CONTINUOUS CORN SILAGE

West Central Experiment Station - Morris

S. D. Evans

I. Experimental Description

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

II. 1978 Operations

In 1978 the variety was Trojan TXS99. Counter was applied at 1 lb./acre (active ingredient) at planting on May 18. Lasso @ 2 lbs./acre plus Bladex @ 2.2 lbs./acre were applied broadcast on May 19. Silage yields were taken on September 20 and grain yields on October 7.

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

Treatment	1978 yield	1966-78 yield
Silage, low fertility	6.55	5.47
Silage, high fertility	6.84	5.89
Grain, low fretility	7.26	5.40
Grain, high fertility	6.67	5.70

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

	1978 yield	1966-78 yield
Grain, low fertility	128.28	89.57
Grain, high fertility	116.37	92.36

V. Check Yields

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

	1978 yield	1966-78 yield
Grain (0 + 0 + 0)	84.87 Bu/A	53.75 Bu/A
Silage (0 + 0 + 0)	4.54 tons/A	3.81 Tons/A

VI. Discussion

A. In 1978 the silage yield on the low fertility grain plots was significantly higher (10% level) than the high fertility grain plots and the low fertility silage plots.

B. The 13-year average yields show very little difference between silage and grain plots, but there is still a slight advantage for the higher fertility level.

ECO-GRO STUDIES ON CORN

Lamberton and Morris, 1978

S. D. Evans and W. W. Nelson

The product Eco-Gro is a low analysis liquid fertilizer manufactured mainly from liquid fish and seaweed. It contains 6 lbs. of pure fish per gallon with 4% seaweed added. In addition it is fortified with urea, phosphoric acid, and potassium hydroxide ending up with a product with an 8-4-4 $N-P_2O_5-K_2O$ analysis. It is to be used on corn as a supplement to the standard fertilizer program. Instructions for corn were to make one application of 1 quart per acre as a foliar spray when the corn was 24-30 inches tall and 1 quart per acre 8-10 days before tasseling.

The objectives of the experiments were to measure the effect of the Eco-Gro on corn yield and nutrient uptake and to compare this with conventional fertilizer materials.

Treatment Description - Lamberton

1. Check - No fertilizer material of any kind added.

2. 1 qt/A of Eco-Gro (8-4-4) applied as a foliar spray on July 10 (corn 40-48 in. tall, tassel 12 in. long but still wrapped inside plant) and 1 qt/A of Eco-Gro on August 3 after tasseling--both applied with Wex, a wetting agent. Total plant food = 0.39 + 0.19 + 0.19.

3. 65.6 lbs/A of N as urea prior to planting plus 100 lbs/A of 12-32-18 starter. Total plant food = 77.60 + 32.00 + 18.00.

4. Combination of treatments 2 and 3.
   Total plant food = 77.99 + 32.19 + 18.19.

5. 90.9 gal/A of Eco-Gro applied prior to planting and worked into the soil. Total plant food = 70.39 + 35.20 + 35.20.

Treatment Description - Morris

1. Check - No fertilizer material of any kind added.

2. 1 qt/A of Eco-Gro (8-4-4) applied as a foliar spray when the corn was 30 inches tall (July 3) plus 1 qt/A of Eco-Gro on July 13 (no tassels showing)--both applied with Wex, a wetting agent.
   Total plant food ($N + P_2O_5 + K_2O$) = 0.39 + 0.19 + 0.19.

3. 65.6 lbs/A of N as ammonium nitrate prior to planting plus 150 lbs/A of 10-26-26 starter. Total plant food = 80.60 + 39.00 + 39.00.

4. Combination of treatments 2 and 3.
   Total plant food = 80.99 + 39.19 + 39.19.

5. 90.9 gal/A of Eco-Gro applied prior to planting and worked into the soil. Total plant food = 70.39 + 35.20 + 35.20.

Table 1. Silage and Grain Yields in 1978.

Treatment	Silage Yield (Tons/A)		Grain Yield (Bu/A)	
	Lamberton	Morris	Lamberton	Morris
1. Check	7.42	5.51	137.9	100.7
2. Eco-Gro (foliar)	6.95	5.44	133.3	103.8
3. Conventional	7.14	6.54	136.9	119.0
4. Conventional + Eco-Gro (foliar)	7.51	6.70	130.4	117.5
5. Eco-Gro (Soil)	7.64	6.55	136.2	118.9
Significance	NS	**	NS	**
Bayes LSD (5%)	-	0.54	-	9.8

The yield data for the trials at Lamberton and Morris are given in Table 1. At Lamberton, there were no significant differences (NS) in either silage or grain yields. The grain yield on the check plot at Lamberton was 137.9. The fact that a yield this high was obtained is due to sufficient nitrogen in the soil for maximum yield. This is probably due to two reasons--(1) high levels of nitrate nitrogen built up in the soil with dry years of 1975 and 1976 and (2) the experimental area was cropped to soybeans in 1977 and nitrogen fixation in the soybean root nodules supplied nitrogen to the soybeans. Therefore, the soybeans did not deplete the already high nitrogen reserves.

At Morris the soil nitrogen levels were somewhat lower with a check yield of 100.7 bu/A. (This site was cropped to corn in 1977.) There were highly significant (**) yield differences of both silage and grain. Statistical analysis shows that treatments 1 and 2 are not significantly different and that treatments 3, 4, and 5 are not significantly different. The Eco-Gro foliar treatments, 2 and 4, did not increase yields over treatments 1 and 3, respectively, apparently because the amount of plant food added--0.39 lb/A of N, 0.19 lb/A of P_2O_5 and 0.19 lb/A of K_2O--was so small compared to the actual needs for corn. Treatment 5, where Eco-Gro was applied at a rate to give the approximate plant food needs of corn, yielded the same as the conventional treatment.

Table 2. Economic Return* Based on Corn Grain Yield.

Treatment	Extra Corn over Check (Bu/A)	Value of Corn ($)	Total Fertilizer Cost ($/A)	Plant Food Cost ($/lb)	Return over Check ($/A)
2. Eco-Gro (foliar)					
Lamberton	-4.6	-8.65	12.70	16.49	-21.35
Morris	+3.1	+5.83	12.70	16.49	-6.87
3. Conventional					
Lamberton	-1.0	-1.88	18.75	.15	-20.63
Morris	+18.3	+34.40	20.73	.13	+13.67
4. Conventional + Eco-Gro (foliar)					
Lamberton	-7.5	-14.10	31.45	.24	-45.55
Morris	+16.8	+31.58	33.43	.21	-1.85
5. Eco-Gro (soil)					
Lamberton	-1.7	-3.20	2309.75	16.41	-2312.95
Morris	+18.2	+34.22	2309.75	16.41	-2275.53

* Prices used: Eco-Gro - $25.39/gallon, urea - 17¢/lb of N, ammonium nitrate - 19.5¢/lb of N, 10-26-26 - $127/ton, 12-32-18 - $152/ton, and corn - $1.88/bu.

The economic analyses (Table 2) shows that all treatments at Lamberton resulted in a negative return (or loss) compared to the return from the check. This is due to the fact that the check treatment was the highest yielding and any other treatment not only resulted in a higher cost but also a lower yield.

The results at Morris show that the conventional treatment resulted in the highest return over check (+$13.67/A). In fact, this was the only treatment that did not result in a loss. Treatment 3, where the Eco-Gro was used as a supplemental foliar treatment, resulted in a loss of $1.85/A. Treatment 5, the Eco-Gro soil treatment, resulted in a loss of over $2000/A because of the high cost of the Eco-Gro needed to provide sufficient nutrients for the corn. At both Lamberton and Morris, the lowest plant food cost was with the conventional treatment.

MANURE RATE STUDY

West Central Experiment Station - Morris

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

The experiment initiated in 1972 was continued. Manure was not applied in the fall of 1977 in order to partially compensate for the low nutrient removal in 1976 due to the drouth in 1976 and subsequent low yields. The check and fertilized treatments were continued as in the past. Treatments and results from previous years are given in Soil Series 91, 95, 97, 99, and 103.

I. Planting Information

The plots were planted to Dekalb XL12 on May 10, 1978. Counter @ 10 lbs./acre (1 lb./acre active ingredient) was applied in the row at planting to the entire area. Starter fertilizer consisting of 154 lbs./acre of 10-26-26 was applied to the fertilized treatment. Nitrogen in the form of ammonium nitrate had been applied on November 3, 1977, prior to plowing to provide 110 lbs./acre of N. Lasso (2 lbs./acre) and Bladex (2.2 lbs./acre) were applied broadcast on May 11, 1978.

II. Soil Sampling and Analysis

A. 1977 Measurements

The results of the analyses of the soil samples collected to a depth of 10 feet are given in Tables 1 and 2.

1. $(NO_3 + NO_2)$-N - There are large increases in the top 3 feet of the manure treated plots as compared to the fertilized plots. At the higher rates of manure (SB2, SB3, LB2, and LB3), the increase is seen at progressively lower depths.

2. Chloride - The manure caused increases in chloride in a manner very similar to that with nitrate-nitrogen.

3. Conductivity - Increases are seen to a depth of 3 feet with SB1 and SB2 and to 4 feet with higher rates of manure.

4. Available P - All manure treatments have increased P levels significantly.

5. Extractable K - The manure treatments greatly increased the K levels in the top foot. In the second foot there is an indication of some increase in K, particularly at the highest rate of solid beef manure.

6. Extractable Ca and Mg - There appears to be no effect of treatment on levels of these two elements.

7. Extractable Na - Manure greatly increased the Na levels in the top 3 feet of the soil profile.

8. Extractable Mn - There is a possible increase of Mn in the top 2 feet of the soil profile due to manure application.

B. 1978 Measurements

The soils were sampled to a depth of 10 feet in the fall of 1978 but the results are not yet available.

III. Plant Tissue Analysis

A. 1977 Harvest Samples

1. Stover

All manure treatments were significantly higher than the fertilized treatment in P and K. The heavier manure treatments tended to have higher N and Mn levels and lower Mg and Cu levels than the fertilized treatment.

2. Grain

All the manure treatments except LB1 had significantly higher N levels than the fertilized treatments.

B. 1978 Samples

1. Early whole corn plants (Table 4)

The only hghly significant effect was at Zn levels where SB1 and all levels of liquid beef manure had significantly lower levels than FE.

2. Corn leaves at silking (Table 5)

a. Nitrogen and Potassium - The level in CK was significantly lower than all other treatments.

b. Phosphorus - The levels in FE were significantly lower than in all solid beef treatments and LB2 and LB3 treatments.

c. Calcium - Solid beef manure significantly reduced calcium levels.

d. Magnesium and Zinc - All manure treatments significantly reduced magnesium and zinc levels.

e. Copper - All levels of solid beef manure and the LB3 reduced the copper levels.

f. Manganese - The CK had lower levels than all other treatments.

g. Boron - Treatment SB1 had a significantly lower boron level than CK.

IV. Yield and Plant Measurements (Table 6)

A. Early Plant Height - The two highest levels of each manure were significantly taller than FE.

B. Broken Stalks - Each increase in rate of solid beef manure increased stalk breakage.

C. Ear Moisture - The application of fertilizer or manure tended to result in drier corn.

D. Grain Yield - Treatment SB1 and LB2 were significantly higher yielding than CK and SB2.

E. Silage Dry Matter - The CK treatment had significantly lower dry matter than most other treatments.

Table 1. Effect of two types of beef cattle manure and commercial fertilizer on the (NO_3 + NO_2)-N content, chloride content, and conductivity - fall 1977.

Depth	CK	FE	SB1	SB2	SB3	LB1	LB2	LB3
				(NO_3 + NO_2)-N, ppm				
0-1'	7.7	8.2	83.1	108.6	65.6	13.7	36.5	77.3
1'-2'	6.4	33.0	158.9	246.6	153.0	38.9	112.8	185.0
2'-3'	12.1	82.3	125.1	239.7	227.0	107.9	191.7	204.3
3'-4'	13.5	20.6	27.0	63.3	142.0	35.0	72.7	69.2
4'-5'	8.4	8.6	11.7	17.6	79.2	8.9	18.5	18.4
5'-6'	7.0	7.8	7.5	10.1	38.1	7.4	9.9	12.2
6'-7'	6.2	6.3	7.1	8.1	22.1	7.1	8.1	8.6
7'-8'	6.5	5.2	7.2	6.1	15.3	5.7	6.1	10.0
8'-9'	6.4	4.8	6.1	5.0	12.0	4.8	5.4	7.5
9'-10'	5.4	4.6	5.5	4.2	9.4	4.3	4.7	6.1
				Chloride, ppm				
0-1'	2.0	5.7	26.2	33.0	10.1	5.1	5.8	17.0
1'-2'	5.3	9.3	106.1	136.5	85.1	16.5	23.2	52.1
2'-3'	26.0	35.7	203.4	239.5	208.5	77.4	133.6	136.8
3'-4'	14.9	14.1	32.9	104.4	177.5	33.2	63.1	54.7
4'-5'	6.4	6.6	12.4	23.6	106.6	9.6	17.4	14.6
5'-6'	7.5	6.9	6.1	7.8	58.3	8.9	11.5	9.7
6'-7'	7.4	5.3	7.2	6.3	30.2	8.6	8.9	9.3
7'-8'	8.5	10.0	7.5	4.4	17.1	5.6	9.0	10.6
8'-9'	8.0	4.2	6.9	5.4	14.1	5.2	5.3	7.5
9'-10'	7.2	3.1	6.7	5.8	10.0	4.7	5.1	7.0
				Conductivity, mmhos/cm				
0-1'	.135	.148	.528	.685	.507	.193	.289	.429
1'-2'	.241	.288	.836	1.103	.858	.290	.605	.868
2'-3'	.411	.490	.817	1.024	1.128	.592	.964	1.007
3'-4'	.268	.239	.270	.407	.834	.296	.457	.443

Table 2. Effect of two types of beef cattle manure and commercial fertilizer on the available P content, and extractable K, Ca, Mg, Na, and Mn contents - fall 1977.

Depth	CK	FE	SB1	SB2	SB3	LB1	LB2	LB3
				Available P, ppm				
0-1'	9.9	9.3	66.2	81.3	80.0	31.6	56.0	74.2
				Extractable K, ppm				
0-1'	158	153	544	868	1184	211	288	337
1'-2'	125	101	108	128	181	107	100	115
2'-3'	97	88	84	105	98	97	87	92
3'-4'	92	99	97	104	107	103	94	101
				Extractable Ca, ppm				
0-1'	3378	3863	3357	3619	3391	4134	3891	2981
1'-2'	4783	4782	4881	4041	4479	3919	4570	3980
2'-3'	4189	4194	4273	4586	3845	4399	4143	4266
3'-4'	3983	4007	3959	4219	4441	4056	3871	4048
				Extractable Mg, ppm				
0-1'	780	606	800	798	816	647	852	728
1'-2'	1062	711	895	916	773	676	897	966
2'-3'	1268	986	1119	1110	879	890	1184	1130
3'-4'	1072	1013	868	1108	956	861	1076	1055
				Extractable Na, ppm				
0-1'	8.5	4.6	74.6	100.6	85.8	30.3	48.2	62.9
1'-2'	23.3	11.7	67.6	151.9	128.7	38.7	61.2	93.2
2'-3'	44.7	28.1	36.9	42.4	69.1	33.5	42.2	42.1
3'-4'	45.3	37.0	35.6	41.9	41.3	38.6	47.0	44.8
				Extractable Mn, ppm				
0-1'	3.83	2.78	4.37	7.18	5.30	3.34	2.64	8.58
1'-2'	.68	.54	.83	1.32	1.33	1.01	.45	1.20
2'-3'	.69	.26	.38	.68	.96	.97	.19	.58
3'-4'	.54	.36	.79	.40	.45	.50	.39	.30

Table 3. Summary of analysis of stover and grain samples - 1977.

Treatment	Stover N	P	K	Ca	Mg	Fe	Zn	Cu	Mn	B	Cl	Grain N
	%					ppm						-%-
CK	.82	.06	1.16	.42	.64	194	13.9	6.9	58	10.0	4550	1.37
FE	.89	.06	1.42	.44	.63	186	19.5	6.1	81	7.1	5439	1.44
SB1	.98	.14	2.31	.41	.43	168	9.5	5.5	76	6.0	6694	1.66
SB2	1.13	.24	2.65	.49	.39	205	12.3	4.3	100	8.4	6406	1.73
SB3	1.06	.26	2.65	.45	.29	166	17.3	4.2	101	6.4	6437	1.67
LB1	.87	.08	2.87	.47	.54	387	20.5	6.7	95	6.2	4724	1.58
LB2	1.07	.15	1.99	.62	.48	158	11.8	5.5	125	8.6	4943	1.64
LB3	1.12	.20	2.17	.62	.40	163	17.3	4.9	148	8.3	4783	1.70
Signif.:	*	**	**	+	**	NS	NS	*	**	NS	+	**
BLSD(.05)	.24	.09	.46	-	.12	-	-	2.0	42	-	-	.15

Table 4. Summary of analysis of early corn plant samples - 1978.

Treatment	P	K	Ca	Mg	Fe	Zn	Cu	Mn	B
	%				ppm				
CK	.41	3.79	.59	.46	1280	34.1	7.3	94	4.1
FE	.33	3.52	.63	.41	1599	40.3	7.2	104	4.1
SB1	.49	4.37	.56	.38	1638	30.3	6.6	92	3.3
SB2	.55	4.19	.52	.44	1251	38.1	6.0	83	4.3
SB3	.62	4.78	.41	.31	1536	46.6	6.0	76	4.4
LB1	.36	3.94	.64	.40	1633	29.9	7.3	92	3.6
LB2	.45	4.19	.56	.39	1549	29.9	7.1	96	3.8
LB3	.53	4.27	.50	.35	1596	30.9	5.8	88	3.8
Significance:	NS	NS	+	NS	+	**	+	+	NS
BLSD(.05)	-	-	-	-	-	7.0	-	-	-

Table 5. Summary of analysis of corn leaves at silking - 1978.

Treatment	N	P	K	Ca	Mg	Fe	Zn	Cu	Mn	B
	%					ppm				
CK	2.23	.21	1.84	.60	.45	106	12.5	6.2	55	5.7
FE	3.36	.28	2.24	.64	.46	119	21.2	8.9	87	5.4
SB1	3.15	.47	2.44	.44	.25	112	10.3	5.3	64	3.3
SB2	3.35	.52	2.83	.46	.21	127	14.9	5.1	66	4.4
SB3	3.33	.49	2.85	.40	.19	114	16.4	4.9	60	3.8
LB1	3.10	.33	2.48	.60	.37	121	14.4	8.4	80	4.9
LB2	3.16	.47	2.69	.57	.30	130	12.3	7.1	93	4.4
LB3	3.21	.51	2.98	.55	.27	145	14.1	5.8	87	4.4
Significance:	**	**	**	*	**	NS	**	*	*	*
BLSD(.05)	.64	.16	.52	.15	.08	-	4.6	2.7	28	1.4

Table 6. Summary of plant measurements - 1978.

			Harvest measurements		Grain		Silage		
Trt.	Early plant height inches	Early plants (10) dry wt. grams	Root lodged 30° or more %	Stalks broken below ear %	Ear moisture at harvest %	Yield @ 15.5% M bu/A	Dry matter at harvest %	Silage yield (D.M.) lb/A	Ear wt. ÷ silage wt. %
CH	18.4	41.9	2.4	5.7	31.8	101.4	42.8	12520	55.2
FE	14.0	36.4	1.0	7.2	26.8	110.2	49.3	13582	54.2
SB1	19.8	58.5	0	10.0	21.1	124.2	50.8	14917	56.4
SB2	18.7	50.6	0	24.3	18.3	101.1	50.4	12190	51.6
SB3	22.9	58.2	0	27.6	19.6	119.8	46.0	13514	54.0
LB1	14.2	42.6	0	10.0	23.7	117.8	52.1	12667	56.1
LB2	17.5	53.2	0	7.1	20.7	130.9	54.2	12810	56.2
LB3	21.1	64.2	0	16.7	19.8	120.4	49.9	13612	55.8
Signif.:	*	NS	NS	**	**	*	*	NS	NS
BLSD(.05)	6.0	-	-	7.2	3.1	22.2	5.7	-	-

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

West Central Experiment Station - Morris

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

The experiment initiated in 1970 was continued. Treatments and results in previous years are given in Soil Series 88, 89, 91, 95, 97, 99, and 103. Manure was applied in 1970 and 1971 only. Fertilizer has been applied to the fertilized checks each year.

I. Planting Information

Twenty-four rows of corn (var. Dekalb XL12) were planted in each plot on May 10, 1978. Counter @ 10 lbs./acre (1 lb./acre active ingredient) was applied to the entire area. Starter fertilizer consisting of 154 lbs./acre of 10-26-26 was applied to the fertilized treatment only. Nitrogen in the form of ammonium nitrate was applied to the fertilized plots to provide 110 lbs./acre of N on November 3, 1977. Lasso (2 lbs./acre) and Bladex (2.2 lbs./acre) were applied broadcast on May 11, 1978.

II. Soil Sampling and Analysis

A. 1977 Measurements

The results of the analyses of the soil samples collected to a depth of 4 feet are given in Tables 1 and 2.

1. NO_3-N - The SB and LB treatments continued to have higher levels than FE. The LH treatment has essentially the same levels as FE in the top 3 feet, but higher levels in the 3- to 4-foot zone.

2. Available P - Levels in the manure treated plots are much higher than in FE.

3. Extractable K - Levels in the 0 to 1-foot layer are much higher in the manure treated plots than in FE. Below 1 foot the levels are not different.

4. Extractable Na - The manure treated plots have higher levels of Na at all depths than FE. The total Na in the top 4 feet is essentially equal to that one year earlier.

5. Chloride - Levels of chloride in the top foot of the manure treated plots are equal to those of CK and FE. In the second foot SB and LB still have much higher levels than FE. In the third and fourth foot all manure treatments have higher levels than FE. The total chloride in the top 4 feet has increased in all treatments over levels one year earlier indicating some upward movement of chloride.

6. Electrical conductivity - The manure treated plots have higher EC than FE. There has been an increase in EC in the past year in the 2- to 3-foot zone of all treatments except for CK.

7. Extractable Ca - The levels of Ca are higher than FE in the 0 to 1-foot zone of LB and the 1- to 2-foot zone of SB and LH.

8. Extractable Mg - There are no consistent effects of manure on the Mg levels.

9. Extractable Mn - There are no significant effects of manure on the Mn levels.

10. Soil pH - There are no effects of manure on the pH levels.

B. 1978 Measurements

The soils were sampled to a depth of 16 feet in the fall of 1978 but the results are not yet available.

III. Plant Tissue Analysis

A. 1977 Harvest Samples (Table 3).

1. Stover

All manure treatments were significantly higher than the FE treatment in P and K and significantly lower in Mg and Zn. SB was significantly higher than all other treatments in iron.

2. Grain

The SB treatment was significantly higher in N than CK and LH.

B. 1978 Samples

1. Early whole corn plants (Table 4)

The only significant effect was on iron with LH higher than all other treatments.

2. Corn leaves at silking (Table 5)

All manure treatments were significantly higher than FE in K and significantly lower in Mg. The LB treatment was significantly higher than FE in P. The Ca levels in SB were significantly lower than in FE. The Zn levels in SB and LB were significantly lower than in FE.

IV. Field and Plant Measurements (Table 6)

A. Early plant height and dry weight - The manure treated plots were significantly taller and heavier than CK and FE.

B. Root lodging - The FE treatment had more root lodging than all other treatments.

C. Ear moisture at harvest - The CK treatment was significantly wetter than all other treatments and FE was significantly wetter than SB.

D. Grain yield - The CK treatment was significantly lower yielding than all other treatments, but there was no difference between FE and any manure treatment.

E. Silage dry matter - The CK treatment was lower in dry matter than all other treatments.

F. Silage yield - The CK treatment was lower yielding than all other treatments. There was no significant difference between FE and any manure treatments.

V. Summary

The effects of the manure treatments applied in 1970 and 1971 are still quite apparent in most soil and plant measurements. The soil levels of nutrients are as high or higher than a year earlier. Plant analysis in 1978 still shows large effects of the manure treatments, particularly in the leaves.

In 1978 there were no significant differences in either grain or silage yields between the fertilized treatment and the manure treatments.

Table 1. Effects of high rates of manure and commercial fertilizer seven years (fall 1977) after application on the (NO_3+NO_2)-N, available P, extractable K, and Na, Cl, and electrical conductivity of a Tara soil profile.

Depth	CK	FE	SB	LB	LH
			- NO_3 + NO_2)-N, ppm -		
0-1'	6.3	6.8	13.1	23.3	9.7
1'-2'	5.0	19.2	83.9	101.5	18.2
2'-3'	5.4	97.7	160.7	213.3	113.4
3'-4'	6.9	36.4	93.3	129.0	74.4
			- Available P, ppm -		
0-1'	3.6	25.6	63.0	62.2	59.6
			- Extractable K, ppm -		
0-1'	133	157	558	422	256
1'-2'	108	126	118	125	103
2'-3'	94	92	78	88	99
3'-4'	91	92	84	77	89
			- Extractable Na, ppm -		
0-1'	8.0	15.4	40.8	54.2	26.3
1'-2'	17.0	27.9	108.5	153.7	55.7
2'-3'	27.3	32.3	99.2	127.3	58.3
3'-4'	36.8	40.4	62.8	62.6	38.6
			- Cl^-, ppm -		
0-1'	4.8	5.2	5.4	5.1	3.9
1'-2'	4.4	8.2	46.9	43.5	8.0
2'-3'	6.4	58.9	196.7	173.0	77.6
3'-4'	8.1	31.7	147.0	124.3	59.7
			- Electrical conductivity, mmhos/cm -		
0-1'	.171	.104	.214	.250	.147
1'-2'	.183	.264	.556	.642	.250
2'-3'	.203	.598	.984	1.094	.664
3'-4'	.191	.332	.623	.729	.458

Table 2. Effects of high rates of manure and commercial fertilizer seven years (fall 1977) after application on the extractables Ca, Mg, and Mn levels and pH of a Tara soil profile.

Depth	CK	FE	SB	LB	LH
		- Extractable Ca, ppm -			
0-1'	4457	3115	3195	3743	2972
1'-2'	3902	4220	4738	4195	4606
2'-3'	4115	4370	4296	4369	4489
3'-4'	4040	4263	3949	3817	4143
		- Extractable Mg, ppm -			
0-1'	644	727	646	659	591
1'-2'	780	839	628	789	582
2'-3'	894	805	745	839	800
3'-4'	906	772	839	721	787
		- Extractable Mn, ppm -			
0-1'	2.03	3.32	2.73	2.91	3.15
1'-2'	.58	.55	.41	.48	.32
2'-3'	.15	.16	.18	.23	.26
3'-4'	.19	.23	.23	.22	.14
		- pH -			
0-1'	7.5	7.0	7.3	7.2	7.3

Table 3. Summary of analysis of stover and grain samples - 1977.

Treatment	Stover											Grain
	N	P	K	Ca	Mg	Fe	Zn	Cu	Mn	B	Cl	N
	%					ppm						-%-
CK	.88	.07	1.38	.49	.60	237	14.7	6.8	64	6.8	3693	1.25
FE	.97	.09	1.55	.47	.57	217	19.5	6.7	66	7.0	4609	1.69
SB	1.02	.23	2.55	.38	.35	389	9.6	5.5	75	6.2	3362	1.80
LB	1.01	.36	2.77	.43	.32	281	9.0	4.3	68	6.2	3715	1.56
LH	.87	.12	2.11	.41	.38	215	12.4	4.7	61	6.3	3811	1.37
Signif.:	NS	**	**	NS	**	**	+	+	NS	NS	NS	*
BLSD(.05)	-	.15	.36	-	.10	62	-	-	-	-	-	.38

Table 4. Summary of analysis of early corn plant samples - 1978.

Treatment	P	K	Ca	Mg	Fe	Zn	Cu	Mn	B
	%				ppm				
CK	.34	3.07	.66	.48	1165	32.7	7.2	86	5.7
FE	.37	3.24	.61	.44	1381	37.5	6.8	87	4.9
SB	.47	3.91	.54	.39	1306	33.0	6.9	82	4.8
LB	.55	4.21	.49	.34	1284	40.8	5.9	70	5.4
LH	.41	3.75	.54	.31	1650	44.4	6.1	80	5.3
Significance:	NS	NS	NS	NS	+	NS	NS	NS	NS
BLSD(.05)	-	-	-	-	-	-	-	-	-

Table 5. Summary of analysis of corn leaves at silking - 1978.

	N	P	K	Ca	Mg	Fe	Zn	Cu	Mn	B
	%					ppm				
CK	1.85	.17	1.66	.63	.49	87	11.4	5.6	54	5.3
FE	3.26	.30	1.99	.54	.44	113	21.9	7.3	71	4.5
SB	3.02	.39	2.51	.41	.20	106	12.9	5.7	56	3.7
LB	3.11	.48	2.76	.50	.22	131	16.3	5.7	62	4.1
LH	2.82	.33	2.48	.53	.25	113	18.4	6.4	55	4.5
Significance:	**	**	**	*	**	*	**	NS	NS	NS
BLSD(.05)	1.04	.06	.39	.11	.09	23	3.2	-	-	-

Table 6. Summary of plant measurements - 1978.

			Harvest measurements		Grain		Silage		
Trt.	Early plant height inches	Early plants (10) dry wt. grams	Root lodged 30° or more %	Stalks broken below ear %	Ear moisture at harvest %	Yield @ 15.5% M. bu/A	Dry matter at harvest %	Silage yield (D.M.) lb/A	Ear wt. ÷ silage wt. %
CK	12.2	15.0	0	1.4	32.5	79.7	41.9	9968	50.3
FE	14.7	40.2	2.9	5.5	26.0	111.2	47.6	14200	51.5
SB	19.9	59.3	0	7.6	18.5	119.6	52.4	14148	56.6
LB	22.2	68.1	0	12.9	20.3	117.5	49.1	14716	54.3
LH	19.2	54.7	0	5.2	22.9	119.7	51.5	13958	60.2
Signif:	**	**	**	+	**	**	*	**	+
BLSD(.05)	3.4	10.9	1.0	-	5.5	14.8	6.1	1175	-

Influence of Nitrogen on Forage Production Nitrogen Utilization by Three Small Grain Varities

G.L. Malzer and S. Evans

The semi-dwarf varieties of hard red spring wheat account for the major portion of acreage in Minnesota planted to hard red wheat. The advent of these short stemmed wheat varieties not only provided improved physical characteristics and a high yield potential, but also provided a plant system which was capable of responding to higher application rates of nitrogen without lodging. The reason why some semi-dwarf wheat varieties appear to be more responsive to nitrogen application is not well understood but it has been suggested that it may be an inter-relationship of a highly efficient rooting system along with its above ground physical characteristics An experiment was established to investigate the root growth characteristics of different hard red spring wheat varieties as influenced by nitrogen application and to access if below ground parameters could be used in the selection of small grain varieties for efficient nitrogen utilization.

Experimental Procedures

Six treatments including three hard red spring wheat varieties were combined with two nitrogen treatments into a randomized complete block design with three replications and plots established at the West Central Experiment Station at Morris. The three wheat varieties included Chris (medium height), Era (semi-dwarf) and MN 7125 (Experimental semi-dwarf). The nitrogen treatments included either zero or 120 #N/A as ammonium nitrate.

Dry matter production was determined at three different times during plant growth and analyzed for nutrient composition. Grain was harvested on August 9 by hand harvesting known areas from each plot. Soil samples were obtained at the four samplings above (June 13, June 28, July 11, and August 9) for determination of rooting density, soil moisture and soil nitrate nitrogen. Root samples were obtained utilizing a coring technique. For root analysis samples were collected over the row and between the row to a depth of four feet. Each core (2 5/8" diameter) was divided into eight 6" increments and each sample consisted of a composite of two cores. The root samples at this time are in the process of being analyzed. Soil samples for moisture and nitrate analysis were taken in a similar manner by obtaining one core in the immediate area from which the roots samples were obtained.

General Results

Preliminary nitrate soil tests indicated a very low nitrate nitrogen content in the 0-2' depth. Appreciable quantities of nitrate nitrogen were present in the 2-4' depth in 1978. Significant dry matter production increases were obtained due to nitrogen application with both Chris and Era wheat with the first two samplings while MN 7125 was increased only at the second sampling. No significant (.10) dry matter response was obtained with nitrogen rate or variety at the third sampling. Nitrogen removal with the forage (both concentration and total removal) was significantly influenced by both nitrogen rate as well as variety at all three forage harvests. The nitrogen content of the forage was increased due to nitrogen application at all three harvest dates but was increased only with the first sampling with MN 7125 and only on the first and third

sampling with Chris. Total nitrogen removal with each sampling was the same at all three harvest when no nitrogen was applied. At the first sampling Chris had taken up more nitrogen than MN 7125 when fertilizer was applied. No differences were obtained with total nitrogen removal between varieties within nitrogen treatments. All varieties reflected significant responses in uptake to applied nitrogen at the first sampling; however MN 7125 showed no response past the first sampling date and Chris was not significant at the third harvest. Grain yields at harvest and total nitrogen removal with the grain at harvest were not influenced by either variety or nitrogen treatment

Table 1. Forage Yield, Forage N Content, Total Forage Nitrogen Removal and Yield Grain Characteristics of Three Small Grain Varieties as Influenced by Nitrogen Treatment.

Treatment		Forage Yield Harvest No.			Forage N Content Harvest No.		
Variety	N Rate	1	2	3	1	2	3
	#/A	---------T/A----------			----------%----------		
Chris	0	.52	1.44	2.48	3.16	2.24	1.57
Chris	120	.80	1.97	2.88	4.01	2.68	1.94
Era	0	.49	1.46	2.02	3.23	2.48	1.58
Era	120	.70	1.74	2.72	4.07	3.03	2.04
MN 7125	0	.59	1.39	2.68	2.82	2.35	1.57
MN 7125	120	.63	1.74	2.97	4.07	2.61	1.80
Significance		**	*	NS	**	*	*
BLSD(.05)		.13	.32		.30	.47	.33

		Forage N Removal			Wheat Grain Yield	Wheat Grain Test Wt	Wheat Grain N Content	Wheat Grain N Removal
		--------#/A----------			bu/A	#/bu	%	%/A
Chris	0	32.9	64.7	77.2	32.3	58.0	3.20	61.9
Chris	120	63.9	105.1	111.6	24.2	53.3	3.34	48.5
Era	0	31.6	73.3	65.1	32.0	53.2	2.96	56.5
Era	120	56.7	105.6	111.2	28.9	49.3	3.25	56.4
MN 7125	0	32.5	65.5	85.0	36.2	51.6	2.67	57.8
MN 7125	120	51.6	90.8	106.9	34.0	50.2	2.86	58.4
Significance		**	*	*	NS	*	**	NS
BLSD(.05)		8.0	26.2	37.1		5.1	.27	

PESTICIDE INTERACTION PLOTS AT ROSEMOUNT

Russell S. Adams, Jr.

The experiment studying the effects of combinations of the insecticide Furadan, the herbicide atrazine and soil pH was continued for the sixth and final year in 1978. Treatments included five residual lime treatments, Furadan at 0, 1/2 and 2 lb./A, atrazine at 0, 2, 4, and 8 lbs/A, and their combinations. Each treatment was replicated four times. The plots have been managed so as to maximize both weed and corn root worm infestation.

Data are summarized in Tables 1 and 2. Average yields for the six year period ranged from 69 to 104 bu/A. From Table 2 one can surmise that weed control accounted for about a 25 bu/A increase, corn root worm control about a 4 bu/A increase, improved soil pH a 6 bu/A increase. No interaction effects are evident in corn yields.

In terms of weed control Furadan demonstrated a significant reduction in weed growth. Weed growth varied inversely and proportionately to the amount of atrazine used, with no interaction effect between Furadan and atrazine evident. The 8 lb/A atrazine rate accomplished only 90% control of weeds. The reader needs be reminded that the plots were managed to maximize weed growth so that this degree of control is by no means typical. However, the data emphasize that to attempt 100% control is impractical.

Lodging was never a severe problem in this field, on the average affecting only about one-third of the stand. However, corn root worm control reduced lodging by nearly 50%. No effect of atrazine on corn root worm control could be observed nor was an interaction effect of atrazine and Furadan detectible. Lodging was substantially greater under higher pH conditions. Poorer control of root worms under these conditions has been confirmed.

Higher soil pH produced a very significant reduction in weed growth across all treatments. This was due primarily to the fact that atrazine is much more effective under these conditions.

Table 2. Effect of insecticide, herbicide and soil pH across all treatments.

Rate of Chemical lbs/A	Lodging %	Weeds t/A	Yield ~~b~~ μ/A
Furadan			
0	35	1.23	87
1/2	26	1.08	92
2	19	0.90	92
Atrazine			
0	28	2.55	79
2	28	1.08	91
4	25	0.64	95
8	27	0.27	96
Soil pH			
~5.4	24	1.30	86
~6.3	24	1.29	89
~6.7	27	1.07	92
~6.8	27	1.01	90
~7.2	32	0.76	94

Table 1. The amount of lodging, weed growth, and corn yields in Atrazine-Furadan-pH studies at Rosemount, 6 year average

Rate of Furadan and Lime Status		No Atrazine			2 lbs/A Atrazine			4lbs/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	36	2.78	69	35	1.58	83	38	0.72	86	34	0.48	87
	1/2	16	2.68	76	21	0.78	91	22	0.82	86	20	0.30	96
	2	15	2.34	81	23	0.92	91	10	1.00	90	20	0.20	97
Moderate lime-slightly acid (~pH 6.3)													
Furadan	0 lbs/A	28	3.24	76	30	1.62	84	29	0.44	95	44	0.26	94
	1/2	38	2.94	77	24	1.42	90	24	0.84	103	24	0.38	93
	2	20	2.34	81	10	1.30	86	13	0.66	97	16	0.56	94
Well limed, near neutral (~pH 6.8)													
Furadan	0 lbs/A	34	2.34	74	35	1.38	84	32	0.42	91	30	0.18	100
	1/2	31	1.94	73	24	1.23	91	24	0.92	98	32	0.18	98
	2	17	1.92	80	24	0.96	98	18	0.46	97	18	0.22	98
Heavily limed, slightly alkaline (~pH 7.2)													
Furadan	0 lbs/A	41	2.64	73	40	0.76	90	36	0.34	92	37	0.08	93
	1/2	30	2.02	87	29	0.74	96	28	0.28	104	29	0.10	98
	2	30	1.64	92	31	0.10	97	20	0.32	104	27	0.08	103

ALFALFA AND RED CLOVER POTASSIUM TRIALS

Staples, Minnesota - 1978

C. J. Overdahl, Melvin Wiens, R. Schoper and J. Lensing

Alfalfa and red clover trials at Staples were first extablished in July, 1970. At that time experiments were established using varying amounts of phosphorus, sulfur, lime and potassium. Soil tests were high for sulfur and phosphorus and after 1974 these trials were discontinued; no responses had been obtained. The lime trial was also discontinued at that time because lime in the irrigation water had raised the pH of all plots above 7. In the last 2 years pH in the trial area is above 7.6.

After 1974 only the potassium trials on alfalfa and red clover are continued. The red clover had to be reseeded in 1974 and no red clover yields were obtained that year. In 1977 both alfalfa and red clover areas were plowed and reseeded. The main purpose was to have the higher yielding anchor alfalfa and Arlington red clover in the comparisons.

Yield and soil test results

The objective of the alfalfa-red clover comparisons is to measure the approximate economic differences of these crops on soils where considerable potash is needed.

Potassium soil tests were below expectations through 1976, even with annual treatments of 240 pounds of K_2O per acre. Table 1 shows a K test as low as 128 pounds of exchangeable K in 1976 where 2 treatments of 120 pounds of K_2O had been added annually since 1970. There the 120 pounds treatment was increased to 180 and the 240 pound treatment was increased to 360 for the 1978 crop. Soil tests taken in the fall of 1978 show an increase in the test levels up to 287 pounds of K from a 360 pound treatment.

Alfalfa responded significantly to potash with the 360 pound treatment resulting in yields only slightly higher than the 180 pound treatment in spite of the much greater difference in soil test K.

Red clover did not significantly respond to potash even with a K soil test as low as 58. Red clover yielded nearly as well as alfalfa in 1978 and produced approximately a ton more per acre on the no-potash plot than did the alfalfa.

There has been no real difference in yield between October or June application.

Yields of over 5 tons of alfalfa have been measured on the no-potash treated plots (1974 & 1975), while the 0 to 6 inch soil sample is very low, i.e., between 40 and 60 pounds of exchangeable K. Subsoil samples taken in 1974 show K tests of 50 at 1 to 2 feet and 20 at 2 to 3 feet deep indicating that subsoil K source cannot explain the good alfalfa yields on the check plots. In 1978, however, the no-potash plots yielded approximately 2 tons per acre and shows K deficiency symptoms.

Plant analysis

Generally October treated plots show more K in leaves at the first cut since the June application goes on just after the first cutting. On the other hand

K levels are higher for the third cut from June application than from the October treatment (Table 2).

The critical level of 2.5% K described in some research reports would indicate that many of the samples before 1978 were below this level. In 1978 only a few of the 180 pound treated plots were below this level and none from the plots receiving 360 pounds of K_2O. The check plots for both alfalfa and red clover were considerably below this level in most samples for all the years of the trial.

Table 1a. Potassium treatments effect on red clover and alfalfa yields and soil tests.

	Annual treatments of K_2O in lbs/A and time of application						
	None	June 240	Oct. 240	June 120	Oct. 120	June 120 Oct. 120	Significance
			Yields Tons/Acre at 15% Moisture				
Alfalfa							
1972	3.4	3.6	3.8	3.5	3.4	3.6	ns
1973	4.0a	4.8bc	4.6bc	4.6bc	4.3ab	4.8c	5%
1974	5.1a	6.5b	6.4b	6.4b	6.3b	6.5b	5%
1975	5.1a	6.4bc	6.6.c	6.1b	6.2b	6.4bc	1%
1976	4.5a	6.2c	6.1c	5.8b	5.6b	5.7b	1%
Red Clover							
1972	4.2	5.0	4.5	4.7	4.7	4.7	ns
1973	3.3	3.6	3.3	3.4	3.6	3.7	ns
1974*	-	-	-	-	-	-	
1975	5.0a	6.0b	5.8b	5.8b	5.6b	6.0b	5%
1976*	2.8a	3.2b	3.3b	3.2b	3.1b	3.2b	5%

	Soil Test K lbs/A						
	None	June 240	Oct. 240	June 120	Oct. 120	June 120+ Oct. 120	1978
Alfalfa							
1972	92	258	322	160	165	185	Avg. pH=7.6
1973	85	290	210	150	140	195	
1974	60	175	240	95	75	200	Avg. P Alf=47
1975	48	178	160	75	63	135	R.C.=72
1976	40	210	145	68	68	128	
1978**	54	287	216	123	91	212	
Red Clover							
1972	107	262	230	182	167	162	
1973	90	290	240	160	190	310	
1974*	135	180	200	150	155	180	
1975	60	180	83	108	60	115	
1978**	58	300	170	138	86	210	

*red clover failed in 1974, was reseeded August 1, 1974
**crops reseeded in 1977 to Anchor alfalfa and Arlington red clover. No yields or soil samples taken in 1977. Treatments of K_2O in 1978 were increased to from 120 to 180 pounds of K_2O per acre and the 240 pound treatment was increased to 360.

Table 1b. Potassium treatment effect on red clover and alfalfa yields in 1978.

	K_2O in lb/A annually and time of application							
Cutting	None	June 360	Oct. 360	June 180	Oct. 180	June 180 + Oct. 180	Significance	
Alfalfa								BLSD
1	.38	1.31	1.22	1.05	1.05	1.22	**	.20
2	.71	1.19	1.20	1.08	1.12	1.14	**	.14
3	.88	1.31	1.39	1.28	1.25	1.37	**	.12
Total	1.97	3.81	3.81	3.41	3.42	3.73	**	.32
Red Clover								
1	.96	1.40	.95	.87	1.12	1.06	ns	-
2	.97	1.19	1.21	1.20	1.20	1.19	**	.12
3	1.02	1.27	1.20	1.26	1.17	1.21	ns	-
Total	2.95	2.86	3.36	3.33	3.49	3.46	ns	-

Table 2. Potassium (%) in alfalfa and red clover tops.

	Plant Analysis %K						
		K_2O treatments					
	None	June 240	Oct. 240	June 120	Oct. 120	June 120 Oct. 120	Significance
Alfalfa							
1972-1st cut	2.05	2.76	2.98	2.20	2.74	2.65	
2nd cut	2.00	2.50	2.46	2.27	1.92	2.34	
3rd cut	2.52	3.44	3.08	2.94	2.85	3.18	
1973-1st cut	1.74a	2.74b	2.88b	2.40b	2.45b	2.47b	5%
2nd cut	1.58	2.76b	2.76b	2.48b	2.39b	2.65b	1%
3rd cut	1.64a	2.60b	2.57b	2.45b	2.17b	2.56b	5%
1974-1st cut	1.37	3.08	3.59	2.17	2.32	3.21	
2nd cut	1.29	2.40	2.85	2.25	1.89	2.60	
3rd cut	1.11	2.18	2.48	2.08	1.62	2.46	
1975-1st cut	1.24a	2.19c	2.67d	1.67b	2.15c	2.31c	1%
2nd cut	1.39a	2.74c	2.49bc	2.27b	1.93a	2.67c	1%
3rd cut	1.23a	2.60c	2.85c	2.15b	1.72a	2.56bc	1%
1976-1st cut	1.24a	3.66f	3.26de	1.55b	2.38c	2.99d	5%
2nd cut	1.45a	2.98d	2.83d	2.68c	2.02b	2.90d	5%
3rd cut	1.49a	2.78cd	2.86d	2.26b	2.03b	2.68c	5%
1977-None							
Red Clover							
1972-1st cut	2.14	3.05	2.83	3.02	2.61	3.04	
2nd cut	2.20	2.86	2.60	2.51	2.21	2.44	
3rd cut	2.65	3.54	2.98	3.32	2.87	2.98	
1973-1st cut	1.76a	2.63b	2.65b	2.56b	2.42b	2.66b	5%
2nd cut	2.03a	2.84c	2.97c	2.65bc	2.48b	2.92c	1%
3rd cut	1.81a	3.00d	2.53c	2.40c	2.10b	2.66c	1%
1974-None							
1975-1st cut	1.55a	2.59d	2.33cd	2.01bc	1.87ab	2.45d	1%
2nd cut	1.69a	3.00c	2.18b	2.80c	2.05b	2.89c	1%
3rd cut	1.78a	3.12d	2.37b	2.68c	2.25b	2.87c	1%
1976-1st cut	1.43	2.96	3.18	2.08	2.47	2.80	5%
2nd cut	1.70a	3.09c	2.67b	2.66b	2.47b	3.05c	5%
1977-None							

Where letters differ, the values are significantly different. (5%)

Table 2 a. Plant Analysis %K (1978)

	K_2O treatments and dates of application							
	None	June 360	Oct. 360	June 180	Oct. 180	June 180 Oct 180	Significance	BLSD 5%
Alfalfa								
1st cut	1.51	2.66	2.83	2.33	2.48	2.71	**	.15
2nd cut	1.52	2.74	2.77	2.37	2.30	2.81	**	.14
3rd cut	1.58	2.96	2.86	2.56	2.33	2.81	**	.12
Red Clover								
1st cut	1.64	3.11	2.74	2.40	2.49	2.86	**	.44
2nd cut	1.63	3.12	2.72	2.77	2.50	3.02	**	.15
3rd cut	1.60	3.21	2.74	2.82	2.39	2.94	**	.26

Sufficiency levels for alfalfa 2.5%

Barley Fertilization Trials
Under Irrigation at Staples in 1978

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Mike O'Leary, Peter Groves, Mel Wiens.

Agricultural production on the sandy soils of central Minnesota has expanded in recent years due largely to the development of irrigation. Although corn, potatoes, alfalfa, and some vegetable crops are grown under irrigation, there is wide interest in the production of small grains. Considerable work has been done on the production of wheat under irrigation, but there is an increased interest in producing barley if satisfactory yields and acceptable quality can be obtained for malting. Three separate experiments were initiated to determine the importance of nitrogen fertilization on the production of malting barley under irrigation at Staples, Minnesota on a sandy loam soil in 1978.

Soil tests of the area taken prior to fertilization indicated an extractable phosphorus test of 78 lbs per acre, an exchangeable potassium test of 88 lbs per acre with a soil pH of 6.6. All experimental areas received 60 lbs K_2O/A and 10 lbs S/A as gypsum broadcast preplant and incorporated. 20 lbs P_2O_5/A was applied with the seed at planting time. Weeds were controlled with ¼ lb/A of bromoxynil + ¼ lb/A MCPA applied prior to 4 leaf stage.

A. Variety x Nitrogen Rate Trial

This trial was designed to evaluate the performance of a semi-dwarf and two tall varieties of malting barley with various nitrogen rates applied as split applications under irrigation. A split plot design replicated four times with varieties as main plots and nitrogen rates as subplots were used. Varieties included were Manker, Morex and an experimental semi-dwarf, M-32. The nitrogen rates used were 0, 45, 90, and 135 lbs nitrogen per acre applied as ammonium nitrate with 2/3 of nitrogen applied as preplant incorporated and 1/3 applied at tillering stage prior to an irrigation.

There was a significant varietal difference in yield potential, test weight, percent plump and percent protein in seed. (Table 1) Nitrogen increased yields significantly up to 90 lbs nitrogen per acre with significant increase in percent protein to 135 lbs nitrogen per acre. Nitrogen significantly decreased plumpness of the kernals and the test wt of the barley was significantly reduced with 135 lbs of nitrogen per acre. Malting grade barley (percent protein less than 13.5% and plump kernals greater than 65%) was produced with nitrogen rates to 45 lbs. nitrogen per acre.

The nitrogen content of the M-32 forage was significantly higher than the other varieties (Table 2). Nitrogen content and removal were significantly increased with nitrogen rates.

Table 1. Effect of variety and N rate on yield, test weight, % plumpness, and % protein of barley grain at Staples, MN in 1978.

Treatment	Yield	Test Weight	Plumpness	Protein
Variety	Bu/A	lbs/bu	%	%
Manker	60.8	45.7	56.0	13.25
Morex	59.3	44.1	63.2	13.81
M-32	64.6	42.4	64.1	12.63
Signif.	*	*	**	**
BLSD(.05)	4.3	1.8	3.1	.31
N RATE				
0 #N/A	40.6	45.3	72.5	11.38
45 #N/A	62.7	45.1	65.8	11.81
90 #N/A	73.5	44.2	56.7	14.19
135 #N/A	69.6	41.6	49.3	15.63
Signif.	**	**	**	**
BLSD(.05)	3.4	1.3	3.2	.44
Interaction				
Manker x 0#N/A	39.2	46.9	65.8	11.06
Manker x 45 "	61.0	46.8	60.2	11.63
Manker x 90 "	74.0	45.5	52.4	14.44
Manker x 135 "	69.0	43.7	45.6	15.94
Morex x 0 "	39.9	45.0	75.0	11.75
Morex x 45 "	63.1	44.6	69.7	12.19
Morex x 90 "	68.0	44.5	57.7	14.88
Morex x 135 "	66.1	42.1	50.5	16.44
M-32 x 0 "	42.6	44.0	76.6	11.38
M-32 x 45 "	63.9	43.9	67.6	11.50
M-32 x 90 "	78.4	42.7	60.1	13.19
M-32 x 135 "	73.6	39.1	51.9	14.50
Signif.	NS	NS	NS	NS
C.V.	7.6	3.8	7.0	4.7

Table 2. Effect of variety and N rate on dry matter yield; % N in tissue, and total N removal of barley forage at Staples, MN in 1978.

Treatment	Yield	N Content	N Removal
Variety	Tons/A	%	lbs/A
Manker	2.99	1.19	74.5
Morex	2.91	1.24	76.1
M-32	2.72	1.38	78.8
Signif.	NS	**	NS
BLSD(.05)	-	.07	-
N Rate			
0 #N/A	1.67	.98	32.6
45 #N/A	2.86	1.04	59.5
90 #N/A	3.37	1.43	96.3
135#N/A	3.59	1.64	117.4
Signif.	**	**	**
BLSD(.05)	.24	.10	10.0
Interaction			
Manker x 0 #N/A	1.65	.97	31.8
Manker x 45 #N/A	2.87	1.01	58.2
Manker x 90 #N/A	3.65	1.35	98.7
Manker x 135 #N/A	3.80	1.44	109.4
Morex x 0 #N/A	1.66	.95	31.4
Morex x 45 #N/A	3.01	1.01	60.6
Morex x 90 #N/A	3.22	1.34	85.8
Morex x 135 #N/A	3.75	1.68	126.6
M-32 x 0 #N/A	1.69	1.02	34.7
M-32 x 45 #N/A	2.73	1.09	59.8
M-32 x 90 #N/A	3.23	1.62	104.5
M-32 x 135 #N/A	3.23	1.80	116.2
Signif.	NS	NS	NS
C.V.	11.3	10.1	17.8

B. Time of Application Trial

This trial was designed to evaluate various application schemes of nitrogen on the production of malting barley under irrigation. A randomized complete block design with four replications of five treatments was used. Nitrogen was applied at various times at a rate of 90 lbs nitrogen per acre as ammonium nitrate.

Treatment Code	Treatments	
A	0 Nitrogen	
B	90 #N/A - preplant	
C	60 #N/A - preplant;	30 #N/A - tillering stage
D	60 #N/A - preplant;	30 #N/A - early boot stage
E	40 #N/A - preplant;	30 #N/A - tillering stage 20 #N/A - early boot stage

The application of nitrogen significantly increased the yield and percent protein of the grain (Table 3). 90#N/A applied preplant and 90#N/A applied at 2/3 preplant and 1/3 early boot dignificantly decreased yields compared to the other application schemes. The three time application scheme produced significantly higher protein content.

Forage yield, percent N content, and nitrogen removal were significantly increased with nitrogen (Table 4). Two time application schemes percent nitrogen were lower than the other application schemes percent nitrogen. Three times of application scheme had significantly higher percent nitrogen than 90#N/A applied preplant.

C. Density x Nitrogen Rate x Potassium Rate

This trial was designed to evaluate the affects of seeding rate, nitrogen rate, and potassium rate on yield and quality of malting barley under irrigation. Treatments were set out in a factorial arrangement (2 x 2 x 2) replicated four times in a randomized complete block design. Seeding rates of 96 and 144 #/A, nitrogen rates of 90 and 135 #/A, and K_2O rates of 60 and 260 #/A were used. Nitrogen was applied as ammonium nitrate with 2/3 applied preplant incorporated and 1/3 applied at tillering stage. Potassium was applied preplant incorporated.

Nitrogen significantly increased grain yield and protein (Table 5). No significant difference was obtained due to density or potassium rates, however the interaction of density with potassium showed a significant decrease in yield at high density and high potassium rates.

Table 3. Effect of time of nitrogen application on Manker barley yield, test weight, percent plumpness and percent protein at Staples, MN in 1978.

Treatment Code	Yield Bu/A	Test Wt. #/bu	Plumpness %	Protein %
A	36.2	48.3	64.2	10.56
B	69.8	45.6	54.3	12.41
C	76.5	45.9	53.5	12.63
D	70.6	47.1	59.5	11.63
E	76.7	46.2	57.0	13.25
Signif.	**	NS	*	**
BLSD(.05)	4.9	-	6.2	1.00
C.V.	5.3	3.5	6.7	5.7

Table 4. Effect of time of nitrogen application on Manker barley dry matter yield, percent N, and total N removal of forage at soft dough stage at Staples, MN in 1978.

Treatment Code	Yield T/A	N Content %	N Removal #/A
A	1.68	.74	24.5
B	3.30	1.07	70.5
C	3.80	.98	76.9
D	3.42	.92	63.9
E	3.38	1.18	79.7
Signif.	**	**	**
BLSD(.05)	.76	.12	22.8
C.V.	16.2	8.6	24.1

Table 5. Effect of seeding rate, nitrogen rate and potassium rate on yield, grain protein, test weight, and percent plump of Manker Barley at Staples, 1978.

Treatment			Yield	Grain Protein	Test Weight	Plump
Seeding Rate			Bu/A	%	lbs/bu	%
96 #/A			77.1	14.6	44.1	51.4
144 #/A			75.0	14.8	45.5	53.1
Significance			NS	NS	NS	NS
N-Rate						
90 #/A			73.2	14.1	45.6	54.2
135 #/A			78.9	15.3	44.0	50.3
Significance			**	**	NS	NS
BLSD (.05)			3.8	.6	-	-
K_2O Rate						
60 #/A			76.4	14.7	44.9	54.3
260 #/A			75.7	14.7	44.6	50.2
Significance			NS	NS	NS	NS
Interaction						
Seeding Rate	#N/A	#K_2O/A				
96	90	60	71.1	13.8	44.7	55.0
96	90	260	77.1	14.2	43.9	51.6
96	135	60	78.8	15.1	44.3	53.0
96	135	260	81.2	15.3	43.4	46.0
144	90	60	73.8	14.5	46.2	57.4
144	90	260	70.8	13.8	47.5	52.9
144	135	60	81.8	15.4	44.5	51.8
144	135	260	73.7	15.4	43.7	50.4
Significance			NS	NS	NS	NS
C.V., %			5.8	6.7	11.4	5.8

Influence of Nitrogen Rate, Timing of Application and Use of Nitrification Inhibitors on Irrigated Corn at Staples.

J. Coffman, G.L. Malzer, J.N. Lensing and T. Graff

Nitrogen management on irrigated sands has been one of the grower's chief concerns for best utilization of nitrogen. To minimize losses of nitrogen due to leaching, nitrogen is usually applied in split applications either through irrigation water or sidedressed during the growing season. Concerns exist as to whether nitrification inhibitors can stop leaching losses of nitrate nitrogen. Can nitrogen be applied once with a nitrification inhibitor thereby eliminating the need for split applications? What effect on yield will they have? The objectives of this experiment are to investigate the influence of nitrogen application on yield and nitrogen utilization of corn under irrigation. Also to determine the impact of nitrification inhibitors on nitrogen management under irrigation.

Experimental Procedures

Nine treatments were replicated four times and combined in a randomized complete block design. The treatments were established on a Sverdrup sandy loam at the CMDIR station at Staples, Minn. Potassium (200 # K_2O/A) and sulfur (25 #S/A as $CaSO_4$) were broadcast and disked in prior to planting. The treatments included a check, two nitrogen rates (80 and 160 # N/A as urea), two methods of application and two nitrification inhibitors (N-Serve-Dow Chemical, Terrazole-Olin Corporation). Nitrogen treatments were applied in either one single preplant application or in multiple applications during the growing season. Split applications of nitrogen were applied on May 5 (preplant), June 13 (12" height), June 27 (36" height), and July 13 (prior to silking) in a ratio of 1/6, 1/6, 3/6, and 1/6 respectively.

Nitrification inhibitor treatments were applied with the single nitrogen application treatments as coatings onto the urea (0.5 #a.i./A) for both N-Serve and Terrazole. The preplant nitrogen applications were broadcast over the plot area and immediately incorporated by disking. An adapted corn variety (Pioneer 3978 - 85 day R.M.) was hand planted on May 5 in 30" rows at a population of 26,000 seeds/A. Good weed control was obtained with a tank mix of Atrazine and Sutan. The experimental area received a total of 29.72 inches of water from rainfall and irrigation during the growing season.

Leaf samples from opposite and below the ear at silking were collected on July 27, dried and analyzed for Kjeldahl nitrogen. Dry matter production and nitrogen utilization were determined by harvesting one row 15 ft. long from each plot on September 14 (Physiological maturity). Ears were separated from the stalks, field weights obtained and samples removed for moisture determination and nitrogen analysis. Yields were obtained October 10 by harvesting two rows 20' long. Field weights were obtained and samples collected for moisture and nitrogen concentration. Corn grain yields were adjusted to 15.5% moisture.

General Results

Corn grain yields in 1978 ranged from 121 to 180 bu/A (Table 1). Nitrogen responses up to 80 #N/A were obtained. No additional yield increases were obtained with the 160 #N/A rate. Splitting the applications at both the 80 and 160 #N/A rate resulted in no significant increase in yield. The nitrification inhibitors had no effect on yield. Nitrogen concentration in corn grain showed increases up to the 160 #N/A rate. Split applications of nitrogen increased the nitrogen content in corn grain at the 80 #N/A rate. Terrazole increased the percent nitrogen in corn grain at the 80 #N/A rate but not at the 160 #N/A rate. N-Serve had no effect on the percent nitrogen in corn grain at either rate. Nitrogen concentration in leaf samples increased with nitrogen rates up to 80 #/A. Splitting of the nitrogen applications and use of nitrification inhibitors at both rates showed no increases in percent nitrogen in the leaf. Nitrogen removal in corn grain increased up to 80 #N/A with splitting of the nitrogen applications being more effective than the single application. Terrazole with the 80 #N/A rate in a single application was as effective as the split nitrogen application.

Total corn dry matter production was increased up to the 80 #N/A rate of application (Table 2). Splitting of the nitrogen applications and use of nitrification inhibitors resulted in no influence in total corn dry matter production.

Nitrogen content and nitrogen removal of the corn stover showed increases up to the 160 #N/A rate (Table 3). Splitting the nitrogen applications and nitrification inhibitor treatments had no influence in percent nitrogen in stover. Split applications did show increases in nitrogen content in grain and nitrogen removal in grain at the rate of 80 #N/A. N-Serve and Terrazole showed increases in nitrogen content in the grain and N-Serve increased nitrogen removal at the 80 #N/A rate of application. The nitrification inhibitors did not show any increase in nitrogen content or nitrogen removal of the grain at the rate of 160 #N/A.

Table 1. Influence of Nitrogen Rate, Timing of Nitrogen Application, and Nitrification Inhibitors on Leaf Nitrogen Concentration, grain yield and Nitrogen Utilization of Corn.

Treatments			Leaf N	Corn Grain		
N Rate	No. of Appl.	Inhibitor		Yield	N	N Removal
#/A			%	bu/A	%	#/A
0	-	0	2.04	120.9	1.09	62.4
80	1	0	3.07	163.3	1.26	97.4
80	1	N-S	2.96	167.6	1.30	103.4
80	1	Terr.	2.99	171.8	1.41	115.1
80	4	0	3.29	178.3	1.36	114.6
160	1	0	3.20	163.7	1.35	104.2
160	1	N-S	3.19	179.5	1.38	116.8
160	1	Terr.	3.24	172.9	1.40	114.2
160	4	0	3.43	171.2	1.28	104.0
Signif.			**	**	**	**
BLSD(.05)			.29	19.2	.06	14.1
C.V.			6.9	8.1	3.7	9.9

Table 2. Influence of Nitrogen Rate, Timing of Nitrogen, Application and Nitrification Inhibitors on the Stover and Grain Components of Corn at Physiological Maturity.

Treatments			Corn Dry Matter		
N Rate	No. of Appl.	Inhibitor	Stover	Grain	Total
#/A			-T/A-		
0	-	0	2.53	2.40	4.93
80	1	0	3.27	3.45	6.72
80	1	N-S	3.13	3.64	6.77
80	1	Terr.	3.35	3.54	6.89
80	4	0	3.41	3.73	7.14
160	1	0	3.60	3.61	7.21
160	1	N-S	3.26	3.21	6.47
160	1	Terr.	3.49	3.76	7.25
160	4	0	3.54	3.63	7.17
Signif.			**	**	**
BLSD(.05)			.34	.33	.51
C.V.			7.3	7.0	5.6

Table 3. Influence of Nitrogen Rate, Timing of Nitrogen Application, and Nitrification Inhibitors in Nitrogen Utilization of Corn at Physiological Maturity.

Treatments			Corn Forage				
N Rate	No. of Appl.	Inhibitor	N Content		N Removal		
			Stover	Grain	Stover	Grain	Total
#/A			-------%-------		--------#/A---------		
0	-	0	.78	1.14	39.2	54.7	93.9
80	1	0	.87	1.27	56.5	87.3	143.8
80	1	N-S	1.13	1.46	71.4	105.6	177.0
80	1	Terr.	1.05	1.37	70.0	96.6	166.6
80	4	0	1.07	1.36	73.0	101.1	174.1
160	1	0	1.16	1.34	83.5	97.0	180.5
160	1	N-S	1.07	1.40	70.1	89.9	160.0
160	1	Terr.	1.11	1.41	77.2	106.2	183.4
160	4	0	1.23	1.36	85.3	99.6	184.9
Signif.			+	**	**	**	**
BLSD(.05)			.28	.10	18.3	11.5	23.1
C.V.			17.8	5.4	17.8	9.1	10.3

N Rate Studies of Dryland and Irrigated Wheat and Oats With and Without Legume Underseeding, Staples 1978

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

1978 was the fourth crop year of studies investigating the effect of N rates on oat and wheat yields under intensive irrigation. A dryland study evaluating N rates initiated in 1977 was continued in 1978.

The study evaluating the effect of red clover as an underseeding and as a plowdown crop prior to seeding of grain was continued.

Stout oats, Era wheat, and Lakeland red clover were the varieties used in the study. The experiment consists of a randomized complete block design with four replications and four N rates. Urea was the N source. N rates were 0, 40, 80, and 120 for oats and 0, 60, 120, and 180 for wheat.

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 urea was incorporated by harrowing prior to seeding and by irrigation following seeding. Desired seeding rate was 120 pounds for oats, 96 pounds for wheat, and 16 pounds per acre for red clover.

Plots were moldboard plowed on April 12, harrowed twice and packed prior to seeding. The crops were planted on April 14.

Oats were harvested July 21 and the wheat harvested on August 11.

Table 1. Wheat Grain Yield as Influenced by N Rates, Staples 1978 (Chemical weed control, intensive irrigation).

Lbs N/A	Bu/A	Test wt Lbs/Bu	% N in Grain	Lbs N Removed
0	13.6	57.8	2.64	21.4
60	35.4	56.6	2.51	53.2
120	37.5	54.6	2.85	63.8
180	35.6	53.3	3.18	67.9
Signif.	**			*
BLSD (.05)	3.3	N.S.	N.S.	6.9

Table 2. Wheat Grain Yield as Influenced by N Rates, Staples 1978 (Following plowdown of Red Clover, intensive irrigation, and chemical weed control).

Lbs N/A	Bu/A	Lbs/Bu	% N in Grain	Lbs N Removed
0	30.8	56.4	2.51	46.4
60	34.1	54.4	2.73	56.1
120	34.9	54.7	2.98	62.4
180	37.1	55.6	3.10	68.9
Signif. BLSD (.05)	N.S.	N.S.	N.S.	N.S.

Table 3. Wheat Grain Yield as Influenced by N Rates, Staples 1978 (Red Clover underseeding, intensive irrigation).

Lbs N/A	Bu/A	Lbs/Bu	% N in Grain	Lbs N Removed
0	25.8	55.9	2.60	40.4
60	24.0	54.1	3.01	43.2
120	24.1	53.0	3.28	47.3
180	22.3	53.0	3.28	43.5
Signif.	N.S.	N.S.	**	N.S.
BLSD (.05)			.29	

Table 4. Wheat Grain Yield as Influenced by N Rates, Staples 1978 (Dryland, chemical weed control).

Lbs N/A	Bu/A	Lbs/Bu	% N in Grain	Lbs N Removed
0	11.5	60.2	2.60	17.9
60	23.9	59.3	2.68	38.4
120	24.2	57.4	3.13	45.6
180	21.2	56.8	3.18	40.2
Signif.	**	**	**	**
BLSD (.05)	4.3	.6	.17	6.6
C.V.	13.8	1.0	3.9	12.3

Table 5. Oat Grain Yields as Influenced by N Rates, Staples 1978 (Chemical weed control, intensive irrigation).

Lbs N/A	Bu/A	Lbs/Bu	% N in Grain	Lbs N Removed
0	38.4	33.8	2.06	25.4
40	77.0	30.7	2.07	51.0
80	100.0	31.2	2.43	77.8
120	101.8	29.4	2.34	76.3
Signif.	**	*	**	**
BLSD (.05)	6.2	2.8	.16	3.7
C.V.	5.3	5.4	5.9	4.4

Table 6. Oat Grain Yields as Influenced by N Rates, Staples 1978 (Red Clover underseeding, intensive irrigation).

Lbs N/A	Bu/A	Lbs/Bu	% N in Grain	Lbs N Removed
0	84.5	30.5	2.04	55.2
40	88.2	29.4	2.24	63.1
80	86.5	29.1	2.36	65.3
120	80.5	28.2	2.52	65.0
Signif.	N.S.	**	**	**
BLSD (.05)		1.1	.22	5.5
C.V.	4.3	2.1	5.9	5.4

Table 7. Oat Grain Yields as Influenced by N Rates, Staples 1978 (Chemical weed control, dryland).

Lbs N/A	Bu/A	Lbs/Bu	% N in Grain	Lbs N Removed
0	31.9	34.0	2.60	19.3
40	54.0	33.5	2.68	39.5
80	50.4	33.0	3.13	40.0
120	61.2	32.3	3.18	48.0
Signif.	**	N.S.	**	**
BLSD (.05)	8.9		.16	6.6
C.V.	11.9	2.4	4.8	11.9

Summary: Wheat yields and test weight were reduced by disease, primarily scab. Oat yields were to a much lesser extent but appeared to lower test weight, particularly with the irrigated oats.

Table 8. Wheat Grain Yields, Bu/A, Staples Station, 1975-1978.

	Irrigated												Dryland			
	Chemical Weed Control				Red Clover Underseeding				Plow Down of Red Clover							
N, Lbs/A	0	60	120	180	0	60	120	180	0	60	120	180	0	60	120	180
1975 1/	7	18	21	24	5	13	16	17								
1976	24	53	66	68	53	58	55	57	59	70	69	67				
1977	27	47	65	69	51	50	52	41	53	58	58	59	9	17	22	20
1978	14	35	38	36	26	24	24	22	31	34	35	37	12	24	24	21

1/ N rates 0, 40, 60, and 120 Lbs/A in 1975 only.
Late spring, excessive high temperatures May and June

Table 9. Oat Grain Yields, Bu/A, Staples Station, 1975-1978.

	Irrigated								Dryland			
	Chemical Weed Control				Red Clover Underseeding							
N, Lbs/A	0	40	80	120	0	40	80	120	0	40	80	120
1975	24	36	41	35	24	45	52	41				
1976	54	84	101	111	86	88	90	93				
1977	45	90	106	114	84	101	110	101	32	63	60	62
1978	38	77	100	102	84	88	86	80	32	54	50	61

Table 10. Nutrient Removal in Dryland Oat Grain and Straw, Staples Station, 1977.

Lbs N/A Applied	Lbs/A Straw	N	P_2O_5	K_2O	Bu/A Grain	N	P_2O_5	K_2O	Total nutrients removed in grain and straw, Lbs/A N	P_2O_5	K_2O
0	1037	3	12.4	26.8	32	22	18.2	6.9	25	30.6	33.7
40	1981	6	9.8	51.7	63	48	36.2	13.8	54	46.0	65.5
80	2114	11	5.6	55.5	60	50	34.3	17.9	61	39.9	73.4
120	2032	12	5.3	55.1	62	52	34.5	18.7	64	39.8	73.8
Signif.	*	**	NS	*	**	**	**	**			
C.V.	25.6	33	65.1	28.5	7.6	21.3	7.0	11.6			

Table 11. Nutrient Removal in Dryland Wheat Grain and Straw, Staples Station, 1977.

Lbs N/A Applied	Lbs/A Straw	N	P_2O_5	K_2O	Bu/A Grain	N	P_2O_5	K_2O	Total nutrients removed in grain and straw, Lbs/A N	P_2O_5	K_2O
0	400	2.2	1.5	8.0	9.4	14	6.1	3.3	16.2	7.6	11.3
60	1100	7.5	3.9	26.6	16.9	28	10.9	6.1	35.5	14.8	44.0
120	1100	10.4	3.4	31.2	21.6	40	14.1	7.8	50.4	17.5	39.0
180	1420	14.3	3.6	35.6	19.6	38	13.0	7.3	52.3	16.6	42.9
Signif.		**	*		**	**		**			
C.V.		33.0	24.1		13.8	15.4		14.0			

Table 12. Nutrient Removal in Irrigated Oat Grain and Straw, Staples Station 1977.

Lbs N/A Applied	Lbs/A Straw	N	P_2O_5	K_2O	Bu/A Grain	N	P_2O_5	K_2O	Total nutrients removed in grain and straw, Lbs/A N	P_2O_5	K_2O
0	1242	7.2	8.0	31.4	45	35	13.0	6.9	42	21.0	38.3
40	2480	12.1	7.8	71.6	90	58	24.2	13.8	70	32.0	85.4
80	3097	22.8	6.9	74.8	106	97	29.7	17.9	120	36.6	92.7
120	3400	26.1	7.13	115.4	114	112	33.1	18.7	138	40.2	134.1
Signif.	**	**	N.S.	**		**	**	**			
C.V.	4.1	23.6	23.6	16.9		10.7	7.0	11.6			

Table 13. Nutrient Removal in Irrigated Wheat Grain and Oats, Staples Station 1977.

Lbs N/A Applied	Lbs/A Straw	N	P_2O_5	K_2O	Bu/A Grain	N	P_2O_5	K_2O	Total nutrients removed in grain and straw, Lbs/A N	P_2O_5	K_2O
0	1726	7.2	7.4	30.1	29	35	12.4	8.7	42.2	19.8	38.8
60	3387	12.1	8.1	75.6	47	58	21.6	14.1	70.1	29.7	89.7
120	4831	22.8	7.3	153.4	65	97	25.8	18.1	119.8	33.1	171.5
180	4079	26.1	7.8	130.2	69	112	31.7	20.7	138.1	39.5	150.9
Signif.	**	**	N.S.	**	**	**	**	**			
C.V.	17.8	23.6	26.2	18.5	10.3	10.7	24.4	13.4			

Water Quality Studies

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

Water quality studies were continued in 1978 to gain a greater insight as to dissolved minerals in irrigation water.

Experimental plots on the Staples Station were intensively sampled to determine the effect of dissolved minerals in the irrigation water on soil pH.

Table 1. Soil pH of Blocks 1 and 2 Cropped to Wheat and Oats 1975-1978, Staples Station.

Treatment	1975 1/	1976 2/	1977 2/	1978 2/
1	5.9	6.3	6.7	6.7
2	5.9	6.2	6.5	6.5
3	5.9	6.1	6.4	6.3
4	5.8	6.0	6.3	6.2

1/ April sampling
2/ August sampling

Treatments:
1 - no nitrogen
2 - 50 lbs N/A/yr
3 - 100 lbs N/A/yr
4 - 150 lbs N/A/yr

Table 2. Soil pH of the Soil Profile under Blocks 1, 2, 2A, and 3A. Staples Station (Sampled in August 1975).

Depth, In.	1	2	2A	3A
3-6	5.5	5.8	5.7	5.8
6-9	5.4	5.7	5.7	6.0
9-12	5.7	5.7	5.7	6.2
12-18	5.5	5.4	5.6	6.5
18-24	5.7	5.5	5.7	6.4
24-36	5.8	5.7	5.9	6.3
36-48	6.0	7.2	7.6	6.4

Table 3. Irrigation Water Application 1975-1978 and Total Calcium Carbonate Equivalent.

Year	Inches	Lbs $CaCO_3$ eq/A/yr
1975	13.5	470
1976	24.1	796
1977	15.8	706
1978	13.3	617
Total	66.7	2589

Table 4. Calcium Carbonate Equivalent of Dissolved Minerals in Irrigation Water, Staples Station Expressed as mg $CaCO_3$ eq/l (Center Well).

1975	1976	1977	1978
164	175	238	236
148	136	238	222
132	172	200	178
155	113	224	173
182	149	228	264
157	133	174	194
141		140	176
		136	198
		180	
Average: 154	146	198	205

Table 5. Analyses of Water Samples of the Three Pumping Wells at Staples Station Used for Plot Work, 1978.

		Lbs/A in water	
Sampling date	Well	S	$CaCO_3$ eq
5/2	North	.4	59
	South	.2	48
	South	.2	50
5/15	Center	.7	50
5/24	Center	.5	61
	North	.4	59
	South	.4	50
6/14	North	.6	58
7/7	Center	.6	56
	North	.6	62
7/10	South	.4	53
8/7	South	.3	50
Average		.44	55

Water samples were taken on 16 farms in the area in 1978 from sources as creeks, ponds, pits, and wells. The average $CaCO_3$ eq per acre with water was 43. The range was 8 to 80. Only 3 samples were below 20 and only 1 was above 60.

SOUTHERN EXPERIMENT STATION - WASECA
WEATHER DATA - 1978

Month	Period	Precipitation 1978	Precipitation Normal	Avg. Air Temp. 1978	Avg. Air Temp. Normal	Growing Degree Days 1978	Growing Degree Days Normal
		inches		°F			
January	1-31	1.14	.73	2.8	12.9		
February	1-28	.45	.96	7.0	17.5		
March	1-31	.84	1.94	24.8	28.5		
April	1-30	3.82	2.48	44.6	45.6		
May	1-10	.86		48.8		48.0	
	11-20	.59		60.6		123.0	
	21-31	3.95		67.8		193.5	
	Total	5.40	3.86	59.1	57.7	364.5	323
June	1-10	.24		61.2		127.0	
	11-20	2.71		68.8		184.0	
	21-30	0.43		69.6		196.5	
	Total	3.38	4.75	66.5	67.1	507.5	521
July	1-10	1.27		70.5		201.5	
	11-20	0.54		71.2		210.0	
	21-31	2.19		66.2		179.0	
	Total	4.00	4.02	69.3	71.4	590.5	637
August	1-10	1.07		65.4		161.0	
	11-20	1.00		70.8		205.5	
	21-31	0.72		69.6		214.0	
	Total	2.79	3.60	68.6	69.7	580.5	583
September	1-30	3.97	3.45	65.8	60.3	489.0	310
October	1-31	.59	1.89	47.0	50.3	40.0	44
November	1-30	2.95	1.25	29.8	32.9		
December	1-31	1.55	1.02	10.7	19.0		
Year	Jan-Dec	30.88	29.95	41.4	44.4	2572.0	2418
Growing Season	May-Sept	19.54	19.68	65.9	65.3	2532.0	2374

Notes:

1) Highest temp. on September 8 - 97°

2) Highest 24-hour precipitation on September 13 - 2.60"

3) Frost on October 8

4) Maximum air temps ranged between 86 and 97° from September 3-12

POSTEMERGENCE APPLICATION OF UAN (28% N) TO CORN

Waseca, 1978

G. W. Randall

Urea-ammonium nitrate (UAN) solutions are rapidly gaining acceptability in Minnesota as a source of nitrogen fertilizer. One of the common uses of UAN is to combine herbicides with the N solution and to apply both in one application, commonly called "weed and feed". Another possible usage for UAN is a late postemergence treatment in areas where N has been lost by denitrification or leaching. Sometimes this late treatment is placed over the top of corn or banded as a substitute for sidedressing anhydrous ammonia. The purpose of this study was to increase the efficiency of N fertilizer applied as UAN to corn by determining the:

1) maximum rate of UAN applied postemergence to corn without significant plant damage and/or yield loss.

2) optimum stage of corn growth or method of application for greatest N efficiency.

3) possible synergistic effect of UAN and atrazine on corn production.

EXPERIMENTAL PROCEDURES

A randomized complete-block experiment with 20 treatments (Table 1) and five replications was continued again in 1978 on a Webster clay loam at the Southern Experiment Station. Broadcast P and K (0+80+120 N+P_2O_5+K_2O/A) was applied to corn stalks and plowed down in October 1977. Supplemental N as ammonium nitrate was added to each plot to bring the total N amount to 150 lb N/A (except trt 3 which received 200 lb N/A). The ammonium nitrate was broadcast and disked in before planting.

Corn (Pioneer 3709) was planted in 30-inch rows at 26,100 ppa on May 16. Starter fertilizer (140 lb/A of 0-23-30) and insecticide (1 lb Furadan/A) were used. Weeds were chemically controlled with Lasso plus Bladex (3 + 2½ lb/A).

UAN was applied over the top of the corn with a calibrated bicycle sprayer at the 4-leaf (June 7) and 8-leaf (June 22) stages. Weather conditions were cloudy and moderately warm (73°F) on the 7th and partly cloudy and warm (77°F) on the 22nd. A light shower (0.07") fell within 24 hours after the 8-leaf stage treatments were applied. Atrazine was mixed with the UAN and applied at the rate of 2 lb/A at the 4-leaf stage (trts 18, 19 & 20). At the 12-leaf stage premeasured amounts of UAN were sidedress-applied by hand (July 10). No cultivation followed the sidedress application.

Early plant growth as affected by the application at the 4- and 8-leaf stages was determined on 10 plants from the border rows of each plot on June 22 and July 11. All other data were obtained from the center two rows of each four-row plot.

Results

Topdress applications to emerged corn at the 4-leaf stage did affect the vigor and growth about the same as in 1977. However, the severe visual symptoms (necrosis) did not occur as rapidly. The cloudy conditions at application perhaps accounted for the delay of up to 48 hours. The inclusion of atrazine in the UAN increased the leaf burn approximately equal to an additional 30 lb N increment as UAN, i.e., 60 lb N with atrazine was similar to 90 lb N without atrazine. The damage due to atrazine was slightly less than in 1977.

Early plant growth measured 15 days after application at the 4-leaf stage showed significant stunting with all UAN rates above 30 lb N/A (Table 1). Plant weights were reduced 12, 25, 31, 45 and 55% by the 30, 60, 90, 120 and 150-lb rates, respectively. Adding two pounds atrazine/A to the 60, 90 and 120-lb N rates reduced weights from the 150-lb soil treatment by 37, 46 and 55%, respectively.

The early stunting was less apparent 5 weeks after application. Plant weights from the 30, 60 and 90-lb N rates as UAN were not different from the 150-lb N soil-applied treatment (Table 1). However, the 120 and 150-lb rates without atrazine and the 90 and 120-lb rates with atrazine were still significantly smaller.

At the 8-leaf stage, topdressed UAN resulted in only slightly more burning and necrosis than comparable rates applied at the 4-leaf stage. This was markedly different than in 1977 when applications of all rates of UAN at the 8-leaf stage resulted in significant weight reductions. In 1978, plant weights were changed by +17, +4, -14, -19 and -38% by the 30, 60, 90, 120 and 150-lb N rates, respectively (Table 1). Perhaps the rainfall of 0.07" within 24 hours of application in 1978 accounted for the difference between years.

The treatments receiving sidedress applications of UAN at the 12-leaf stage (1 day before weights were taken) had the largest plants, which indicates that the plants were not suffering from N deficiency before the late sidedressing.

Plant heights to the top of the tassel and to the base of the ear in late August were influenced by both the rate and stage of UAN application (Table 1). However, no rate X stage interaction was found in 1978 contrary to 1977.

Final population was not influenced at the 95% level.

Table 1. Effect of post-emergence application of UAN on growth, height and final population of corn at Waseca in 1978.

Treatments				Plant Growth		Plant Height		Final
	N rate[1]		Growth[2]					
No.	UAN	AN	stage	6/22[3]	7/11[4]	Tassel	Ear	population
	-----lb N/A------		leaf	---g/plant----		---inches---		ppA x 10^{-3}
1	0	0	pre		45	93	40	23.6
2	0	150	"	6.7	52	99	44	23.9
3	0	200	"		54	100	45	23.3
4	30	120	4	5.9	52	97	42	23.3
5	30	120	8		61	99	44	23.7
6	60	90	4	5.0	47	99	44	23.1
7	60	90	8		54	97	42	22.9
8	60	90	12		63	100	45	24.3
9	90	60	4	4.6	47	99	44	24.5
10	90	60	8		45	97	41	23.5
11	90	60	12		51	98	43	24.2
12	120	30	4	3.7	42	98	42	23.5
13	120	30	8		42	96	41	24.2
14	120	30	12		57	98	44	24.8
15	150	0	4	3.0	38	98	41	24.3
16	150	0	8		32	95	38	22.2
17	150	0	12		50	97	44	22.9
18	60 + 2 At[5]	90	4	4.2	46	98	42	24.3
19	90 + 2 At	60	4	3.6	44	97	41	23.8
20	120 + 2 At	30	4	3.0	42	98	42	22.8
	Significance:			**	**	**	**	+
	BLSD (.05) :			1.1	8	3	2	
	CV (%) :			20.	13.4	2.2	3.7	5.1
Individual Factors								
	UAN Rate (lb N/A)							
	60				54.8	99	44	23.4
	90				47.4	98	43	24.1
	120				46.9	97	42	24.2
	150				40.5	96	41	23.1
	Significance:				**	+	**	+
	BLSD (.05) :				4.4		1	
	Growth Stage							
	4-leaf				43.5	98	43	23.8
	8-leaf				43.4	96	41	23.2
	12-leaf				55.3	98	44	24.0
	Significance:				**	**	**	+
	BLSD (.05) :				3.7	1	1	
	Rate X Stage IA				NS	NS	NS	NS

1/ Supplemental N as AN (ammonium nitrate) was added to each plot to total 150 lb N/A except trt. 3 which received 200 lb N.

2/ UAN applied at the 4- and 8-leaf stages was topdressed. UAN applied at the 12-leaf stage was sidedressed.

3/ 15 days after application at the 4-leaf stage.

4/ 34 days and 19 days after application at the 4- and 8-leaf stages, respectively.

5/ Atrazine was applied at 2 lb/A with UAN.

Nitrogen in the leaf opposite and below the ear at silking was influenced significantly by the N treatments (Table 2). All N treatments resulted in higher N concentrations than the check. No difference in N content existed between the 4 and 8-leaf stages of N application but both were significantly higher than when applied at the 12-leaf stage. This probably indicates insufficient time for uptake between N application and sampling (17 days).

Grain yields were influenced again in 1978 (Table 2). When comparing the 20 treatments only the 150-lb N rate as UAN and 120-lb N rate as UAN plus atrazine applied at the 4-leaf stage and the 120 and 150-lb N rates applied at the 8-leaf stage reduced yield significantly below the 150-lb N soil-applied treatment (no. 2). These reductions averaged -12, -9, -8 and -17%, respectively. Yields were reduced significantly (11.8 bu/A) by the 150-lb treatment when averaged across all three application dates. UAN applied at the 8-leaf stage reduced yields by 12.2 bu/A when averaged across all N rates. Applications at the 4 and 12-leaf stages when averaged across rates did not affect grain yield.

Grain moisture at harvest was highest for the check treatment and was generally decreased by the applications at the 8 and 12-leaf stages.

Grain N (protein) was increased significantly over the check by all N treatments except no. 11 (Table 2). Differences in grain N were not found among the N rates as UAN. Highest grain N was associated with the UAN applied at the 8-leaf stage, which was in direct contrast to the 1977 results.

Summary

UAN applied to the growing corn plant did result in some phytotoxicity but was not as severe as in 1977. Perhaps the application at the 4-leaf stage in 1978 as compared to 5-leaf in 1977 and the slight rain shower following the 8-leaf application in 1978 were the main reasons for less phytotoxicity. Applications at the 4-leaf stage resulted in greater phytotoxicity with increasing N rates; however, yields were only depressed with the 150-lb N rate as UAN and the 120-lb N rate of UAN plus atrazine. When applied at the 8-leaf stage the severity of leaf burn was again increased with increasing N rate. Yields were reduced by both the 120 and 150-lb N rates as UAN at this stage. Sidedressed UAN resulted in yields equal to the soil-applied treatment.

Table 2. Effect of post-emergence application of UAN on leaf N, corn grain yield, grain moisture and grain N at Waseca in 1978.

Treatments							
	N rate[1]		Growth[2]	Leaf	Grain		
No.	UAN	AN	stage	N	Yield	Moisture	N
	-----lb N/A------		leaf	%	bu/A	-------%-------	
1	0	0	pre	2.46	112.7	26.4	1.28
2	0	150	"	2.85	149.3	23.4	1.44
3	0	200	"	2.89	148.1	24.4	1.47
4	30	120	4	2.85	144.1	25.2	1.41
5	30	120	8	2.85	149.1	24.0	1.54
6	60	90	4	2.81	146.0	24.6	1.48
7	60	90	8	2.86	144.8	23.0	1.51
8	60	90	12	2.72	151.7	22.9	1.49
9	90	60	4	2.86	146.8	24.2	1.48
10	90	60	8	2.92	142.6	22.5	1.51
11	90	60	12	2.88	144.4	24.1	1.39
12	120	30	4	2.86	143.1	24.2	1.45
13	120	30	8	2.77	136.8	24.2	1.52
14	120	30	12	2.68	149.6	23.3	1.43
15	150	0	4	2.86	131.9	25.7	1.44
16	150	0	8	2.92	124.1	24.4	1.51
17	150	0	12	2.70	145.1	23.0	1.44
18	60 + 2 At[3]	90	4	2.91	145.2	23.7	1.51
19	90 + 2 At	60	4	2.82	144.5	25.2	1.46
20	120 + 2 At	30	4	2.86	136.3	24.7	1.49
	Significance[4]:			**	**	**	**
	BLSD (.05) :			.12	10.9	1.8	.13
	CV (%) :			3.6	6.2	5.4	5.7
Individual Factors							
	UAN Rate (lb N/A)						
	60			2.80	147.5	23.5	1.49
	90			2.88	144.6	23.6	1.46
	120			2.77	143.2	23.9	1.47
	150			2.83	133.7	24.4	1.46
	Significance:			*	**	NS	NS
	BLSD (.05) :			.08	6.0		
	Growth Stage						
	4-leaf			2.85	142.0	24.7	1.46
	8-leaf			2.87	137.1	23.5	1.51
	12-leaf			2.75	147.7	23.3	1.44
	Significance:			**	**	**	*
	BLSD (.05) :			.06	5.2	.8	.05
	Rate X Stage IA			NS	NS	NS	NS

1/ Supplemental N as AN (ammonium nitrate) was added to each plot to total 150 lb N/A except trt. 3 which received 200 lb N.

2/ UAN applied at the 4- and 8-leaf stages was topdressed. UAN applied at the 12-leaf stage was sidedressed.

3/ Atrazine was applied at 2 lb/A with UAN.

4/ **, *, and + are significant at the 99, 95 and 90% levels, respectively; NS = not significant at the 90% level.

CORN FERTILIZATION WITH NITROGEN CONTAINING ACA

1976-78, THREE-YEAR SUMMARY

Waseca, MN

G. W. Randall

Additives to nitrogen (N) fertilizers have gained popularity within the last few years. One of these additives, ACA, an acronym for agricultural crop additive, is produced and sold by Amoco Oil Company for inclusion with anhydrous ammonia for corn. The purpose of this study was to evaluate ACA applied with N on corn production in south-central Minnesota.

Experimental Procedures

Field studies to evaluate the inclusion of ACA in anhydrous ammonia were conducted on a Webster clay loam at the Southern Experiment Station during 1976, 1977 and 1978. Corn was grown each year with the preceding crop being soybeans in the first two years and corn in the last year. Supplemental P and K was broadcast applied each year.

Three rates of N (0, 75 and 150 lb/A) as anhydrous ammonia were used each year in a randomized, complete-block design with six replications. In 1976, 100 lb N/A was substituted for the 75 lb rate. Both the 75 and 150-lb rates were applied with and without ACA. The ammonia was applied with a standard tool-bar applicator with 4 shanks (1976) or 6 shanks (1977 and 1978) spaced 30" apart. Application consisted of starting the injection and ammonia release approximately 10 to 15 feet outside of the plot and then proceeding immediately at 3 MPH into and through the 55' long plots. All N was applied approximately 7" deep.

Tissue samples were taken of the leaves at silking, of the silage at physiological maturity and of the grain at harvest. All samples were analyzed for total N. Silage yields were taken from 20 feet of row (10' in 1976) while grain yields were obtained by combine harvesting the center two rows of each plot with a modified JD3300 combine.

Results

Nitrogen levels within the leaves, silage and grain were increased significantly by the N treatments in two of the three years (Table 1). In 1977, leaf N, silage N and grain N were all improved by the addition of N. In 1978, linear increases in leaf and grain N to N rate were found while silage N was increased with the first N increment. The inclusion of ACA did not influence the N concentrations of any of the plant tissue parts in any year.

Table 1. Influence of ACA on the N concentration in the corn leaf, silage and grain at Waseca for the three years of the study.

Treatment		Nitrogen								
		1976			1977			1978		
N rate	ACA	leaf[1]	silage	grain	leaf	silage	grain	leaf	silage	grain
lb N/A		%								
0	-	1.87	1.03	1.58	2.37	.84	1.42	2.48	1.10	1.39
75(100)[2]	-	1.82	1.09	1.62	2.93	.96	1.55	2.80	1.24	1.52
75(100)	+	2.08	1.08	1.62	2.99	.94	1.55	2.85	1.35	1.58
150	-	1.97	1.12	1.66	3.04	.97	1.57	3.00	1.26	1.67
150	+	1.95	1.08	1.58	3.00	1.04	1.57	3.03	1.25	1.60
Significance:		NS[3]	NS	NS	**	*	*	**	*	**
BLSD (.05)	:				.25	.11	.10	.17	.15	.11
CV (%)	:	13.1	5.6	3.5	8.0	9.0	5.1	5.2	9.2	6.1

[1] Leaf opposite and below the ear was sampled at silking.

[2] 100 lb N rate used in 1976.

[3] **, *, and + are significant at the 99, 95 and 90% levels, respectively. NS = not significant at the 90% level.

Silage yields were increased significantly by the addition of N and the inclusion of ACA in two of the three years (Table 2). ACA improved the silage yields by 0.71 and 0.62 T DM/A in 1976 and 1977, respectively, but did not improve silage yields in 1978. No explanation can be given for the high check plot yield found in 1976.

Table 2. Influence of ACA on silage and grain yield at Waseca for the three years of the study.

Treatment		Yield					
		1976		1977		1978	
N rate	ACA	silage	grain	silage	grain	silage	grain
lb N/A		T DM/A	bu/A	T DM/A	bu/A	T D M/A	bu/A
0	-	8.30	118.8	6.64	118.2	7.15	126.4
75(100)[1]	-	8.05	138.1	7.40	145.0	8.35	159.9
75(100)	+	8.43	136.6	8.00	151.3	8.12	155.9
150	-	7.86	133.1	7.76	149.3	8.41	163.8
150	+	8.92	134.2	8.40	150.2	8.46	164.1
Significance:		+	**	**	**	*	**
BLSD (.05)	:		6.8	.89	15.7	.92	9.0
CV (%)	:	8.1	4.5	9.4	9.2	8.6	5.3

[1] 100 lb N rate used in 1976.

Grain yields were improved significantly each year by the addition of the first N increment (Table 2). Neither additional N nor the addition of ACA influenced grain yields.

Summary

Nitrogen content of the plant tissue (leaf, silage and grain) and grain yield were generally increased by the addition of N but not by the inclusion of ACA. Silage yields, however, were improved in two of three years by ACA.

INFLUENCE OF EXTEND APPLIED WITH UAN (28% N) ON CORN PRODUCTION

Waseca, 1978

G. W. Randall

Extend, a nitrogen (N) regulator marketed by Kalo Laboratories, Inc., has been purported to provide more efficient use of liquid N fertilizers by encapsulating a portion of the N molecules. The Extend is then said to impart slow release properties to this N, thereby, protecting against N losses and also holding the N within the root zone for a longer period of time.

The purpose of this study was to determine the effect of Extend on

a) the release of NH_4-N from UAN and the movement of N in the surface rooting zone

b) the uptake of N by corn

c) the grain and silage yield of corn.

Experimental Procedures

Ten treatments consisting of five N rates (0, 50, 100, 150 and 200 lb N/A) as UAN (28% N) were applied with and without Extend in a 5 x 2 completely randomized factorial design with six replications. Water was substituted for UAN in the 0 lb N treatment plus Extend. All treatments were applied preemergence to the soil surface on May 23 with a pre-calibrated bicycle sprayer. No incorporation was attempted. Flood jet nozzles (TK 2.5) spaced 30" apart were used.

Primary tillage of this Webster clay loam soil (Typic Haplaquoll) consisted of fall moldboard plowing the corn residue from the previous crop. Prior to planting the site was field cultivated twice. On May 17, Pioneer 3780 corn was planted in 30" rows at a population of 26,100 ppA. Starter fertilizer consisting of 140 lb 0-23-30/A ($N+P_2O_5+K_2O$) and an insecticide (Furadan at 1 lb a.i./A) were applied with the planter. Adequate amounts of broadcast P and K were applied the previous fall. Weeds were controlled by Lasso + Bladex (3 lb + 2½ lb/A) applied preemergence immediately after planting.

Soil samples consisting of 5 cores per composite were taken from all treatments on June 7 (15 days after treatment application) and from the 0, 100 and 200 lb N rates on June 22 (30 days after application) and on July 25 (63 days after application). June 7 samples were taken from the 0-8" profile while the subsequent samples were obtained from the 0-8" and 8-24" profiles. All soil samples were frozen immediately and were kept frozen

until analysis. Ammonium and NO_3-N concentrations were determined by the Research Analytical Lab of the University.

Leaf samples (opposite and below the ear) from 10 random plants were taken on July 27 at the early silking stage. Silage yields were taken by harvesting 10 feet of row at physiological maturity on September 16. Subsamples were obtained for chemical and dry matter analyses by passing the stalks thru a silage chopper. All tissue samples were oven-dried at 150°F. Grain yields were taken on October 13 by combine harvesting the center two rows (each 55' long) with a modified JD 3300 plot combine. Grain samples for moisture and N analyses were obtained concurrently. All tissue analyses were conducted by the Research Analytical Laboratory.

Results

Soil NH_4-N and NO_3-N concentrations in the top 0-8" 15 days after treatment application were increased by the N treatments but were not influenced by the inclusion of Extend with the UAN (Table 1). Soil NO_3-N was increased linearly about 4-fold with N rate whereas NH_4-N was increased only slightly. A N rate x Extend interaction was not found.

Table 1. Influence of N rate and Extend on soil NH_4-N and NO_3-N in the 0-8" profile 15 days after treatment application.

Treatment			
N rate	Extend	NH_4-N	NO_3-N
lb N/A		-------ppm-------	
0	-	6.8	10.3
0	+	7.0	10.7
50	-	7.6	18.1
50	+	6.7	17.3
100	-	8.1	24.4
100	+	8.1	25.4
150	-	8.4	29.4
150	+	9.5	35.3
200	-	9.8	43.3
200	+	8.1	39.8
Averages			
0 lb N/A		6.9	10.5
50 " "		7.1	17.7
100 " "		8.1	24.9
150 " "		8.9	32.3
200 " "		8.9	41.6
No Extend		8.1	25.1
Extend		7.9	25.7
Significance:			
N rate		**	**
Extend		NS	NS
N x E IA		NS	NS
N BLSD (.05):		1.2	5.1
CV (%) :		16.7	24.9

A linear increase in soil NO_3-N still remained 30 days after treatment application in both the 0-8" and 8-24" profiles (Table 2). Soil NH_4-N was not influenced by the N rates. Extend had no effect on either soil NH_4-N or NO_3-N. Interactions between the N rate and Extend were not shown.

Table 2. Influence of N rate and Extend on soil NH_4-N and NO_3-N in the 0-8" and 8-24" profile 30 days after treatment application.

Treatment		NH_4-N		NO_3-N	
N rate	Extend	0-8"	8-24"	0-8"	8-24"
lb N/A		ppm			
0	-	5.3	3.8	9.9	9.5
0	+	6.1	4.4	11.5	8.2
100	-	7.1	4.8	24.1	12.5
100	+	6.6	3.9	25.4	11.9
200	-	6.1	6.0	34.5	16.3
200	+	6.5	5.0	34.9	14.9
Averages					
0 lb N/A		5.7	4.1	10.7	8.9
100 "	"	6.9	4.4	24.7	12.2
200 "	"	6.3	5.5	34.7	15.6
No Extend		6.1	4.9	22.8	12.8
Extend		6.4	4.4	23.9	11.7
Significance:					
N rate		NS	NS	**	**
Extend		NS	NS	NS	NS
N x E IA		NS	NS	NS	NS
N BLSD (.05):				6.2	3.9
CV (%) :		25.7	34.5	31.9	34.8

A slight increase in soil NH_4- and NO_3-N due to N rate was shown 63 days after application (Table 3). However, nitrate-N at this time (silking stage) was quite low in both areas of the profile. The addition of Extend to the UAN fertilizer did not affect soil NH_4- or NO_3-N concentrations. Again, interactions were not found.

Table 3. Influence of N rate and Extend on soil NH_4-N and NO_3-N in the 0-8" and 8-24" profile 63 days after treatment application.

Treatment		NH_4-N		NO_3-N	
N rate	Extend	0-8"	8-24"	0-8"	8-24"
lb N/A		ppm			
0	-	6.2	4.9	4.3	2.1
0	+	6.6	5.4	4.2	2.1
100	-	9.2	5.2	3.5	2.7
100	+	8.4	5.2	4.0	2.4
200	-	8.7	6.6	8.1	5.3
200	+	8.8	5.1	8.0	5.0
Averages					
0 lb N/A		6.4	5.2	4.3	2.1
100 "	"	8.8	5.2	3.7	2.5
200 "	"	8.7	5.9	8.1	5.1
No Extend		8.0	5.6	5.3	3.3
Extend		7.9	5.2	5.4	3.1
Significance:					
N rate		*	NS	**	**
Extend		NS	NS	NS	NS
N x E IA		NS	NS	NS	NS
N BLSD (.05):		2.0		1.4	0.5
CV (%) :		26.4	24.2	29.8	19.5

Leaf, silage and grain N concentrations were influenced by the treatments (Table 4). Although leaf N in the check treatment was not extremely low, leaf N concentrations were increased significantly by the increasing N rates. Extend had no influence on leaf N.

Nitrogen concentrations in the silage were extremely variable (CV = 20.9). Thus, even though a significant interaction between N rate and Extend was found it cannot be interpreted. N rate and Extend did not affect silage N. N uptake in the silage was increased significantly by N rates up thru 100 lb/A; largely due to increased silage yields (Table 5).

Table 4. Influence of N rate and Extend on the leaf, silage and grain N levels and N uptake and removal amounts at Waseca.

Treatment		Leaf	Silage N		Grain N	
N rate	Extend	N	Conc.	Uptake	Conc.	Uptake
lb N/A		%	%	lb/A	%	lb/A
0	-	2.14	1.13	140	1.37	74
0	+	2.15	0.86	112	1.38	77
50	-	2.36	0.91	138	1.38	92
50	+	2.38	1.15	170	1.47	94
100	-	2.49	0.86	151	1.45	101
100	+	2.43	1.12	171	1.55	109
150	-	2.55	1.23	196	1.54	108
150	+	2.50	0.92	142	1.66	115
200	-	2.64	1.19	195	1.66	117
200	+	2.66	1.08	177	1.66	116
Averages						
0 lb N/A		2.14	0.99	126	1.38	75
50 "	"	2.37	1.03	154	1.43	93
100 "	"	2.46	0.99	161	1.50	105
150 "	"	2.52	1.07	169	1.60	111
200 "	"	2.65	1.13	186	1.66	116
No Extend		2.44	1.06	164	1.48	98
Extend		2.42	1.02	154	1.54	102
Significance:						
N rate		**	NS	**	**	**
Extend		NS	NS	NS	*	+
N x E IA		NS	**	*	NS	NS
N BLSD (.05):		.10		30	.07	6
N x E IA BLSD(.05):			.18	46		
CV (%):		5.6	20.9	22.5	6.0	7.8

Grain N (protein) concentrations were increased significantly by N rate (P = .01 level) and Extend (P = .05 level). Grain N was increased significantly with N rates up thru 150 lb/A. The inclusion of Extend resulted in an average increase of 0.06% N or 0.4% protein. This influence was greatest at the 50, 100 and 150 lb-N rates. Nitrogen removed in the grain (protein) was also increased by N rate (P = .01 level) and Extend (P = .10 level). This removal was influenced by both grain yield and grain N level.

Plant population at harvest was not influenced by any of the treatments (Table 5).

Table 5. Influence of N rate and Extend on corn production on a Webster clay loam at Waseca in 1978.

Treatment		Final plant	Silage	Grain	
N rate	Extend	population	yield	Moisture	Yield
lb N/A		ppA x 10^{-3}	T DM/A	%	bu/A
0	-	22.8	6.22	24.4	112.8
0	+	21.9	6.56	23.1	117.0
50	-	23.2	7.70	21.8	140.2
50	+	23.0	7.32	21.8	134.8
100	-	22.8	8.66	20.8	146.3
100	+	24.1	7.65	21.4	149.0
150	-	23.8	7.96	20.4	147.4
150	+	22.3	7.86	20.4	146.4
200	-	22.8	8.24	20.2	148.7
200	+	23.0	8.23	19.8	147.5
Averages					
0 lb N/A		22.3	6.39	23.8	114.9
50 "	"	23.1	7.51	21.8	137.5
100 "	"	23.4	8.15	21.1	147.6
150 "	"	23.1	7.91	20.4	147.0
200 "	"	22.9	8.23	20.0	148.1
No Extend		23.1	7.75	21.5	139.1
Extend		22.9	7.52	21.3	139.0
Significance:					
N rate		NS	**	**	**
Extend		NS	NS	NS	NS
N x E IA		NS	NS	NS	NS
N BLSD (.05):			0.54	1.0	5.2
CV (%) :		6.5	9.2	6.0	5.1

Silage and grain yield and grain moisture were affected significantly by the N rates but not by Extend (Table 5). Although the silage yields were somewhat variable, both silage and grain yields were increased by N rates thru 100 lb/A. Nitrogen rates of 150 and 200 lb/A resulted in the lowest grain moisture at harvest (an indication of maturity). No interactions between N rate and Extend were found.

Summary

The inclusion of Extend in UAN (28% N) applied preemergence to a Webster clay loam did not result in the regulation (slow release) of ammonium N as evidenced by soil NH_4- and NO_3-N analyses. Silage and grain yields were not influenced by Extend. Leaf and silage N concentrations also were not affected by Extend. However, Extend did result in slightly higher grain N (protein) values. Based on this one year's research, Extend cannot be recommended as an additive to UAN applied preemergence to a Webster clay loam soil.

SYMBEX
1978

Waseca, Minnesota

G. W. Randall and D. K. Langer

The Symbex system was developed and is being marketed by the Agro-K Corporation. The Symbex system includes, Symbex the soil inoculant, Sym-Coat seed treatment, and Sym-Spray foliar spray. Symbex soil inoculant contains inactive ingredients of 41% water and 57% whey. The 2% active ingredients contain fungi, bacteria, yeasts, and according to Agro-K an enzyme system with activator which causes rapid breakdown of crop residue. Agro-K claims that this should release and make available the nitrogen, phosphorus, and potassium already in the soil so they can be utilized by the crop. Sym-Coat seed treatment increases and accelerates germination states Agro-K with resulting healthier stands. Sym-Spray foliar feeds micronutrients and is a growth regulator declares Agro-K. The purpose of this study was to evaluate the Symbex system on corn production in south-central Minnesota.

Experimental Procedures

The Symbex study was established on a Nicollet clay loam soil which had not received P or K fertilizer in four years. Corn grown on the area the previous year was removed as silage. Treatments were arranged in a four replicate randomized, complete-block design and included a check, Symbex, Symbex + 30 lb N/A, and 175 lb N/A. The complete Symbex system was applied to the Symbex treatments at the recommended rates (Symbex one gal/A, Sym-Coat 10 g powder/10 lb seed, Sym-Spray .05 gal + 9 lb N/A).

Symbex soil inoculant was applied May 1 and corn (Pioneer 3780) was planted at a rate of 26,100 ppA in 30 inch rows on May 15 with the Symbex plots receiving Sym-Coated seed. Chemical weed control consisted of 3 qts Lasso/A and 2½ qts Bladex/A applied preemerge. The nitrogen for the Symbex + 30 lb N/A treatment was sidedressed as feed grade urea and the 175 lb N/A treatment was sidedressed as fertilizer grade urea. Both sidedressed treatments were cultivated in after application on June 17. Sym-Spray plus 9 lb N/A as feed-grade urea was applied to the Symbex treatments on July 24 just prior to tasseling.

The leaf opposite and below the ear was sampled from 12 plants at silking and submitted for chemical analyses. Silage samples taken from 10 feet of row at physiological maturity (black layer stage) were measured for yield. Corn grain yield, moisture, and protein were determined on corn harvested from 40 feet of the center two rows. The grain data were collected at physiological maturity and yields were converted to 15.5% moisture because the corn in the plot area was to be removed as silage.

Results

The nutrients N, P, Mg, Mn, Zn, and Cu were all increased significantly in the corn leaf with the addition of 175 lb N/A (Table 1). Symbex apparently had little effect on corn leaf nutrient concentration. The trend shows that the Symbex + 30 lb N/A did increase some of the nutrient concentrations probably due to the added nitrogen; however, none of these increases were statistically significant.

Table 1. Influence of Symbex on the nutrient concentrations in the corn leaf at Waseca in 1978.

Treatment	Nutrient[1]									
	N	P	K	Ca	Mg	Fe	Mn	Zn	Cu	B
	%					ppm				
Check	1.79	.19	1.58	.62	.43	119	37	22	5.2	9
Symbex	1.91	.20	1.59	.57	.44	109	39	20	4.6	9
Symbex + 30 lb N/A	2.10	.21	1.60	.60	.45	120	40	25	5.7	9
175 lb N/A	2.58	.24	1.51	.64	.53	124	51	32	7.8	9
Signif :	*[2]	+	NS	NS	**	NS	**	**	**	NS
BLSD(.05):	.58				.04		8	6	1.3	
CV (%) :	16.2	12.3	6.5	8.8	5.2	11.1	11.5	14.6	14.1	9.4

[1] Leaf opposite and below the earleaf was sampled at silking.

[2] **, *, + are significant at the 99, 95 and 90% levels, respectively. NS = not significant at the 90% level.

At physiological maturity silage yield, grain yield and grain protein percentage at the 175 lb N/A treatment were all significantly higher than any of the other treatments (Table 2). The Symbex + 30 lb N/A treatment was significantly better than the check for grain yield and significantly better than the check and the Symbex treatment for grain protein. This indicates that the additional 30 lb N/A with the Symbex caused the increase in protein percentage. These results show that Symbex did not enhance corn production in south-central Minnesota in 1978.

Table 2. Influence of Symbex on corn yields, protein, and moisture content at Waseca in 1978.

Treatment	Yield		Grain	
	Silage	Grain	Moisture	Protein
	T DM/A	bu/A	%	%
Check	3.85	73.6	43.1	5.88
Symbex	4.69	77.1	43.0	6.00
Symbex + 30 lb N/A	4.80	92.2	41.2	7.12
175 lb N/A	5.82	112.8	40.2	9.81
Significance:	**	**	NS	**
BLSD (.05) :	.96	16.7		.88
CV (%) :	12.3	11.8	4.3	8.6

After harvest soil samples were taken from each plot and Agro-K provided funds for a complete soil analysis by Harris Laboratories (Table 3). The resulting data indicate that the various treatments had little effect over the background level of the check treatment.

Table 3. Influence of Symbex on soil test results at Waseca in 1978.

Treatment	OM	pH	NO_3-N	P	K	Ca	Mg	Na	S	Fe	Mn	Zn	Cu	B
	%	ppm												
Check	3.2	6.2	4.0	16	100	2325	400	22	10	60.8	8.0	.9	.7	1.2
Symbex	4.1	6.2	2.5	11	98	2375	452	21	10	68.6	9.0	1.0	.7	1.0
Symbex + 30 lb N/A	3.2	6.2	2.2	13	112	2350	395	20	9	58.0	9.1	1.0	.8	1.0
175 lb N/A	3.4	6.0	5.0	13	98	2375	372	20	10	68.4	9.2	1.0	.7	1.0

Summary

Symbex did not have any effect on silage or grain yields and did not influence grain protein or nutrient concentrations in the leaf. The addition of nitrogen appeared to increase yields, protein and some nutrient concentrations in the leaf.

Use of Terrazole as a Nitrification Inhibitor in Fall vs. Spring Nitrogen Application Program 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 1978. The objectives of the trial were to evaluate not only rate of nitrogen application but also timing of application and comparisons of different nitrogen forms with and without the use of Terrazole.

Experimental Procedures

Nineteen treatments including a control, two rates of nitrogen (75 and 150 #N/A) and a fall vs. spring application were combined with Terrazole at two rates of application above the control (0.5 and 1.0 #ai/A). Urea fertilizer was utilized in both fall and spring comparisons, while anhydrous ammonia was utilized only in the spring application programs. The nitrogen applied as urea was broadcast and immediately incorporated after application with Terrazole treatments consisting of coatings on the urea fertilizer. The anhydrous ammonia treatments were injected at 30" knife spacings, and Terrazole applications were made simultaneously with the use of a dual-tube anhydrous shank and a separate pressurized system for application of the Terrazole. All treatments were replicated four times and arranged in a randomized complete block design. Corn (Pioneer 3780) was planted into the experimental area in 30" rows 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 machine harvesting the center two rows from each plot and collecting subsamples for moisture determination and Kjeldahl nitrogen. Soil samples were also collected from the surface 0-1 ft. depth from all treatments receiving 150 #N/A at approximately two week intervals 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.

General Results

Grain yields were above average in 1978, but yield responses to the application of nitrogen fertilizer were not obtained above the 75 #N/A rate of application. The higher rate of application (150 #N/A) significantly increased the nitrogen content in the leaf at silking as well as grain N and total N removal with the grain, but this did not reflect a yield increase.

The treatments had no influence on total dry matter production (stover, grain, or total), but did have a significant influence on other measured parameters dealing with nitrogen utilization and nitrogen availability.

In general, measured parameters such as leaf N at silking, grain N, and nitrogen removal with the grain indicated that nitrogen utilization was increased at the highest rate of application. With the spring application of fertilizer nitrogen there was very little difference between urea and anhydrous ammonia. Comparisons of fall vs. spring applications of urea reflected no significant differences between times of fertilizer application. Terrazole when applied with 150 #N/A appeared to have no significant effect on nitrogen availability. At the 75 #N/A rate of application, the highest rate of Terrazole application (1.0 #ai/A) with spring application appeared to reduce nitrogen availability. The same rate of Terrazole application in the fall showed trends of improved nitrogen availability. The interactions of nitrogen rate, timing of nitrogen application, and the interaction with nitrification inhibitor rates deserve further investigation.

Table 1. Influence of Nitrogen Form, Rate of Application, Time of Application, and Use of Terrazole as a Nitrification Inhibitor on Various Yield Components and Nitrogen Utilization Characteristics of Corn.

Treatments				Leaf	Yield Grain			Corn Forage Production							
								Stover			Grain			Total	
Date of Appl.	N Form	Terrazole Rate	N Rate	N	Yield	N	N Removal	Yield	N	N Removal	Yield	N	N Removal	Yield	N Removal
		#ai/A	#/A	%	bu/A	%	#/A	T/A	%	#/A	T/A	%	#/A	T/A	#/A
Control		0	0	2.00	124.6	1.12	65.9	4.49	.37	33.5	3.21	.97	62.8	7.69	96.2
Oct. 14	Urea	0	75	2.74	157.6	1.38	103.3	4.27	.42	36.0	3.76	1.25	94.3	8.03	130.3
Oct. 14	"	0	150	2.74	166.2	1.64	129.3	4.48	.53	47.2	3.96	1.49	117.6	8.44	164.8
Oct. 14	"	½	75	2.58	157.9	1.38	103.3	4.80	.48	45.7	4.08	1.29	105.3	8.87	151.0
Oct. 14	"	½	150	2.96	160.6	1.58	120.1	4.85	.53	51.0	3.97	1.57	124.5	8.81	175.5
Oct. 14	"	1	75	2.89	171.0	1.42	115.1	4.28	.46	39.6	3.80	1.33	101.1	8.08	140.7
Oct. 14	"	1	150	2.86	167.4	1.59	125.9	4.99	.51	51.1	4.16	1.48	123.2	9.14	174.3
May 3	A.A.	0	75	2.76	162.4	1.40	107.7	4.52	.48	43.2	4.12	1.40	115.7	8.65	158.9
May 3	"	0	150	3.01	161.9	1.72	131.8	4.94	.62	61.6	4.25	1.77	150.4	9.19	212.0
May 3	"	½	75	2.91	163.2	1.44	111.6	4.81	.60	58.0	4.15	1.54	127.8	8.97	185.8
May 3	"	½	150	2.97	163.2	1.80	138.7	4.48	.68	61.0	4.11	1.61	132.4	8.59	193.4
May 3	"	1	75	2.79	152.8	1.38	99.3	4.69	.53	49.7	3.99	1.46	117.4	8.69	167.1
May 3	"	1	150	3.04	161.4	1.68	127.7	4.96	.73	72.3	4.27	1.67	142.9	9.23	215.2
May 3	Urea	0	75	2.62	160.4	1.36	103.2	4.84	.47	45.4	3.98	1.31	104.0	8.82	149.4
May 3	"	0	150	2.94	160.0	1.62	122.0	4.77	.62	59.0	4.00	1.54	123.3	8.77	182.3
May 3	"	½	75	2.80	162.0	1.41	108.0	4.66	.42	39.2	3.93	1.33	104.8	8.58	144.0
May 3	"	½	150	2.67	159.8	1.50	113.2	4.66	.50	47.2	4.07	1.36	111.0	8.73	158.2
May 3	"	1	75	2.50	144.6	1.32	90.5	4.44	.38	33.6	3.74	1.21	90.6	8.17	124.2
May 3	"	1	150	2.75	150.0	1.61	114.2	4.65	.56	52.7	3.91	1.64	128.5	8.56	181.2
Significance				**	**	**	**	NS	**	**	NS	**	**	NS	**
BLSD(.05)				.15	17.8	.11	13.7		106	8.4		.39	19.6		25.5