.63	94	22	0.30	96	20	0.09	93
Heavily lime, slightly alkaline (~pH 7.2)												
Furadan 0 lbs/A	49	1.36	65	48	0.29	84	42	0.12	88	40	0.04	88
1/2	29	1.17	82	34	0.36	92	32	0.15	96	31	0.05	95
2	32	0.73	83	35	0.28	91	24	0.15	102	31	0.02	101

Table 3. Influence of soil pH and pesticide treatment on corn root worm counts in 1977.

Pesticide Treatment	No lime somewhat acid (pH 5.4)	Moderate lime near netural (pH 6.7)	Heavily limed slightly alkaline (pH 7.2)
		(number/1000gm soil)	
None	2.82	2.51	1.66
2 lbs/A Furadan	0.39	0.65	2.24
2 lbs/A Furadan and 8 lbs/A Atrazine	0.12	0.52	1.20

NITROGEN TRIALS ON BARLEY UNDER IRRIGATION
Staples - 1976

G. Nelson, A. C. Caldwell, R. Schoper

An experiment on barley was conducted under irrigation on a sandy loam soil at the CMDIR station at Staples, Minnesota. The experiment was designed to study the effect of nitrogen on yield and protein content of barley.

A randomized complete block design with three replications of five treatments was used. The treatments each differed in the amount of nitrogen applied per acre.

Treatment No.	1	-	0	lbs.	N/A	
"	2	-	40	"	"	
"	3	-	80	"	"	
"	4	-	120	"	"	(80 + 40)
"	5	-	160	"	"	(80 + 80)

Nitrogen applications were applied prior to seeding, with the second of the split applications applied just before early boot. All nitrogen was applied as ammonium nitrate. In addition, the entire experimental area received 60 pounds K_2O/A and 10 pounds S/A applied as gypsum.

The plot was spring plowed. On April 4, the plot was harrowed twice and packed. On April 6, the plot was fertilized, harrowed, and seeded to Manker Barley at a rate of 96 pounds per acre. Good weed control was achieved with ¼ pound bromoxynil plus ¼ pound MCPA per acre applied at the four leaf stage.

Grain yield, percent protein and percent plump kernels are given on the following table. The data indicates that 80 pounds of N/A provided the greatest yield with a protein content low enough to allow the barley to be used for malting purposes.

Effect of nitrogen fertilization on yield, plumpness, and protein content of barley.

Treatment Lbs. N/A	Bu/A	% Plump	% Protein
0	50.5	72.3	10.4
40	63.4	76.3	12.1
80	68.2	75.3	11.6
80 + 40	79.6	73.3	13.8
80 + 80	84.9	75.6	14.3
Significance	**	ns	**
BLSD (.05)	12.6	--	.8
C.V.	9.8	3.2	3.2

INFLUENCE OF TIMING OF NITROGEN APPLICATION ON NITROGEN UPTAKE BY IRRIGATED CORN AND NITROGEN IN GROUND WATERS

A. C. Caldwell, J. Gerwing, G. Buzicky, M. Wiens

An experiment was established on a Sverdrup sandy loam at the CMDIR station at Staples, Minnesota, in the spring of 1977 to study the effects of timing of N fertilizer applications on N uptake by irrigated corn and the movement of N into shallow ground water.

In the fall of 1976, three wells were drilled to the aquifer (15 feet below the soil surface) in each plot. The well screens were placed 2 feet below the top of the aquifer. In spring, a 90 day hybrid was planted at 26,000 seeds per acre in 30 inch rows. All plots received 150 lbs/A K as potassium chloride, 30 lbs/A P as superphosphate, and 20 lbs/A S as gypsum. Nitrogen was applied at 160 lbs/A as urea in one application at planting or in smaller allotments through the growing season. The N in the split application was applied in four allotments, 20 lbs as starter, 40 lbs when the corn was 9 inches tall, and 50 lbs each when the corn was 2 feet tall and at tasseling. Subplots were treated with ^{15}N labeled urea for use as a tracer. Irrigation water was applied twice a week, amounting to 1 inch per week early in the season and increasing to 2 inches per week as the season progressed. The irrigation schedule was adjusted for significant rainfalls.

Whole plant yields were obtained by sampling the corn when it reached physiological maturity. All plant material was analyzed for total N and plant material from ^{15}N treated subplots was also analyzed for percent ^{15}N. Ground water was sampled from the wells twice a week and analyzed for NO_3-N.

Whole plant yields were not different between the two N application methods, both yielding 6.70 tons of dry matter per acre. Total N removed by the crop was 147 lbs from the one time application treatment and 153 lbs from the split N application, the latter amount being larger due to a higher percent N in the plant tissue from that treatment.

^{15}N analysis showed that 30.1% of the fertilizer N was recovered in the plant when the N was applied at one time at planting while 52.1% of the applied N was recovered in the plant when the N was applied in split applications during the growing season.

Nitrate nitrogen concentration in the ground water below the split application treatment decreased during the growing season while the NO_3-N concentration in the ground water below the one time spring applied N treatment increased 7 ppm.

NITROGEN TRIAL ON SPRING WHEAT

UNDER IRRIGATION AT STAPLES IN 1977

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

As a continuation of spring wheat trials initiated in 1974, a variety by nitrogen experiment was conducted under irrigation on a sandy loam soil at Staples in 1977. In 1977, a split plot design, replicated four times with varieties as main plots and nitrogen rates as split plots was used. Era, Kitt, Angus, and 70-170 were the semi-dwarf spring wheat varieties grown. Nitrogen rates of 0, 75, and 125 lbs N/A were applied as split applications (2/3 applied prior to seeding and 1/3 applied at early boot stage). All nitrogen was applied as ammonium nitrate. In addition to nitrogen treatments 20 lbs. P_2O_5/A was applied with the seed. Also 60 lbs K_2O/A and 10 lbs S/A as gypsum was broadcast over the experimental area.

Grain yields in 1977 were lower than expected from 25-57 bu/A (Table 1) as compared to a range of 32-77 bu/A produced in 1976. The lower yield may be due to high temperatures and/or inadequate water at flowering and seed filling stage as indicated by the low test weights of the wheat.

There was a significant varietal difference in yield potential, protein content and test weight. Yield was significant increased with 75 lbs N/A and highest protein content achieved at 125 lbs N/A. With an increase in N rate there was a trend of decreasing test weight.

Forage yields were collected at the soft dough stage to determine total dry matter yield, percent nitrogen in tissue and total N removal. The results of these measurements are shown in Table 2.

Table 1. Effect of variety and N rate on yield, grain protein, and test weight of wheat at Staples, 1977.

Treatment	Yield	Grain Protein	Test Weight
Variety	Bu/A.	%	lbs/bu.
Era	45	14.2	57.9
Kitt	41	16.0	55.6
Angus	33	16.9	55.8
70-170	46	15.1	58.7
Significance	**	**	**
BLSD (.05)	5	0.8	1.0
Rate			
0 # N/A	28	13.9	57.7
75 # N/A	47	15.7	57.0
125 # N/A	49	17.0	56.3
Significance	**	**	**
BLSD (.05)	4	0.4	0.7
Interaction			
Era x 0 # N/A	34	12.6	58.3
Era x 75 # N/A	47	14.2	58.5
Era x 125 # N/A	54	15.7	57.0
Kitt x 0 # N/A	25	14.2	57.4
Kitt x 75 # N/A	47	16.6	55.8
Kitt x 125 # N/A	52	17.4	53.6
Angus x 0 # N/A	21	15.3	56.1
Angus x 75 # N/A	39	16.9	55.5
Angus x 125 # N/A	40	18.5	55.9
70-170 x 0 # N/A	30	13.6	59.0
70-170 x 75 # N/A	57	15.3	58.4
70-170 x 125 # N/A	51	16.4	58.7
Significance	NS	NS	**
BLSD (.05)	-	-	1.5
C.V., %	12.6	3.6	1.5

Table 2. Effect of variety and N rate on dry matter yield; % N in tissue, and total N removal of wheat forage at Staples, 1977.

Treatment	Yield	N Content	N Removal
Variety	Tons/A	%	lbs/A
Era	2.57	1.22	64
Kitt	2.64	1.50	80
Angus	2.48	1.38	70
70-170	2.64	1.29	70
Significance	NS	*	*
BLSD (.05)	-	0.21	13
Rate			
0 # N/A	1.77	1.19	42
75 # N/A	2.87	1.33	76
125 # N/A	3.10	1.53	95
Significance	**	**	*
BLSD (.05)	.30	0.14	10
Interaction			
Era x 0 # N/A	1.78	1.10	39
Era x 75 # N/A	2.79	1.24	69
Era x 125 # N/A	3.14	1.34	84
Kitt x 0 # N/A	1.77	1.38	50
Kitt x 75 # N/A	2.81	1.38	76
Kitt x 125 # N/A	3.32	1.74	115
Angus x 0 # N/A	1.66	1.18	40
Angus x 75 # N/A	2.68	1.33	70
Angus x125 # N/A	3.10	1.61	100
70-170 x 0 # N/A	1.88	1.08	41
70=170 x 75 # N/A	3.20	1.38	88
70-170 x 125 # N/A	2.85	1.43	81
Significance	NS	NS	NS
C.V., %	16.9	13.1	18.8

N RATE STUDIES OF DRYLAND AND IRRIGATED WHEAT AND OATS WITH AND WITHOUT LEGUME UNDERSEEDING, STAPLES 1977

H. Meredith, M. Wiens, R. Schoper and J. Lensing

1977 was the third crop year of studies investigating the effect of various rates of nitrogen on oat and wheat yields under irrigation.

A dryland N rate study was initiated in 1977 to evaluate the impact of nitrogen on the yields of wheat and oats. The study evaluating the effect of red clover as an underseeding and as a plowdown crop prior to seeding was continued.

The objectives of the study are:

a) evaluate effect of applied N on yield of wheats and oats under dryland and irrigated condition

b) evaluate effect of applied N on yield of irrigated wheat and oats with red clover underseeding

c) evaluate effect of applied N on yield of irrigated 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 source of N. N rates were 0, 40, 80 and 120 pounds per acre for oats. Wheat received 0, 60, 120 and 180 pounds N per acre.

N was applied to oats in two applications. One-half just prior to seeding and one-half immediately preceeding boot formation.

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

All plots received a broadcast application of 425 pounds of K per acre in early April. Urea was incorporated by harrowing. Desired seeding rate was wheat, 120; oats, 96; and red clover, 16 pounds per acre.

Plots were moldboard plowed on March 28, harrowed twice and packed on April 4. Seeding was begun on April 5 and completed on April 7.

The oats was harvested July 15-18, wheat was harvested on July 25.

Table 1. Oat grain yield, Staples 1975, 1976 and 1977.

	1975		1976		1977		
Lbs N/A	Oats[1]	Oats[2]	Oats[1]	Oats[2]	Oats[1]	Oats[2]	Oats[3]
	----- BU/A -----		------ BU/A -----		---------- BU/A ----------		
0	24.0	24.0	54.4	85.7	44.7	84.1	31.5
40	35.8	44.8	84.0	87.7	90.2	101.2	63.4
80	40.8	51.8	100.9	90.2	106.5	110.2	59.8
120	34.8	41.0	111.2	93.2	114.2	100.8	62.4
Treatments	*	NS	**	NS	**	*	*
BLSD (05)	4.3	--	28.5	--	10.0	-	20.3
C.V.	17.3	29.9	20.1	15.9	7.6	11.4	22.7

[1] Chemical weed control (irrigated).

[2] Seeded with red clover companion crop (irrigated).

[3] Chemical weed control (dryland).

Table 2. Oat forage yield, percent protein and lbs N removed per acre, Staples 1977.

	Oats, Irrigated[1]			Oats-Red Clover, Irrigated			Oats, Dryland[1]		
Lbs N/A	Tons D.M./A	Percent Protein In Forage	N-lbs/A Removed In Forage	Tons D.M./A	Percent Protein In Forage	N-lbs/A Removed In Forage	Tons D.M./A	Percent Protein In Forage	N-lbs/A Removed In Forage
0	1.1	5.8	20.4	3.0	5.6	52.8	.8	7.0	18.6
40	2.6	6.2	51.4	3.1	7.3	73.3	1.6	7.4	37.9
80	3.3	5.8	61.5	3.2	8.1	83.3	1.7	9.5	52.9
120	3.6	8.0	91.2	3.2	8.6	87.6	1.7	10.2	55.8
Treatments	**	**	**	NS	**	**	**	**	**
BLSD (.05)	.32	1.0	13.3	-	1.1	12.0	.38	0.7	10.2
C.V.	8.2	10.0	15.8	7.2	9.9	10.5	16.4	5.4	16.2

[1] Chemical weed control.

Table 3. Oats, grain - percent protein, N removed, test weight, and straw data, Staples, MN 1977.

	Straw T/A			Straw % Protein			Straw Lbs N Removed/A		
Lbs N/A	1/	2/	3/	1/	2/	3/	1/	2/	3/
0	.6	2.1	.5	1.7	3.3	1.9	3	23	3
40	1.2	2.0	1.0	1.5	3.3	1.9	6	21	6
80	1.5	2.3	1.0	2.3	3.6	3.2	11	27	11
120	1.7	2.3	1.0	2.9	4.0	3.7	16	30	12
Treatments	**	NS	**	**	NS	**	**	NS	**
BLSD (.05)	.25	.	.4	.4	-	.5	2.5	-	4.2
C.V.	4.1	19	26	13	25	13	18.3	39	33

1/ Chemical weed control (irrigated).

2/ Red clover companion crop (irrigated).

3/ Chemical weed control (dryland).

Table 3. Oats, grain - percent protein, N removed, test weight, and straw data, Staples, MN 1977.

	% Protein			Lbs N Removed/A			Test Wt Lbs/bu		
Lbs N/A	1/	2/	3/	1/	2/	3/	1/	2/	3/
0	13.4	13.2	13.6	46	57	22	36.1	37.6	34.1
40	13.3	14.2	14.6	61	73	48	34.5	34.6	35.0
80	13.9	15.5	16.4	76	88	50	32.8	35.5	36.1
120	15.6	16.1	16.4	91	83	52	32.4	33.5	34.0
Treatments	*	**	*	**	**	**	NS	NS	NS
BLSD (.05)	1.8	1.3	2.1	11.1	15.1	14.6	-	-	-
C.V.	7.4	5.7	8.2	11.1	12.5	21.3	10.0	6.0	7.1

1/ Chemical weed control (irrigated).

2/ Red clover companion crop (irrigated).

3/ Chemical weed control (dryland).

Table 4. Wheat grain yield, Staples, MN 1975, 1976 and 1977.

	1975			1976				1977			
Lbs N/A	Wheat[1]	Wheat[2]	Lbs N/A	Wheat[1]	Wheat[2]	Wheat[3]		Wheat[1]	Wheat[2]	Wheat[3]	Wheat[4]
	BU/A			BU/A				BU/A			
0	7.3	5.0	0	24.3	53.0	59.1		28.7	51.0	53.2	9.4
40	18.0	13.0	60	53.0	58.3	70.0		47.3	49.8	58.5	16.9
80	21.3	16.5	120	66.4	55.2	69.2		64.6	52.3	57.5	21.6
120	24.0	17.0	180	68.0	56.7	66.7		68.9	41.3	58.6	19.6
Treatments	**	**		**	NS	*		**	NS	NS	**
BLSD (.05)	5.8	4.1		8.1	-	7.6		8.1	-	-	3.6
C.V.	21.1	20.8		10.2	12.6	6.8		10.3	19.8	13.5	13.8

[1] Chemical weed control (irrigated).

[2] Red clover underseeding (irrigated).

[3] Established red clover stand plowed down, chemical weed control (irrigated).

[4] Chemical weed control (dryland).

Table 5. Wheat forage yield, percent protein and lbs N removed per acre, Staples 1977.

	Wheat, Irrigated[1]			Wheat-Red Clover, Irrigated[2]		
Lbs N/A	Tons D.M./A	Percent Protein In Forage	N-lbs/A Removed In Forage	Tons D.M./A	Percent Protein In Forage	N-lbs/A Removed In Forage
0	.9	6.6	20	2.9	7.2	69
60	2.3	6.0	45	3.0	8.4	81
120	3.0	8.5	83	2.9	10.0	95
180	3.3	9.4	98	3.1	11.2	111
Treatments	**	**	**	NS	**	*
BLSD (.05)	.26	1.25	16.2	-	1.9	24.2
C.V.	7.4	10.6	17.5	4.8	13.1	16.5

[1] Chemical weed control.

[2] Underseeding of red clover.

[3] Chemical weed control following plowdown of an established stand of red clover.

Table 5. Wheat forage yield, percent protein and lbs N removed per acre, Staples 1977. (continued)

	Wheat, Irrigated[3]			Wheat, Dryland		
Lbs N/A	Tons D.M./A	Percent Protein In Forage	N-lbs/A Removed In Forage	Tons D.M./A	Percent Protein In Forage	N-lbs/A Removed In Forage
0	2.6	7.5	62	.6	8.2	15
60	3.0	8.9	87	1.4	9.8	43
120	3.0	9.5	92	1.4	12.3	57
180	2.9	11.4	107	1.6	12.2	64
Treatments	NS	**	**	**	**	**
BLSD (.05)	-	1.73	19.8	.21	1.52	9.1
C.V.	9.8	11.6	14.3	11.0	11.0	13.6

[1] Chemical weed control.

[2] Underseeding of red clover.

[3] Chemical weed control following plowdown of an established stand of red clover.

Table 6. Wheat grain - percent protein, N removal and test weight, Staples, MN 1977.

Lbs. N/A	% Protein				Lbs N Removed/A				Test Wt, Lbs/Bu			
	1/	2/	3/	4/	1/	2/	3/	4/	1/	2/	3/	4/
0	11.8	12.2	13.4	14.4	35	65	75	14	61	59	59	60
60	11.8	14.7	15.3	15.7	58	77	94	28	59	57	58	59
120	14.3	15.9	15.7	17.6	97	87	95	40	58	57	57	60
180	15.5	16.7	16.4	18.6	112	72	101	38	59	55	56	59
Treatments	**	**	**	**	**	NS	+	**	+	**	NS	NS
BLSD (.05)	1.0	1.2	1.1	.7	12.1	-	-	7.0	-	2.0	-	-
C.V.	4.9	5.2	4.8	3.4	10.7	19.0	13.9	15.4	2.2	2.2	3.1	2.0

1/ Chemical weed control (irrigated).

2/ Seeded with underseeding of red clover (irrigated).

3/ Chemical weed control following plowdown of an established stand of red clover (irrigated).

4/ Chemical weed control (dryland).

Table 7. Wheat straw data, Staples, MN 1977.

Lbs N/A	Straw T/A			Straw Lbs/Bu Grain			Grain/Straw			% Protein Straw			Straw Lbs N Removed		
	1/	2/	3/	1/	2/	3/	1/	2/	3/	1/	2/	3/	1/	2/	3/
0	.9	1.7	.2	60	66	38	1.0	.91	1.6	2.5	2.6	3.6	7.2	15.8	2.2
60	1.7	2.0	.55	72	70	66	.83	1.2	.91	2.1	2.8	3.9	12.1	20.7	7.5
120	2.4	2.2	.55	75	77	54	1.2	.78	1.1	2.7	4.2	5.1	22.8	32.2	10.4
180	2.0	2.3	.71	59	80	72	1.0	.75	.82	3.6	4.2	5.6	26.1	34.5	14.3
Treatments	**	*	**	-	-	-	-	-	-	*	**	**	**	**	**
BLSD (.05)	.5	.3	.2	-	-	-	-	-	-	.9	.3	.8	6.2	3.8	4.5
C.V.	17.8	10.1	21.9	-	-	-	-	-	-	20.4	6.3	11.0	23.6	9.9	33.0

1/ Continuous small grain, chemical weed control (irrigated).

2/ Following plow-down of an established crop of red clover chemical weed control (irrigated).

3/ Chemical weed control (dryland).

Table 8. Grain-straw makings of small grain yields, Staples, MN 1977.

	Wheat							
Lbs N/A	Wheat (irr)[1]		Wheat-Red Clover (irr)		Wheat, Plowdown Clover[1]		Wheat (dryland)[1]	
	% Grain	% Straw	% Grain	% Straw	% Grain	% Straw	% Grain	% Straw
0	49.3	50.7	60.7	39.3	57.2	47.8	39.0	61.6
60	54.4	45.6	62.3	37.7	53.9	46.1	52.1	47.9
120	55.5	44.5	62.8	37.2	56.2	43.8	47.2	52.8
180	49.3	50.7	69.2	30.8	57.2	42.8	54.5	45.5

	Oats					
Lbs N/A	Oats (irr)[1]		Oats-Red Clover (irr)		Oats (dryland)[1]	
	% Grain	% Straw	% Grain	% Straw	% Grain	% Straw
0	46.4	53.6	60.9	39.1	50.5	49.5
40	45.9	54.1	54.3	45.7	49.3	50.7
80	47.6	52.4	56.8	43.2	52.1	47.9
120	48.1	51.9	58.8	41.2	50.5	49.5

[1] Chemical weed control.

Table 9. Rainfall, irrigation and open pan evaporation data by month, Staples.

	Inches Rainfall	Inches Irrigation	Rainfall + Irrigation	Ave. Pan Evaporation/Day
April	2.8	2.20	5.0	.20 1/
May	5.1	4.65	9.75	.28
June	3.1	6.4	9.5	.24
July	4.5	2.5	7.0	.27
Total In.	15.5	15.75	31.25	28.3 1/

1/ April 17-30 only.

$$\text{Ratio: } \frac{\text{Rainfall + Irrigation}}{\text{Pan Evaporation}} = \frac{31.25}{28.3} = 1.1 \quad (1977)$$

$$= \frac{31.3}{29.5} = 1.06 \quad (1976)$$

$$= \frac{22.0}{24.5} = 0.89 \quad (1975)$$

Water Quality Studies

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

Water samples were analyzed at different locations and at different intervals following pumping to better understand water quality and the potential alteration of soil characteristics.

Of greatest importance is the alkalinity of water. Most of the irrigation water is being applied to coarse textured soils in Minnesota. Typically these soils have low exchange capacity and an initial pH less than 6.0.

Tables 1 and 2 contain the analysis of Ca CO_3 equivalent and sulfur content in pounds per acre inch from 32 wells in Hubbard and 2 from Becker counties. Sulfur range was .4 - 1.6 lbs. S/Acre inch. Total alkalinity expressed as $CaCO_3$ equivalent range was 13-58. The average sulfur content of these samples was .68 pounds S/Acre inch water. The average $CaCO_3$ equivalent of the water was 20.5 Lbs./Acre inch water. Many of the irrigators reported pumping 16 acre inces of water in 1977. Using average values, this would equate to 10.9 pounds S/Acre and 328 Lbs. $CaCO_3$ equivalent/Acre.

Data of other locations sampled in 1977 appears in Tables 3 and 4.

The N rate-small grain study at Staples is an excellent exercise in determining the effect of varying the pH of the soil via irrigation. Countering the pH effect of the alkalinity in the water is the pH depression offered by the conversion of urea to nitric acid in the soil. The data in Tables 5 and 6 contrast the pH change from August 1976 to August 1977. Blocks 1 and 1A have received nitrogen three years.

The soil pH initially was 5.8. The surface soil in plot 1A showed the greatest differential in pH, one-half unit. Data by W. H. Pierre[1] indicates about 1.15 pounds of $CaCO_3$ was required to neutralize the acidity of one pound of N under a continuous corn culture.

Data indicate the south well at Staples is delivering about 36 pounds of $CaCO_3$ equivalent per acre inch, Table 3. After three years this area has received 52 inches of irrigation water or 1872 pounds of fine $CaCO_3$ equivalent.

The zero N plots have increased in pH from 5.8 to 6.7 while the highest N rate has increased to pH 6.2. Therefore, the difference in pH is attributed to the nitrogen or 0.5 pH unit.

Soil analyses data appear in Tables 8 and 9.

[1] Pierre, W. H. "N-Contributor to Soil Acidity-How Much?" 22nd Annual Fertilizer and Ag Chemical Dealers Conference, January 13-14, 1970, pp 13-135.

Table 1. Water Quality Studies

Farmer	County	Township	Section	Description	Depth of well	1st yr. Pumped	Gal/hr	Prin. Crop	S Lbs/A in.	$CaCO_3$ (Lime) Lbs/Ac in.	pH	Date 77
Manloves	Hubbard	Hubbard	20	NE¼	105	1977	650	Corn-alf	.5	19	7.2	8/29
Manloves	"	"	21	W½	155	1976	1100	"	.9	14	7.8	8/29
Manloves	"	"	21	SE¼	85	1976	700	Corn	.9	14	8.1	8/29
M.M.Beelne	"	"	25	NW¼	56	1977	940	Corn, D. beans	.56	16	8.0	8/29
M.M.Beelne	"	"	25	SE¼	130	1977	920	Corn	.56	16	8.0	8/29
M.M.Beelne	"	Crow Wing	30	SW¼	154	1977	1020	Dry beans	.75	14	8.3	8/29
P. Pohl	"	"	8	SW¼	182	1976	1000	Corn-alf	.4	23	8.2	8/29
S. Pike	"	Hubbard	15		130	1977	1300	Corn, D. beans	1.2	24	8.0	8/30
S. Pike	"	"	22	NE¼	50	1972	800	Corn-alf	.56	14	8.0	8/31
G. Bolton	"	"	23	SW¼	160	1977	800	Corn, D. beans	.4	20	8.0	8/30
F. Bliss	"	"	14	NE¼	170	1977	1200	Corn, D. beans	.63	20	8.0	8/30
F. Bliss	"	"	13	W½	174	1976	1350	Corn	.5	14	8.0	8/30
Ron Griffith	Becker	Osage	36	NE¼	110	1977	800	D. beans	.9	25	8.0	8/31
Lance Larson	"	"	34	SE¼	60	1977	750	D. beans	.5	24	8.0	8/31
Ron Griffith	Hubbard	SA Run	5	NE¼	108	1976	800	Corn, D. beans	.5	24	8.0	8/31
Ron Griffith	"	Todd	32	SE¼	160	1977	900	Corn, Beans	1.0	27	8.0	8/31
Chas.Andress	"	Wh.Dak.	32	SW¼	103	1976	800	Corn, D. beans	.5	17	8.0	9/8
M.Svenson	"	Crow Wing	6		75-80	1977	780	Corn	.5	24	8.0	9/12
Curt Corkste	"	Todd	21	NE¼	131	1977	800	Corn	.5	24	8.1	9/15
Boyd Steams	Becker	Carnsihit			140	1977	1400	Corn,D.bean	.5	27	8.0	9/15
Don Rooney	"	Pine Point	6	SW¼	130	1976	1000	Corn-alf	.5	25	8.1	9/15

Table 2. Water Quality Studies

Farmer	County	Township	Section	Description	Depth of well	1st yr. Pumped	Gal/hr	Prin. Crop	S Lbs/A in.	$CaCO_3$ (Lime) Lbs/Ac in.	pH	Date 77
Korst, E.	Hubbard	Hubbard	24	NW¼	60	1975	800	Pot., Corn	.7	18	8.0	8/22
Benham	"	"	21	NE¼	212	1975	800	Pot., Corn	.5	24	8.1	8/22
Buckholtz,N.	"	"	29	NE¼	134	1977	1000	Pot., Corn	1.0	22	8.1	8/22
Pollock	"	"	33	SE¼	168	1977	800	Pot., Corn	1.3	13	8.1	8/22
Norman, E.	"	"	35	SE¼	64	1974	800	Pot., Corn	.6	17	7.9	8/22
Shores	"	"	27	NW¼	119	1977	800	Pot., Corn	1.1	23	7.9	8/22
Korst, W.	"	"	23	NE¼	60	1975	800	Pot., Corn	.8	16	8.3	8/22
Fischer	"	"	33	SW¼	166	1977	800	Pot., Corn	Sample lost			8/22
Norman, M.	"	"	35	SW¼	150	1977	600	Pot., Corn	.6	19	8.1	8/22
Blanchard	"	"	24	SW¼	117	1977	800	Pot., Corn	.8	16	8.1	8/22
Vic	"	St. Rives	11	SE¼	90	1976	800	Pot., Corn	1.3	21	8.2	8/22
Johnson	"	Hubbard	28	SW¼	186	1977	800	Pot., Corn	.7	58	8.4	8/22
Normand, W.	"	"	34	SE¼	61	1977	600	Pot., Corn	1.6	24	8.1	8/22

Table 3. Water Sample Analyses at Staples Station 1977.

Date	Location	Sulfur Lbs/A In.	Total Alkalinity Lbs $CaCO_3$/A in.
5/17/77	C. Well	1.5	36
6/9/77	L. Grove	1.8	43
8/8/77	S. Well	.8	41
7/25/77	S. Well	.5	39
7/29/77	S. Well	.5	32
"	S. Well	.6	31

Table 4. Summary of Water Analyses 1977

No.	County	Location	SO_4 S (Lbs/A. in.)	Spec. cond. μmhos @ 25°C)	Total Alkalinity Lbs $CaCO_3$/ Acre-inch	B (ppM)	Ca (ppm)	Mg (ppm)	Cl (ppM)	$NO_3^- + NO_2^-$ Nitrogen (ppM)
1	Wadena	Carlson	.72	82	8.6	.02	25	4.4		
2	Wadena	South	1.04	251	20	.05	32	14		
3	Wadena	Home	.81	148	28	.05	41	23		
4	Kandi-yohi	Buer (1)		412	26					
5	"	Buer (2)		398	27					
6	Meeker	Met (1)	5.3	357	24.3	.02			3.0	< .01
7	Meeker	Met (2)	5.3	343	24.2	.02			3.2	< .01
8	Ramsey	N Co. Line	.6		59.6					

Table 5. Soil pH [1] and N Treatments Identified by Blocks, Staples, Minn. 1976.

Lbs N/A	1	1A	3
	- - - - - - pH - - - - - -		
0	6.3	6.2	6.3
60	6.2	6.2	6.4
120	6.2	6.1	6.2
180	6.0	6.0	6.2

[1] Soils samples August 1976.

Table 6. Soil pH and Treatments Identified by Blocks, Staples, Minn. 1977 [1].

Lbs N/A	1 [1]	1A [1]	2 [1]	2A [1]	3 [1]	3A [1]
	- - - - - - - - - - - - - - - - pH - - - - - - - - - - - - - - - -					
0	6.6	6.7	6.3	6.5	7.0	6.6
60	6.5	6.5	6.3	6.5	6.9	6.7
120	6.5	6.3	6.4	6.2	7.0	6.6
180	6.4	6.2	6.2	6.2	7.0	6.5

[1] Soils Sampled August 1977.

Table 7. Soil pH and Depth of Horizon, Staples, Minn. 1977.

Depth, Inches	pH	P	K
0-3	7.0	71	555
3-6	6.8	38	580
6-9	6.5	40	331
9 12	6.2	20	150

Sampled Fall 1977.

Table 8. P 1/ Soil Test Values from Same P Treatments, Staples, Minn. 1977.

Lbs N/A	1	1A	2	2A	3	3A
0	31	48	27	28	34	34
60	31	34	24	23	32	32
120	35	36	23	24	33	34
180	33	31	23	25	34	32

1/ No P applied 1975 and 1976. 20 # P_2O_5 applied at seeding 1975. Sampled August 1977.

Table 9. K 1/ Soil Test Values from Same K Treatments, Staples, Minn. 1977.

Lbs N/Ac	1	1A	2	2A	3	3A
0	467	488	418	484	326	358
60	431	472	346	361	324	324
120	397	477	396	393	352	316
180	435	368	378	401	325	299

1/ Sampled August 1977

K_2O Applied: 1977 - 510 Lbs/A
1966 - 600 Lbs/A
1975 - 500 Lbs/A

SOUTHERN EXPERIMENT STATION - WASECA
WEATHER DATA - 1977

Month	Period	Precipitation 1977	Precipitation Normal	Avg. Air Temp. 1977	Avg. Air Temp. Normal	Growing Degree Days 1977	Growing Degree Days Normal
		inches		°F			
January	1-31	.49	.73	-2.2	12.9		
February	1-28	1.06	.96	21.0	17.5		
March	1-31	4.37	1.94	36.6	28.5		
April	1-30	3.46	2.48	52.2	45.6		
May	1-10	.79		58.9		112.5	
	11-20	2.40		70.7		205.0	
	21-31	2.77		69.7		213.5	
	Total	5.96	3.86	66.6	57.7	531.0	323
June	1-10	.31		65.6		156.5	
	11-20	2.72		66.2		162.5	
	21-30	1.25		70.1		197.0	
	Total	4.28	4.75	67.4	67.1	516.0	521
July	1-10	.78		72.7		222.5	
	11-20	1.04		75.0		236.5	
	21-31	2.43		69.2		211.5	
	Total	4.25	4.02	72.4	71.4	670.5	637
August	1-10	.35		67.4		175.0	
	11-20	1.31		61.4		123.5	
	21-31	1.95		65.2		169.0	
	Total	3.61	3.60	64.6	69.7	467.5	583
September	1-30	6.15	3.45	61.0	60.3	363.0	310
October	1-31	4.34	1.89	45.8	50.3		44
November	1-30	1.53	1.25	31.1	32.9		
December	1-31	1.66	1.02	13.6	19.0		
Year	Jan-Dec	41.16	29.95	44.2	44.4	2553.0	2418
Growing Season	May-Sept	24.25	19.68	65.3	65.3	2548.0	2374

Notes:

1) Highest temp. on July 6 - 94°

2) Highest 24-hour precipitation on Sept. 24 - 2.66"

3) Frost on October 2

4) Third highest yearly rainfall on record

USE OF TERRAZOLE AS A NITRIFICATION INHIBITOR IN FALL VS. SPRING NITROGEN APPLICATION PROGRAMS FOR CORN PRODUCTION IN SOUTHERN MINNESOTA

G. L. Malzer and G. W. Randall

The use of nitrification inhibitors on the heavy wet soils of southern Minnesota has gained considerable attention over the last several years. There are several chemicals known which are capable of delaying the rate of nitrification but there is only one currently on the market (N-Serve-Dow Chemical, U.S.A.). An experimental chemical Terrazole (Olin Corporation) has shown nitrificide characteristics and was evaluated under field conditions at the Southern Experiment Station at Waseca, MN in 1977. The objectives of the trial were to evaluate not only rate of nitrogen application but also timing of application with emphasis being placed upon fall vs. spring application with and without the use of Terrazole.

Experimental Procedures

Thirteen treatments including a control, two rates of nitrogen (75 and 150 # N/A) and three times of application (2 Fall -- Oct. 1 and Nov. 1 of 1976 and 1 spring -- April 28, 1977) were combined with and without Terrazole (0.5 # a.i/A) with all combinations of the nitrogen treatments. Nitrogen was applied as broadcast and incorporated applications of urea with Terrazole added as a coating onto the urea prior to application. All treatments were replicated five times and arranged in a randomized complete block design. Corn (Pioneer 3709) was planted into the experimental area in early May in 30" rows and at a seeding rate of approximately 24,000 seeds/A.

Leaf samples were collected from opposite and below the ear at silking, dried, and kjeldahl nitrogen determined. Dry matter production was determined by harvesting 15' of row from each plot at physiological maturity separating the sample into ears and stover and subsamples collected for moisture determination and Kjeldahl nitrogen analysis for calculation of nitrogen removal. Corn grain yields were collected by hand harvesting two 20' rows from each plot and collecting subsamples for moisture determination and Kjedahl nitrogen (protein) content. Soil samples were also collected from the surface 0-1 ft. depth from all treatments receiving 150 # N/A at approximately two week interval after the application of the nitrogen and samples analyzed for ammonium and nitrate nitrogen. Soil samples were obtained to a depth of five feet at approximately month intervals from the same plots to monitor nitrate movement and accumulation in the soil profile.

Results

Nitrogen content of the 6th leaf was significantly increased with increasing rates of nitrogen although grain yields and total nitrogen removal with the grain was not influenced with nitrogen rates over 75 # N/A. Nitrogen removal with the grain was significantly reduced with the second fall nitrogen application as compared to the early fall treatment or the spring application. The exact cause for this is unknown but may be related to the soil physical conditions at the time of application. Use of Terrazole had no significant influence on nitrogen utilization or grain and dry matter yields.

Nitrogen content of the grain and stover portions of the total dry matter production was significantly increased with nitrogen rate although only the stover nitrogen removal and total nitrogen removal was significantly increased. The second fall application again resulted in a depressed nitrogen content of the grain as compared to the other two dates of application. Terrazole had no influence on nitrogen content or total nitrogen utilization by the corn crop.

In general very few responses (yield as nitrogen utilization) were found above the first application rate of nitrogen indicating that nitrogen was not a major factor in limiting production under the conditions experienced in this study in 1977. A positive response to a nitrification inhibitor would probably not be anticipated under these conditions.

Table 1. Influence of date and rate of nitrogen application and the use of Terrazole as a nitrification inhibitor on Leaf N content, corn grain yield, nitrogen removal and dry matter production--Waseca, MN 1977.

Treatment			6th Leaf	Corn Grain		Silage Dry Matter		
Date of Appl.	N Rate	Terrazole	N	Yield	N Removal	Grain	Stover	Total
	#/A	0.5 #ai/A	%	bu/A	#/A	--------T/A----------		
Control	-	-	2.51	154.5	106	3.74	3.94	7.68
Oct. 1	75	No	2.71	153.2	114	3.87	4.75	8.62
Oct. 1	75	Yes	2.65	158.1	116	3.95	4.95	8.90
Oct. 1	150	No	2.76	151.2	116	3.98	4.47	8.45
Oct. 1	150	Yes	2.79	150.4	116	3.92	5.01	8.93
Nov. 1	75	No	2.67	144.1	102	3.88	4.80	8.68
Nov. 1	75	Yes	2.71	152.3	109	4.25	4.91	9.16
Nov. 1	150	No	2.74	146.2	112	3.60	4.53	8.12
Nov. 1	150	Yes	2.87	142.5	105	4.03	4.60	8.63
April 28	75	No	2.64	150.7	111	4.02	4.88	8.90
April 28	75	Yes	2.57	148.9	113	3.67	4.66	8.33
April 28	150	No	2.71	151.3	115	4.16	4.98	9.14
April 28	150	Yes	2.78	154.9	115	4.13	4.96	9.09
Signif.			*	NS	*	NS	+	NS
B.L.S.D. (.05)			.21		12.1		.68	
Factorial Arrangement								
Date of Appl.								
Oct. 1			2.73	153.2	115	3.93	4.80	8.73
Nov. 1			2.74	146.3	107	3.94	4.71	8.65
April 28			2.67	151.4	114	4.00	4.97	8.86
Signif.			NS	NS	**	NS	NS	NS
B.L.S.D. (.05)					5			
N Rate - #/A								
75			2.66	151.2	111	3.94	4.83	8.76
150			2.77	149.4	113	3.97	4.76	8.73
Signif.			**	NS	NS	NS	NS	NS
B.L.S.D. (.05)			.09					
Terrazole 0.5 # a.i/A								
No			2.70	149.4	112	3.92	4.73	8.65
Yes			2.73	151.2	112	3.99	4.85	8.84
Signif.			NS	NS	NS	NS	NS	NS
B.L.S.D. (.05)								

Table 2. Influence of date and rate of nitrogen application and the use of Terrazole as a nitrification inhibitor on dry matter nitrogen content and total nitrogen removal--Waseca, MN 1977.

Treatment			Dry Matter Production				
			N Content		N Removal		
Date of Appl.	N Rate	Terrazole	Grain	Stover	Grain	Stover	Total
	#/A	a.s #ai/A	------%-------		----------#/A----------		
Control	-	-	1.46	.63	109	50	159
Oct. 1	75	No	1.57	.73	122	70	192
Oct. 1	75	Yes	1.55	.73	122	73	195
Oct. 1	150	No	1.62	.86	129	76	205
Oct. 1	150	Yes	1.63	.86	128	86	214
Nov. 1	75	No	1.50	.74	116	72	188
Nov. 1	75	Yes	1.51	.70	128	69	197
Nov. 1	150	No	1.62	.94	116	85	201
Nov. 1	150	Yes	1.56	.78	126	73	199
April 28	75	No	1.56	.80	125	79	204
April 28	75	Yes	1.60	.77	117	72	189
April 28	150	No	1.60	.82	133	81	215
April 28	150	Yes	1.57	.84	130	83	213
Signif.			**	**	NS	**	*
B.L.S.D. (.05)			.06	.12		18	34
Factorial Arrangement							
Date of Appl.							
Oct. 1			1.59	.80	125	76	202
Nov. 1			1.55	.79	122	75	196
April 28			1.58	.81	126	79	205
Signif.			*	NS	NS	NS	NS
B.L.S.D. (.05)			.03				
N Rate - #/A							
75			1.55	.75	122	72	194
150			1.60	.85	127	81	208
Signif.			**	**	NS	*	*
B.L.S.D. (.05)			.02	.04		6	11
Terrazole							
No			1.58	.82	124	77	201
Yes			1.57	.78	125	76	201
Signif.			NS	NS	NS	NS	NS
B.L.S.D. (.05)							

ROTATION NITROGEN STUDY

Waseca, 1975-1977

Gyles 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 corn following corn, soybeans, wheat and wheat interseeded with alfalfa in a crop sequence study.

EXPERIMENTAL PROCEDURES

The 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. In the fall of 1974, rates of N (0, 40, 80, 120, 160 and 200 lb N/A) were applied broadcast as urea and plowed down immediately. Nitrogen rates were applied similarily in the fall of 1975. For the 1977 corn crop, N was applied as anhydrous ammonia in the spring. Wheat annually received 50 lb N/A as urea before planting. Broadcast P and K (0 + 50 + 100 lb P_2O_5 and K_2O/A) was applied annually to all plots. Row P and K (0 + 30 + 45 lb P_2O_5 and K_2O/A) was applied to the corn.

Corn was planted in 30" rows at 26,100 ppA in early May each year. The hybrid was Pioneer 3780 in 1975 and 1976 and Pioneer 3709 in 1977. Era wheat and Hodgson soybeans were planted in late April and in mid-May, respectively, each year. A non-winter hardy alfalfa was planted with the wheat in 1974 and 1975. Beginning in 1976 Agate was the alfalfa variety used.

Each year weeds were chemically controlled along with one cultivation of the corn. A combination of 3 qt Lasso plus 2½ lb Bladex/A was applied preemergence each year for corn. Soybeans received 3 qt Lasso plus 5 qt Amiben/A applied preemergence. Broadleaf weeds in the wheat were controlled with ¼ lb MCPA plus ¼ lb Bromoxynil/A. Wheat + alfalfa received no herbicide.

All corn plots regardless of the preceding crop received a band-applied insecticide at planting. The insecticide rotation included Furadan at 1 lb/A in 1974 and 1976 and Counter at 1 lb/A in 1975 and 1977.

Leaf samples were taken at silking from rows 2 and 5 of each six-row plot while rows 3 and 4 were mechanically harvested for yield. Grain moisture and protein data were obtained on the harvested samples.

Soil NO_3-N analyses were conducted on samples taken in increments of 1' to a depth of 5' each fall. The treatments sampled included all 0 and 160 lb N rates for corn plus random samples from the soybeans, wheat and wheat + alfalfa areas.

All plots were moldboard plowed in early November each year.

RESULTS

Corn yields with varying rates of N following the four previous crops are shown in Table 1. Yields in 1975 were somewhat low due to the dry conditions from July thru October. However, corn yields following corn in 1974 were about 25 to 35 bu/A lower than corn following soybeans, wheat or wheat + alfalfa. Sporadic response to N was obtained up to the 80-lb N rate.

In 1976, yields were quite low due to the driest year in recorded history (records were begun at Waseca in 1914). About a 55 bu/A advantage was shown for corn following soybeans, wheat or wheat plus alfalfa rather than following corn. This yield advantage remained about the same regardless of N rate.

Yields in 1977 were high and reflected about a 20 to 30 bu/A advantage when following soybeans, wheat or wheat plus alfalfa. This advantage was greater at the lower N rates and somewhat narrower at the 200 lb rate. Yields were optimized with the 80-lb N rate except with continuous corn when 120 lb N/A was needed.

Three-year yield averages (Table 1) over all N rates indicate a 41 bu/A yield advantage for corn following soybeans, 38 following wheat, and 36 following wheat + alfalfa as compared to continuous corn.

SUMMARY

These results indicate significant and economic yield depressions associated with continuous corn as compared to corn following soybeans, wheat or wheat plus alfalfa, regardless of N rate. Leaf and soil NO_3-N analysis (not included in this report) indicate only slight affects of the previous crop. Hence, causative reasons or explanations must lie with factors other than soil fertility.

Table 1. Corn yields following various crops at Waseca in 1975, 1976 and 1977.

N rate		Corn yield following			
		Corn	Soybeans	Wheat	Wheat + Alfalfa
lb N/A		bu/A			
			1975		
0		56.3	84.0	82.7	96.3
40		59.7	110.2	86.1	94.5
80		75.9	98.3	97.8	103.0
120		68.6	101.3	102.7	102.2
160		84.3	124.4	104.9	124.3
200		83.3	111.0	106.3	108.2
	Avg.	71.4	104.9	96.8	104.8
			1976		
0		35.0	86.9	86.5	88.5
40		44.6	99.0	103.2	93.1
80		42.5	107.5	107.2	97.6
120		41.9	102.9	96.2	100.6
160		43.7	104.4	97.0	94.6
200		50.2	104.8	100.6	102.5
	Avg.	43.0	100.9	98.4	96.2
			1977		
0		96.8	145.6	147.3	120.2
40		124.2	158.4	158.6	140.4
80		129.5	165.0	167.0	161.2
120		143.4	168.3	171.6	161.4
160		147.3	174.3	168.3	168.2
200		151.1	171.1	171.2	163.0
	Avg.	132.0	163.8	164.0	152.4
			1975-77 AVG.		
0		62.7	105.5	105.5	101.7
40		76.2	122.5	116.0	109.3
80		82.6	123.6	124.0	120.6
120		84.6	124.2	123.5	121.4
160		91.8	134.4	123.4	129.0
200		94.9	129.0	126.0	124.6
	Avg.	82.1	123.2	119.7	117.8