Table 1. 1975 Treatment Description.[1]

Treatment	Description
1	Check (0 + 0 + 0 total applied).
2	Nachurs Liquid: With seed: Nachurs liquid 3-18-18 @ 4 gal./acre Broadcast: 70 lbs./acre N as 34-0-0 (71 + 8 + 8 total applied)
3	Same as 2 but no seed treatment (70 + 0 + 0 total applied)
4	Wonderlife (soil conditioner): 150 lbs./acre with the planter (0 + 0 + 0 total applied)
5	Wonderlife (soil conditioner) plus pesticides: Same as treatment 4 plus insecticide and herbicide (0 + 0 + 0 total applied)
6	Shurgro (organic fertilizer, 6-2-1): 200 lbs./acre with the planter (12 + 4 + 2 total applied)
7	Shurgro (organic fertilizer, 6-2-1) plus pesticides: Same as treatment 6 plus insecticides and herbicides (12 + 4 + 2 total applied)
8	Conventional fertilizer: Broadcast: 80 lbs./acre N as 34-0-0 With planter: 121 lbs./acre 8-33-17 (90 + 40 + 21 total applied)
9	High rate of conventional fertilizer: Same as treatment 8 except an additional 100 lbs./acre N and 100 lbs./acre K_2O broadcast before planting (190 + 40 + 121 total applied)
10	Conventional liquid 7-21-7: With seed: Liquid 7-21-7 @ 4 gal./acre Broadcast: 70 lbs./acre N as 34-0-0 65 lbs./acre K_2O as 0-0-60 (73 + 9 + 3 total applied)

[1] All treatments were treated with Furadan @ 1 lb./acre and Lasso @ 2 1/2 lbs./acre preemerge + 2,4-D amine @ 1/2 lb./acre late postemerge except 4 and 6.

Table 2. Effect of broadcast phosphorus on plant measurements.

	No Broadcast	P Broadcast	Significance[1]
Extended leaf ht. on 7-3 (in.)	25.2	26.4	+
Plants/acre at harvest	21,344	21,105	NS
Ears/acre at harvest	16,781	15,562	*
Stalks with ears, %	78.0	72.4	*
Root lodging at harvest, %	37.8	31.2	NS
Harvest ear moisture, %	22.0	22.7	NS
Yield in bu./acre @ 15.5% moisture	67.8	72.2	+

[1] Significance: ** = 99% level; * = 95% level; + = 90% level;
NS = not significant at the 90% level.

Table 3. Effect of fertilizer materials on plant measurements.

Treatment	Extended leaf ht. on 7-3 (in.)	Plants/ac. at harvest	Ears/ac. at harvest	Stalks with ears %	Root lodging at harvest %	Harvest ear moisture %	Yield in bu./acre @ 15.5% moisture
1	23.1	20,310	15,083	74.8	41.7	19.0	45.6
2	29.9	21,617	20,637	95.6	27.4	21.5	104.1
3	24.5	21,072	19,602	93.1	36.5	22.0	88.8
4	19.7	19,439	2,396	12.2	30.4	31.5	3.5
5	23.1	22,433	18,023	80.5	53.6	19.5	50.9
6	23.0	20,255	5,336	26.0	36.8	25.8	9.6
7	25.7	20,745	18,350	88.5	61.5	20.4	62.8
8	28.7	21,889	20,909	95.5	22.4	20.7	117.8
9	30.6	21,562	20,038	92.8	9.0	20.8	115.0
10	29.4	22,923	21,344	93.1	25.8	22.5	101.9
Significance:	**	**	**	**	*	**	**
BLSD (.05)	2.6	1477	1186	6.3	35.1	2.1	9.6
Significance of Interaction	*	NS	*	**	NS	*	**

Table 4. Plant measurements with and without broadcast phosphorus.

Treatment	Extended leaf ht. on 7-3 (in.)		Stalks with ears, %		Ear moisture %		Yield in bu./Ac. at 15.5% moist.	
	-P	+P	-P	+P	-P	+P	-P	+P
1	22.0	24.1	81.9	67.8	18.7	19.3	49.3	41.8
2	28.4	31.5	95.1	96.1	22.8	20.2	88.4	119.7
3	23.1	25.9	90.5	95.7	23.3	20.8	70.7	106.7
4	20.7	18.6	16.2	8.2	26.6	36.5	5.4	1.7
5	21.8	22.4	84.6	76.4	20.0	18.9	55.0	46.8
6	22.4	23.7	40.7	11.4	24.8	26.7	15.0	4.1
7	24.2	27.2	89.9	87.1	21.1	19.6	61.1	64.6
8	29.6	27.8	95.5	95.5	20.2	21.1	124.4	111.2
9	31.4	29.9	91.7	94.0	20.3	21.2	114.9	115.2
10	28.3	30.4	93.9	92.2	22.4	22.6	94.0	109.8

THE 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, and 95. Manure was applied in 1970 and 1971 only. Fertilizer has been applied to the fertilized checks each year. In 1975 the comparison of Furadan vs. no Furadan was dropped and the no Furadan sub-plots were planted to soybeans.

I. Planting Information

Sixteen rows of each plot were planted to corn (var. Pioneer 3965) and eight rows to soybeans (var. Clay) on May 10, 1975. Furadan at 10 lbs./acre (1 lb./acre active ingredient) was applied to the corn. Starter fertilizer consisting of 150 lbs./acre of 8-33-17 was applied to both the corn and soybeans in the fertilized treatment. Nitrogen in the form of ammonium nitrate was applied to the fertilizer plots to provide 110 lbs./acre of N on October 14, 1974. All plots were plowed on October 16, 1974. Lasso was applied broadcast at 2 1/2 lbs./acre on May 8. Sprayed center 12 rows of corn with 2,4-D amine with drop nozzles at 1/2 lb./acre on June 27.

II. Plant Tissue Analysis

A. Early whole corn plants (Table 1)

The manure treatments were significantly higher than FE in P and K and lower in Mg and Cu. The SB treatment was lower than FE in Ca. The LH treatment was higher in Zn than SB and LB. The CK was significantly different from the other four treatments in K, Ca, Mg, Fe, Cu, and Mn.

B. Soybean whole plant samples (Table 2)

The manure treatments were significantly higher than FE in K and lower in Mg, Cu, and Zn. The LB treatment was higher in P than all other treatments except SB and lower than CK in Fe. The CK treatment was significantly different from all other treatments in N and Cu.

C. Corn leaves at silking (Table 3)

There were significant treatment effects on all elements measured. The manure treatments were significantly higher than FE in P and K and lower in Mg and Zn. The LB treatment was significantly higher than LH in P and higher than both SB and LH in Mn. The LH treatment was lower in K and Fe and higher in Zn and Cu than SB and LB.

Table 1. Summary of analysis of early corn plant samples - 1975.[1]

Treatment	P	K	Ca	Mg	Zn	Cu	Mn	B
	%				ppm			
CK	.40	2.00	.66	.45	33.5	7.3	192	7.4
FE	.40	3.11	.51	.35	42.4	5.9	126	6.2
SB	.53	4.26	.38	.24	33.2	4.1	116	6.7
LB	.60	4.25	.40	.24	33.0	4.0	128	6.3
LH	.50	4.15	.44	.25	47.6	4.7	113	6.2
Significance:	**	**	**	**	**	**	*	NS
BLSD (.05)	.07	.54	.12	.06	7.8	1.3	44	-

[1] Iron values are not given because there was soil contamination.

Table 2. Summary of analysis of whole soybean plant samples - 1975.

Treatment	N	P	K	Ca	Mg	Fe	Zn	Cu	Mn	B
	%					ppm				
CK	5.68	.44	1.87	1.44	.73	301	36.3	12.0	94	45
FE	5.99	.47	2.06	1.51	.70	278	52.3	8.9	96	42
SB	5.90	.60	2.58	1.52	.55	257	25.7	4.6	113	36
LB	5.92	.69	2.45	1.60	.53	241	40.4	3.2	75	40
LH	6.04	.52	2.48	1.53	.56	256	40.7	5.6	102	41
Significance:	*	*	**	NS	**	+	**	**	*	*
BLSD (.05)	.22	.14	.35	-	.05	50	8.2	2.2	21	8

Table 3. Summary of analysis of corn leaves at silking - 1975.

Treatment	N	P	K	Ca	Mg	Fe	Zn	Cu	Mn	B
	%					ppm				
CK	1.73	.20	1.59	.58	.46	171	14.9	5.3	44	7.8
FE	2.81	.26	2.00	.63	.43	233	22.8	8.8	70	10.4
SB	2.86	.36	3.29	.46	.23	338	14.0	8.0	88	9.1
LB	2.74	.39	3.10	.50	.21	371	14.5	7.3	118	11.7
LH	2.68	.32	2.78	.54	.27	259	19.7	9.0	72	10.3
Significance:	**	**	**	*	**	**	**	**	**	*
BLSD (.05)	.31	.04	.22	.10	.09	59	3.0	.8	25	2.4

III. Yield and Plant Measurements (Table 4)

A. Early plant height - All manures increased the early plant height as compared to CK and FE.

B. Early plant dry weight - All manure treated plots were significantly heavier than both CK and FE.

C. Root lodging - The LB treatment had the least lodging, but the three manure treatments were not significantly different. The LB and LH treatments were significantly lower than FE.

D. Stalks broken above and below the ear - There were no significant differences.

E. Ear moisture at harvest - The CK and FE treatments were significantly wetter than all manure treatments.

F. Corn grain yield - The FE treatment and all manure treatments were not significantly different. The CK treatment was lower than all other treatments.

G. Silage dry matter - The LH treatment was significantly drier than all other treatments.

H. Silage yield - The CK treatment was significantly lower yielding than all other treatments.

I. Soybean grain moisture - The three manure treatments were not significantly different, and FE < SB and LB and CK < FE.

J. Soybean grain yield - There was no significant difference in yield, but FE was the highest yielding treatment.

IV. Soil Sampling and Analysis

The plots were sampled to a depth of 16 ft. in the fall of 1975, but the results are not yet available.

Table 4. Summary of plant measurements - 1975.

	Corn										Soybeans		
			Harvest Measurements			Grain		Silage					
Treatment	Early plant weight inches	Early plants (10) dry wt. grams	Root lodged 30° or more %	Stalks broken above ear %	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. %	Grain moisture at harvest %	Yield bu/A	Plant height at harvest inches
CK	12.1	34.7	71.3	2.2	2.4	29.7	60.8	50.1	9,100	57.6	14.9	21.9	26.3
FE	16.9	66.0	51.4	3.0	3.7	27.4	104.5	50.8	14,000	58.4	15.4	30.1	29.3
SB	23.7	88.4	29.8	4.6	6.6	22.7	97.5	49.8	13,500	54.7	16.2	26.9	28.0
LB	22.2	88.7	8.0	5.5	10.3	24.0	92.3	49.6	13,400	54.5	16.2	23.5	30.0
LH	23.0	87.6	18.3	5.6	6.5	23.0	96.6	56.9	12,700	54.9	15.6	25.2	29.3
Signif.:	**	**	**	NS	NS	**	**	**	**	NS	*	NS	NS
BLSD (.05)	3.0	18.4	29.2	-	7.1	3.0	16.2	3.0	2,000	-	.7	-	-

THE RESIDUAL EFFECT OF RATES OF SOLID BEEF MANURE ON CORN GROWTH AND YIELD

West Central Experiment Station - Morris

S. D. Evans

The experiment which was initiated in 1971 was continued. Only one application of manure was made. Treatment descriptions and results in previous years are given in Soil Series 89, 91, and 95. The only change in 1975 was that the comparison of Furadan vs. no Furadan on each main plot treatment was dropped.

I. Planting Information

The plots were planted to corn (var. Pioneer 3965) on May 10, 1975. All plots were treated with Furadan at 10 lbs./acre (1 lb./acre active ingredient). Starter fertilizer consisting of 150 lbs./acre of 8-33-17 was applied to the fertilizer plots only. Nitrogen in the form of ammonium nitrate was applied to the fertilizer plots to provide 110 lbs./acre of N on October 14, 1974. All plots were plowed on October 16, 1974. Lasso was applied broadcast at 2 1/2 lbs./acre on May 8 and 2,4-D amine was applied with drop nozzles at 1/2 lb./acre on June 27.

II. Plant Tissue Analysis

A. Early whole plants (Table 1)

The only significant differences were in Zn and Mn contents. The fertilizer treatment was significantly higher in Zn than all manure treatments. The Mn content of SB @ 33 1/3 > SB at 66 2/3 and 100. The fertilized treatment > SB @ 100.

B. Leaf samples at silking (Table 2)

The Fe content of SB @ 100 > SB @ 33 1/3 and 66 2/3. The Zn content of fertilizer treatment was greater than all manure treatments.

III. Yield and Plant Measurements (Table 3)

There were no significant differences in any of the measurements made in 1975.

Table 1. Summary of analysis of early plant samples - 1975.[1]

Treatment	P	K	Ca	Mg	Zn	Cu	Mn	B
	%				ppm			
Fertilized	.45	3.70	.54	.38	50.4	7.4	128	8.0
Solid Beef @ 33 1/3 T/A	.44	3.94	.53	.37	29.0	7.6	140	7.4
Solid Beef @ 66 2/3 T/A	.46	4.03	.51	.34	32.4	6.7	118	6.7
Solid Beef @ 100 T/A	.50	4.40	.52	.32	30.2	5.4	112	5.9
Significance:	NS	NS	NS	NS	*	NS	+	NS
LSD (.05)	-	-	-	-	7.3	-	18	-

[1] Two reps only and iron values not given because of soil contamination.

Table 2. Summary of analysis of leaf samples at silking - 1975.[1]

Treatment	N	P	K	Ca	Mg	Fe	Zn	Cu	Mn	B
	%					ppm				
Fertilized	2.76	.27	2.20	.59	.37	275	21.2	8.2	70	9.6
Solid Beef @ 33 1/3 T/A	2.38	.27	2.46	.50	.33	226	15.0	7.7	64	9.4
Solid Beef @ 66 2/3 T/A	2.76	.29	2.34	.52	.33	249	16.5	8.2	74	10.2
Solid Beef @ 100 T/A	2.68	.29	2.59	.60	.32	308	14.6	8.9	80	9.8
Significance:	NS	NS	NS	NS	NS	+	**	NS	NS	NS
LSD (.05)	-	-	-	-	-	54	1.4	-	-	-

[1] Two reps only.

Table 3. Summary of plant measurements - 1975.[1]

Treatment	Early plant height inches	Early plant (10) dry wt. grams	Harvest Measurements: Root lodged 30° or more %	Harvest Measurements: Stalks broken above ear %	Harvest Measurements: Stalks broken below ear %	Grain: Ear moisture at harvest %	Grain: Yield at 15.5% M. Bu/A	Silage: Dry matter at harvest %	Silage: Silage yield (D.M.) lb/A	Silage: Ear wt. / Silage wt. %
Fertilized	15.6	46.2	63.8	5.1	3.0	27.1	111.3	51.0	14,900	56.4
Solid Beef @ 33 1/3 T/A	16.4	43.4	41.5	6.9	4.8	28.3	113.4	48.6	13,900	58.2
Solid Beef @ 66 2/3 T/A	18.4	46.9	16.8	16.5	2.8	25.8	102.4	50.0	14,200	55.0
Solid Beef @ 100 T/A	20.0	59.8	29.4	11.5	2.2	28.7	94.8	52.6	15,600	54.2
Significance:	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

[1] Two reps only.

MANURE RATE STUDY

West Central Experiment Station - Morris

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

Solid and liquid beef manures were applied and the effects were compared against check plots. Treatments and results from previous years are given in Soil Series 91 and 95.

I. Manure Application and Analysis

Manure was applied for the third time in the fall of 1974. Samples were taken at the time of application and were analyzed by the Animal Waste Laboratory in the Department of Agricultural Engineering. The amounts applied are given in Table 1. The chemical analysis of each manure is given in Table 2. Using these figures, the amount of each nutrient applied to each manure treatment was calculated and is given in Table 3.

II. Planting Information

The plots were planted to Pioneer 3965 on May 10, 1975. Furadan was applied at 10 lbs./acre (1 lb./acre active ingredient) to one-half of each main plot and the other half was left untreated. Starter fertilizer (consisting of 150 lbs./acre of 8-33-17) was used only on the fertilized treatment. Nitrogen had been applied to the fertilized treatment in the fall prior to plowing at a rate to give 110 lbs./acre of N. Lasso was applied broadcast at 2 1/2 lbs./acre on May 8 and 2,4-D amine was applied with drop nozzles at 1/2 lb./acre on June 27.

III. Soil Sampling and Analysis

The plots were sampled to a depth of 10 ft. in the fall of 1975 but the results are not yet available.

IV. Plant Sampling and Analysis

A. 1974 fodder and grain samples

Samples were collected from the insecticide treated portion of each main plot at the silage stage and analyzed.

1. Fodder (Table 4)

   a. Nitrogen - All manure treatments and FE were higher than CK. LB2 was also higher than FE, SB1, and LB1.

   b. Phosphorus - The manure treatments increased the phosphorus content.

   c. Potassium - All manure treatments were higher than FE except LB1. FE was higher than CK.

d. Magnesium - There was some reduction due to manure application with the solid beef manure causing the greatest reduction.

e. Chloride - Both manures increased the chloride content with solid beef manure bringing about the biggest change. There were no differences between rates within each type of manure.

f. Mg, Fe, Zn, Cu, Mn, and B - There were no treatment effects of the manures on these elements.

2. Grain (Table 4)

Only nitrogen was determined. The CK treatment was significantly lower than all other treatments. The manure treatments were not significantly different from FE.

B. 1975 early plants (Table 5)

1. Phosphorus - As the manure rates increased, the phosphorus content increased.

2. Potassium - Both manures increased the potassium content, but solid beef manure increased the levels more.

3. Calcium and magnesium - All manure treatments decreased the content of these two elements.

4. Zinc - There were significant differences, but all levels are adequate and the range is quite small.

5. Copper - Both manures decreased the content with solid beef manure bringing about the greatest reduction. Again the range between the high and low treatments is small.

6. Manganese - All manure treatments decreased the content with solid beef manure again causing the largest reduction.

7. Boron - There was no treatment effect on boron content.

C. 1975 leaf samples at silking (Table 6)

1. Phosphorus - In general the phosphorus levels increased as the manure rates went up.

2. Iron - All manures increased the iron content of the leaves.

3. P, K, Ca, Mg, Zn, Cu, Mn, and B - There were no treatment effects on these elements.

D. 1975 fodder and grain samples

Samples were collected but have not yet been analyzed.

V. Yield and Plant Measurements (Tables 7 and 8)

In 1975 many measurements were made during the growing season. At the silage stage 10 plants were selected at random in the insecticide treated portion of each plot. Silage yields were based on these plants and the average plant population in June for the entire experiment. Root ratings were made in late July. Lodging and other plant measurements were made just prior to ear corn harvest.

A. Main plot effects

1. Early plant height - All manure levels increased the plant height, but on the upper two levels of each manure were significantly higher.

2. Early plant dry weight - All manure treatments were significantly higher than CK, but only the upper two levels of each manure were higher than FE.

3. Root lodging - All manure treatments had less lodging than FE except LB2. FE had less lodging than CK.

4. Silage dry matter - CK and LB1 were the wettest and SB2 and LB3 were the driest.

B. Insecticide effects

The only significant effect was a reduction of 0.5 unit in the root rating due to insecticide application.

C. Interactions

There was an effect on yield which was significant at the 10% level.

VI. Summary

Three rates of solid beef manure and three rates of liquid beef manure have been applied for three consecutive years and the yields and soil measurements have been compared to check and fertilized plots. There are as yet not detrimental effects on the manures on yield. In 1975 the lower rates of both manures were equal to or higher in yield than fertilized plots. The highest rate of solid beef manure and liquid beef manure yielded 21.0 and 17.1 bushels/acre more, respectively, than the fertilized treatment. There were significant effects on many of the nutrients contained in the young plants, leaves at silking, fodder, and grain. The manures continued to reduce plant lodging.

Table 1. Actual amounts of manure applied in the fall of 1974.

Treatment	Dry Weight	Wet Weight
	- tons/acre -	
SB1	8.092	40.000
SB2	16.184	80.000
SB3	24.276	120.000
LB1	.875	18.700
LB2	1.750	37.400
LB3	2.625	56.100

Table 2. Average* analyses of manure samples applied in the fall of 1974.

		Type of Manure	
Measurement	Units†	SB	LB
pH	-	8.9	8.0
Total solids	%	20.2	4.7
Electrical conductivity	mmhos/cm	1.13	1.53
Total Kjeldahl N	%	2.9	9.2
NH_4^+-N	%	1.7	6.6
Organic N	%	1.2	2.6
Phosphates (PO_4-P)	%	0.76	1.99
Cl	%	2.12	2.63
Emission Spectrograph			
P	%	.93	2.06
K	%	2.42	3.05
Ca	%	0.96	2.47
Mg	%	0.46	1.08
Na	%	0.72	1.25
Fe	ppm	849	1124
Al	ppm	916	633
Mn	ppm	89	189
Zn	ppm	74	249
Cu	ppm	15	30
B	ppm	21	27

* Values based on two samples of SB and three samples of LH.

† Dry weight basis.

Table 3. Nutrients applied in 1974 for the 1975 crop year.

Element	SB1	SB2	SB3	LB1	LB2	LB3
			- lbs./acre -			
Total Kjeldahl N	469	939	1408	161	322	483
NH_4-N	275	550	825	116	231	346
Org-N	194	389	583	45	91	137
PO_4-P	123	246	369	35	70	104
Cl	343	686	1029	46	92	138
P	151	301	452	36	72	108
K	392	783	1175	53	107	160
Ca	155	311	466	43	86	130
Mg	74	149	223	19	38	57
Na	117	233	350	22	44	66
Fe	14	27	41	2.0	3.9	5.9
Al	15	30	44	1.1	2.2	3.3
Mn	1.4	2.9	4.3	0.3	0.7	1.0
Zn	1.2	2.4	3.6	0.4	0.9	1.3
Cu	0.2	0.5	0.7	0.05	0.10	0.16
B	0.3	0.7	1.0	0.05	0.09	0.14

Table 4. Chemical analysis of plant and grain samples collected on September 18, 1974.

Treatment	N	P	K	Ca	Mg	Cl	Fe	Zn	Cu	Mn	B	N
	%						ppm					- % -
	Fodder											Grain
CK	.57	.10	.73	.28	.40	.402	255	19.6	4.1	27.2	5.2	1.48
FE	.83	.07	1.16	.36	.51	.772	248	14.2	6.3	41.3	4.9	1.67
SB1	.91	.16	1.73	.34	.37	1.044	242	9.7	5.9	38.3	4.2	1.62
SB2	.94	.15	2.14	.35	.37	1.045	258	10.6	5.4	42.1	4.6	1.71
SB3	.96	.25	2.65	.33	.31	1.049	275	7.2	4.8	53.1	4.8	1.71
LB1	.91	.13	1.31	.40	.46	.863	277	9.5	7.0	43.5	4.9	1.68
LB2	1.02	.17	1.63	.37	.47	.879	325	10.3	6.0	49.6	5.1	1.68
LB3	.93	.13	1.96	.31	.38	.877	191	8.6	5.3	49.3	4.2	1.65
Significance:	**	**	**	NS	**	**	NS	NS	NS	NS	NS	**
BLSD (.05)	.12	.04	.35	-	.09	.125	-	-	-	-	-	.07

Table 5. Summary of analysis of early plant samples - 1975.[1]

Treatment	P	K	Ca	Mg	Zn	Cu	Mn	B
	%				ppm			
CK	.41	2.53	.56	.44	29.7	7.6	162	7.2
FE	.43	3.21	.56	.35	33.6	7.1	154	7.4
SB1	.45	3.97	.40	.29	27.1	5.8	123	6.9
SB2	.51	4.19	.38	.27	32.3	4.8	112	7.0
SB3	.56	4.36	.36	.26	31.6	4.5	108	6.7
LB1	.43	3.32	.54	.35	28.0	6.9	139	7.2
LB2	.46	3.68	.45	.31	26.9	5.5	124	6.7
LB3	.50	3.83	.44	.29	30.1	5.1	136	7.1
Significance:	**	**	**	**	*	**	**	NS
BLSD (.05)	.07	.38	.11	.04	4.5	.8	28	-

[1] Iron values not given because there was soil contamination.

Table 6. Summary of analysis of corn leaves at silking - 1975.

Treatment	N	P	K	Ca	Mg	Fe	Zn	Cu	Mn	B
	%					ppm				
CK	1.99	.22	1.85	.52	.38	151	14.8	6.2	69	8.7
FE	2.51	.26	2.21	.50	.33	176	18.8	7.6	91	9.5
SB1	2.61	.27	2.29	.51	.32	202	18.1	8.6	89	9.3
SB2	2.72	.31	2.90	.46	.23	228	16.1	6.1	114	10.8
SB3	2.82	.36	2.67	.52	.27	239	16.5	6.4	109	11.7
LB1	2.75	.26	2.25	.55	.38	197	15.1	7.9	98	9.0
LB2	2.92	.30	2.51	.55	.31	260	13.3	8.0	133	11.6
LB3	2.75	.33	2.99	.51	.26	266	13.8	7.7	151	11.0
Significance:	**	NS	NS	NS	NS	*	NS	NS	NS	NS
BLSD (.05)	.30	-	-	-	-	73	-	-	-	-

Table 7. Summary of 1975 plant measurements.

Treatment	Early plant height inches	Early plant (10) dry wt. grams	Root Rating (0-5)	Harvest Measurements: Root lodged 30° or more %	Harvest Measurements: Stalks broken above ear %	Harvest Measurements: Stalks broken below ear %	Grain: Ear moisture at harvest %	Grain: Yield at 15.5% M. bu/A	Silage: Dry matter at harvest %	Silage: Silage yield (D.M.) lb/A	Silage: Ear wt. / Silage wt. %
CK	14.3	37.4	3.2	82.6	4.0	1.0	29.6	77.4	50.7	13,400	55.8
FE	16.0	45.9	2.6	59.6	6.8	1.3	27.6	95.3	49.6	13,300	56.0
SB1	19.0	58.8	2.6	31.3	6.5	1.5	27.3	103.2	47.1	13,200	56.3
SB2	20.1	64.0	2.5	34.0	3.6	2.6	28.2	91.3	44.8	13,100	53.2
SB3	21.6	69.2	2.4	21.5	6.7	3.7	27.3	116.3	47.0	14,400	54.7
LB1	17.7	60.1	2.9	33.0	7.7	3.0	27.1	96.8	51.6	12,900	55.1
LB2	20.0	77.1	3.2	44.7	6.0	2.9	26.3	110.4	48.7	13,500	55.3
LB3	21.1	76.0	2.6	14.2	3.1	1.8	27.4	112.4	43.9	14,900	52.8
Significance:	**	**	NS	**	NS	NS	NS	NS	*	NS	NS
BLSD (.05)	3.6	18.8	-	22.1	-	-	-	-	6.1	-	-
+ Insecticide	18.8	N.M.[1]	2.5	35.7	5.7	2.5	27.5	103.2	N.M.	N.M.	N.M.
- Insecticide	18.6	N.M.	3.0	44.6	5.4	2.0	27.7	97.6	N.M.	N.M.	N.M.
Significance:	NS		*	NS	NS	NS	NS	NS			
Interaction Significance:	NS		NS	NS	NS	NS	NS	+	NS		

[1] N.M. = not measured on the (-) insecticide treated portion of each main plot.

Table 8. Plant measurements - 1975.

Main plot treatment	Insecticide	Early plant height inches	Root rating (0-5)	Harvest Measurements: Root lodged 30° or more %	Harvest Measurements: Stalks broken above ear %	Harvest Measurements: Stalks broken below ear %	Grain: Ear moisture at harvest %	Grain: Yield at 15.5% moisture bu/A
CK	W	14.5	3.1	84.0	3.4	1.4	28.6	79.6
	W/o	14.1	3.3	81.1	4.6	.5	30.5	75.1
FE	W	15.7	2.5	52.5	5.6	2.0	27.3	97.0
	W/o	16.4	2.6	66.7	8.0	.5	27.8	93.6
SB1	W	18.3	2.5	19.1	7.3	1.5	27.7	103.4
	W/o	19.6	2.8	43.5	5.7	1.5	27.0	102.9
SB2	W	19.6	2.0	20.8	3.1	2.6	27.9	108.2
	W/o	20.6	3.0	47.2	4.2	2.6	28.6	74.5
SB3	W	22.9	2.2	10.6	7.4	4.7	28.1	124.4
	W/o	20.2	2.5	32.4	6.0	2.7	26.6	108.2
LB1	W	17.3	3.1	39.0	8.7	3.0	27.3	92.7
	W/o	18.1	2.7	27.1	6.7	3.0	26.8	100.8
LB2	W	19.5	2.8	44.1	6.0	2.4	26.1	102.3
	W/o	20.5	3.6	45.2	5.9	3.4	26.4	118.5
LB3	W	22.3	2.1	15.2	4.1	2.0	27.0	117.9
	W/o	19.8	3.1	13.3	2.0	1.5	27.7	107.0

EFFICIENCY OF NITROGEN USE BY CORN FROM FALL VS. SPRING APPLIED UREA

A.C. Caldwell, S.D. Evans, L.L. Goodroad, and J.R. Gerwing

The efficiency of use of a fertilizer nutrient is commonly determined by yield, or by total nutrient uptake (which is yield of tissue times percent of the nutrient in the tissue). A more exact measurement of efficiency use is obtained by tagging a nutrient with an isotope (radioactive or stable) that can be traced in the plant and determined quantitatively. A stable (non-radioactive) isotope of nitrogen (15-N) was used at the West Central Experiment Station, Morris, to determine the relative efficiency of uptake of fall vs. spring applied urea by corn and also to determine the percent of the applied nitrogen which was retained in the top foot of soil. The data obtained in this experiment are shown in the accompanying table.

Percent of fertilizer N as urea taken up by corn forage and roots and retained in the soil.

Crop year	When fert. applied	Rate of N lbs/A	Fertilizer N in: Forage[1] %	Roots (0-3') %	Soil[2] (0-1') %	Total Fert. N accounted for: %
1974	Fall, '73	110	42	0.6	25	67.6
	Spring, '74	110	50	0.5	25	75.5
1975	Fall, '74	110	41	1.7	25	67.7
	Spring, '75	110	48	2.0	25	75.0

[1]Total above-ground portion of corn at physiological maturity.

[2]An average figure for values that ranged between 22 and 28.

The 2 years data show that more of the fertilizer N was taken up when applied in the spring rather than in the fall (about 15% more). This indicates a more efficienct use of the N that is applied nearer to time of need to the plant. In general, somewhat less than half of the total N applied was used by the corn plant when above-ground portions and roots were combined. It is of interest to note the small amount of fertilizer N recovered in the roots. Root samples were obtained when the corn was physiologically mature and were representative of the root population at that time. Earlier roots, which might have been expected to use a greater proportion of the fertilizer N, had long since died and the N in them had likely been taken up by the corn plant and become part of the soil N.

It is also worth of note that about 1/4 of the applied N was found in the top foot of soil. (Samples of soil from lower depths were taken and analyzed, but figures were so low and erratic that the data are not included).

In summary, it can be seen that from 2/3 to 3/4 of the applied fertilizer N was accounted for. The fate of the unaccounted for N can only be speculated upon. Nitrogen in the nitrate (NO_3) form is very water soluble and can be lost from soils in downward movement of soil water. Nitrogen can also be lost from soils in several gaseous forms if oxygen becomes depleted in the soil.

Studies on rates and times of application of fertilizer N on efficiency of use are continuing. Perhaps some combination can be found which will result in an uptake efficiency greater than 2/3 or 3/4 percent of the applied N.

PESTICIDE INTERACTION PLOTS AT ROSEMOUNT

Russell S. Adams, Jr.

An experiment examining the effects of combinations of the insecticide Furadan, the herbicide, Atrazine, and soil pH, continued for the third year in 1975. Treatments included combinations of five residual lime treatments, Furadan at 0, 1/2 and 2 pounds per acre and Atrazine at 0, 2, 4 and 8 pounds per acre. Each treatment was replicated four times. The plot area has been managed to produce severe pest infestation. Weed infestation is severe. About 90% of the weed population is giant foxtail. Most of the remaining 10% is velvet leaf. Corn is planted late to encourage root worm beetles. Infestation has been heavy, although lodging has been quite variable.

As was the case in 1973, in 1975 weed infestation, lodging, corn stands, and corn yields were quite variable. In 1975 rainfall was excessive in May and June and prevented effective mechanical weed control. As a result no-chemical treatment plots produced large amounts of weed vegetation and corn yields were markedly reduced. The effect of the weed competition was more pronounced because of inadequate rainfall in July and August.

Greenhouse studies have shown an interaction between Furadan and Atrazine which enhances the latter's activity. Furadan also has been shown to give some herbicidal effects. Until 1975, no interaction effects were observed in the field. If a three-way interaction exists on corn yields, then yields should increase as one reads down and to the right in the tables. Corn yields appear to increase when examined this way, but due to variability differences are not significant. In the absence of the herbicide Furadan has consistently shown herbicidal activity in the field. The effect was particularly pronounced in 1975.

Greenhouse studies have also confirmed that giant foxtail frequently does not grow as vigorously in high lime soils. Weed yields have been consistently lower on the high lime treatments. Lime also increases the activity of atrazine, which is also demonstrated.

Over the three years of the study Atrazine alone at normal rates has increased yields about 30% and Furadan alone at normal rates has increased yields about 30%. In combination the chemicals have increased yields about 45%.

Table 1. The amount of lodging, weed growth, and corn yields in Atrazine-Furadan-soil pH studies at Rosemount, Minnesota, 1975.

Rate of Furadan lbs/A lime status	Atrazine applied, lbs/A: None			2.0			4.0			8.0		
	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	35	3.20	26	22	1.21	88	28	0.76	103	5	0.28	111
1/2	8	4.00	46	18	1.26	96	8	1.09	89	10	0.32	121
2	12	2.15	78	28	1.97	86	3	1.26	81	5	0.38	118
Moderate lime-slightly acid (~pH 6.3)												
Furadan 0 lbs/A	15	4.20	49	22	1.13	71	5	0.52	111	28	0.04	124
1/2	13	2.60	48	5	0.89	93	2	0.98	109	8	0.25	117
2	0	3.80	64	13	1.78	80	15	0.50	104	10	0.25	122
Well limed-near neutral (~pH 6.8)												
Furadan 0 lbs/A	43	2.49	36	13	1.43	96	30	0.35	104	20	0.14	127
1/2	37	2.85	76	5	1.38	87	8	0.62	106	43	0.20	113
2	20	1.90	71	15	1.87	102	22	0.90	108	15	0.12	110
Heavily limed-slightly calcareous (~pH 7.2)												
Furadan 0 lbs/A	21	3.56	49	15	0.26	93	17	0.11	102	23	0.09	100
1/2	5	2.79	77	10	0.56	96	15	0.28	104	21	0.04	110
2	23	1.21	83	23	0.61	115	4	0.13	119	25	0.01	121

Table 2. The amount of lodging, weed growth, and corn yields in Atrazine-Furadan-soil pH studies at Rosemount, Minnesota, 3 year average.

Rate of Furadan lbs/A lime status	Atrazine applied, lbs/A: None			2.0			4.0			8.0		
	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	50	1.63	58	47	0.82	80	52	0.37	88	32	0.13	93
1/2	23	2.06	67	36	0.59	90	37	0.58	83	34	0.18	95
2	14	1.28	77	37	0.82	90	6	0.58	84	36	0.15	94
Moderate lime-slightly acid (~ pH 6.3)												
Furadan 0 lbs/A	42	2.09	70	53	0.52	79	40	0.28	90	49	0.01	98
1/2	40	1.49	62	34	0.48	87	28	0.41	100	40	0.10	93
2	15	1.87	72	26	0.86	85	15	0.23	94	20	0.11	99
Well limed-near neutral (~ pH 6.8)												
Furadan 0 lbs/A	46	1.52	63	29	0.72	85	47	0.16	91	44	0.06	100
1/2	49	1.47	79	31	0.87	80	31	0.28	97	49	0.07	102
2	17	1.23	78	14	0.80	102	23	0.43	103	23	0.05	100
Heavily limed-slightly calcareous (~ pH 7.2)												
Furadan 0 lbs/A	57	1.64	68	56	0.18	90	56	0.06	88	52	0.03	88
1/2	32	1.47	82	33	0.40	97	36	0.15	96	40	0.04	101
2	36	0.82	88	33	0.29	94	19	0.14	97	31	0.00	103

ALFALFA AND RED CLOVER POTASSIUM AND COPPER TRIALS

Staples, Minnesota - 1975

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

POTASSIUM TREATMENT EFFECT (ALFALFA AND RED CLOVER)

Plots were established in July of 1970. Experiments on phosphorus, lime and sulfur were discontinued after 1974. No significant effect from these treatments were noted. Phosphorus and sulfur tested high in all of these trials. The soil pH was originally low, but it was determined that irrigation water had a calcium carbonate content of 280 ppm. This resulted in over 1,000 pounds of lime equivalent added annually. The check plots in 1974 had a pH of 7.1, making the lime experiment meaningless.

POTASSIUM TREATMENTS ON RED CLOVER AND ALFALFA

	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	6.6c	6.1b	6.2b	6.4bc	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%
	Soil Test K lbs/A						
Alfalfa							
1972	92	258	322	160	165	185	
1973	85	290	210	150	140	195	
1974	60	175	240	95	75	200	
1975	48	178	160	75	63	135	
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	

* red clover failed in 1974, was reseeded August 1, 1974 and a good stand was established for 1975.

	Plant Analysis %K						
	None	June 240	Oct. 240	June 120	Oct. 120	June 120 Oct. 120	Significance
Alfalfa							
1972							
1st cut	2.05	2.76	2.89	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	1.58a	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	2.36	
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	2.45bc	1%
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%

The potassium (K) experiment has provided useful data on differences between alfalfa and red clover K needs.

In 1975, the 240 pound potash treatments were significantly higher than 120 pounds per acre for alfalfa, but not for red clover. There has been no significant difference in yield between October or June application. Plant analyses show higher K content from October treatments at the first cutting time. This is prior to the June K applications. K content in plants at time of the last cutting is higher from June treatments. This is generally

true for all years of the experiment. Check plots after the first year show plant K to be less than 2 percent in both alfalfa and red clover. Potassium soil tests are unusually low in 1975, but are in agreement with K treatment. The basic difference between alfalfa and red clover so far is the loss of red clover stand and the necessary reseeding of this crop in 1974. Alfalfa is still grown from the seeding of 1970.

COPPER OBSERVATIONS

	Lbs/acre of copper applied as copper sulfate		
	0	10	Sig. 5%
		Tons/Acre	
Alfalfa			
1972	0.52	0.60	3rd cutting only
1973	5.3	5.4	ns
1974	6.4	6.9	ns

In 1972 to 1974, copper treatments were made on a special area of alfalfa adjacent to the alfalfa-red clover site. There was a slightly higher yield from copper treatments, but this was not significant at the 5 percent level.

In 1975, two of the four replicates in the alfalfa-red clover trials had 10 pounds per acre of copper.

	Lbs. of copper applied as copper sulfate (1975)		
	0	10	Sig.
		Tons/Acre	
Alfalfa	5.8	6.1	ns
Red Clover	5.6	5.8	ns
		ppm Cu plant tissue	
Alfalfa	0.8	2.2	1%
Red Clover	4.5	4.3	ns

Trials will be continued in 1976.

PLANT AND GRAIN YIELD AND NITROGEN CONTENT OF FERTILIZED CORN UNDER IRRIGATION (CMIDR STATION, STAPLES, MINNESOTA, 1975)

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

An experiment was established on an Estherville loamy sand at the CMIDR Station at Staples, Minnesota in the spring of 1974 to study the effects of time and rate of application of fertilizers on corn yield and to account for those essential nutrients and other elements added to soils by analysis of plant, soil, and materials applied. The results reported below are some observations from the second cropping year, 1975.

A 90-day hybrid was planted at 26-27,000 seeds per acre in middle May in 36" rows. Herbicides were used to control weeds. Irrigation water was applied as needed. Fertilizer treatments and rates are given in the table. The urea was not applied at one time, but at 2, 3, or 4 intervals up to tasseling time depending upon the rate required. For example, the 60 pound rate of nitrogen (treatment 2) was split into 22 and 40 pound allotments of nitrogen as urea; the 240 pound rate was split into 40, 80, 80, and 20 pound allotments of nitrogen as urea. The soybean meal was applied prior to planting, all at one time. The treatments were replicated four times.

Total plant yield was obtained by sampling the corn when it had attained maximum growth and no loss of leaves. Grain yield was determined on mature corn. Grain and plant tissue were analyzed for nitrogen.

Total plant yields increased with increasing nitrogen rates up to about 200 pounds N/A (see accompanying table). An additional 150 pounds of K/A gave about the same yield as the basic application. An additional 30 pounds of P/A appeared to reduce plant yields slightly.

Grain yields increased with increasing nitrogen rates up to about 200 pounds N/A.

Pounds per acre of N in the tissue and grain show the amounts required to produce the dry matter and yields obtained. Treatment 5 (200 lbs N/A) gave about maximum yield but returned less than half (81 lbs) of the original 200 pounds of N applied.

Total plant and grain yield and nitrogen content of corn under irrigation (CMIDR, Staples, 1975).

No.	[1]Fertilizer Treatments N	P	K	Total Plant Yield	Nitrogen in tissue		Grain Yield	Nitrogen in Grain	
	lbs/A			T/A	%	lbs/A	bu/A	%	lbs/A
1	18	10	150	2.10	0.67	28	38	1.10	20
2	80	10	150	4.01	0.87	70	82	1.21	47
3	120	10	150	4.58	1.17	107	98	1.42	66
4	160	10	150	4.86	1.16	112	109	1.46	75
5	200	10	150	5.15	1.23	127	113	1.51	81
6	240	10	150	5.11	1.28	131	114	1.52	82
7	160	40	150	4.55	1.15	105	102	1.46	71
8	160	10	300	4.96	1.21	120	110	1.50	78
9	160	24	194	4.87	0.93	91	94	1.38	61

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

NITROGEN TRIALS ON SPRING WHEAT UNDER IRRIGATION AT STAPLES IN 1975

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

As a continuation of a trial initiated in 1973, a time and rate of nitrogen fertilizer experiment was conducted on a Hubbard sandy loam soil at Staples in 1975. As in 1974, two semi-dwarf wheat varieties, Kitt and Era, were grown. A randomized complete block design was used with six nitrogen treatments, applied as ammonium nitrate, replicated four times.

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

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

Soil nitrate nitrogen levels in the 0-24 zone, when sampled at planting time, were very low at 15 lbs/A. Soil test levels of P and K were very high and medium, respectively.

Grain yields for the two varieites were far below normal ranging from 11-26 bushels per acre (Table 1). In the two previous years Era at the 100 lbs N/A rate yielded an average of 59 bu/A. This drastic reduction in yield was probably due to the combination of a late planting date, May 2, followed by above average temperatures for the month of May.

Table 1. Yields of Era and Kitt wheat as affected by nitrogen fertilizer rates under irrigation at Staples in 1975.

Fertilizer Treatments	Variety	
	Era	Kitt
lbs N/A	---------Bu/A----------	
0	12	11
50	17	17
75	23	19
100	26	25
125	22	20
175	22	22
Significance	**	**
BLSD (.05)	4	4

Forage yields for both varieties were collected at the soft dough stage to determine total dry matter, percent nitrogen and total nitrogen removal at the various nitrogen fertilizer rates. As with grain yield, forage yields were below the average of previous years. The results of these measurements are reported in Tables 2 and 3.

Table 2. The dry matter yield, percent nitrogen concentration and pounds of nitrogen in Era wheat as affected by nitrogen fertilizer rates at Staples in 1975.

Fertilizer Treatment	Forage Yield	N	N Removed in Forage
lbs N/A	Tons/A	%	lbs/A
0	0.7	1.39	20
50	1.5	1.47	45
75	2.1	1.56	66
100	2.0	1.73	69
125	2.4	1.93	92
175	2.3	2.09	98
Significance	**	**	**
BLSD (.05)	0.5	0.19	13

Table 3. The dry matter yield, percent nitrogen concentration and pounds of nitrogen in Kitt wheat as affected by nitrogen fertilizer rates at Staples in 1975.

Fertilizer Treatment	Forage Yield	N	N Removed in Forage
lbs N/A	Tons/A	%	lbs/A
0	1.0	1.68	34
50	2.2	1.46	63
75	2.5	1.62	79
100	2.9	1.88	108
125	3.2	1.98	126
175	3.2	2.24	141
Significance	NS	*	*
BLSD (.05)		0.36	74

N RATE STUDIES ON IRRIGATED WHEAT AND OATS WITH LEGUME UNDERSEEDING, STAPLES, 1975

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

With the high cost of nitrogen in 1974 and prospects for higher priced nitrogen in the future, an experiment was established in the spring of 1975 to take a new look at an old idea with the following goals:

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

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

c) determine optimum N rate for oats and wheat following plowing under of an established stand of red clover.

Froker oats, Era wheat and Lakeland red clover served as the test crops. The experiment consists of a randomized complete block design with four replications and four N rates. Urea was used as the source of N.

N rates were 0, 40, 80 and 120 pounds per acre. One-half of the N was applied at seeding and the remaining N applied just prior to the boot stage.

Soil tests prior to initiation of the experiment were: pH, 5.9; phosphorus, 60 and potassium 100.

Potassium was broadcast at the rate of 300 pounds K/acre prior to plowing. One-half of the urea was applied broadcast and incorporated by harrowing prior to seeding. Seeding rate in pounds per acre was: wheat, 120; oats, 96; and red clover, 16.

Potash was broadcast on April 24 and the experimental area was plowed, disced on April 25 and seeded on May 2. Grain emerged on May 10. N deficiency symptoms became severe on the check and low N plots by June 6.

Stooling occurred in late May and the boot stage was reached about mid-June. The second increment of N was applied on June 16 to correspond with booting.

Bacterial infection of the wheat became quite evident by the first week of June.

Although the late spring did not permit seeding as early as desired, the warm temperatures in May permitted catch up and near normal development dates were recorded. Grain yields were determined on August 5.

Table 1. Rainfall and Irrigation of Small Grain Plots, Staples 1975.

Month	Irrigation (Inches)	Rainfall (Inches)	Total (Inches)
May	3.60	1.64	5.24
June	1.75	6.0	7.75
July	6.85	2.2	9.05
August	1.25	--	1.25
	13.50	9.90	23.40

Table 2. Grain Yield from Irrigated Rotational Study, Staples, 1975.

#N/Ac	Oats	Oats and Red Clover	Wheat	Wheat and Red Clover
		Bu/A		
0	24.0	24.0	7.3	5.0
40	35.8	44.8	18.0	13.0
80	40.8	51.8	21.3	16.5
120	34.8	41.0	24.0	17.0
Treatments	*	NS	**	**
BLSD (.05)	4.3	--	5.8	4.1
C.V.	17.3	29.9	21.1	20.8

Table 3. Protein in Grain from Irrigated Rotational Study, Staples, 1975.

#N/Ac	Oats	Oats and Red Clover	Wheat	Wheat and Red Clover
		(% Protein)		
0	14.4	11.9	12.4	12.3
40	13.6	12.0	11.8	11.1
80	15.1	12.4	13.0	12.4
120	15.7	14.0	15.7	13.4
Treatments	NS	NS	**	**
BLSD (.05)	--	--	.58	.44
C.V.	12.4	10.1	6.2	4.9

Table 4. Oat Forage Yields, Staples, 1975.

lbs N/Ac	Tons D.M./Ac	Percent Protein in forage	Lbs Protein per acre in forage	Lbs N per acre in forage
0	1.36a	5.28	143.2	22.9
40	3.00b	5.19	311.4	49.8
80	3.12b	6.00	377.9	60.5
120	3.09b	7.03	441.1	70.6
Treatments	*	NS	NS	NS
BLSD (.05)	.89	--	--	--
C.V.	14.5	17.5	34.8	34.8

Table 5. Oat and Red Clover Forage Yields, Staples, 1975.

lbs N/Ac	Tons D.M./Ac	Percent Protein in forage	lbs Protein per acre in forage	lbs N per acre in forage
0	1.82a	7.32bc	260a	42a
40	1.95a	5.22a	204a	33a
80	3.00b	6.69ab	401b	64b
120	2.76b	8.38c	461b	74b
Treatments	*	*	**	**
BLSD (.05)	.79	1.58	70	11
C.V.	14.2	9.7	6.6	6.6

Table 6. Wheat Forage Yields, Staples, 1975.

lbs N/Ac	Tons D.M./Ac	Percent Protein in forage	lbs Protein per acre in forage	lbs N per acre in forage
0	0.6a	7.56a	91a	73.3
40	1.33b	6.81a	179b	42.7
80	2.27c	8.16ab	370c	57.3
120	2.67c	9.53b	510d	76.6
Treatments	**	*	**	**
BLSD (.05)	.55	1.46	83.6	13.4
C.V.	10.0	7.7	9.1	9.1

Table 7. Wheat and Red Clover Forage Yields, Staples, 1975.

lbs N/Ac	Tons D.M./Ac	Percent Protein in forage	lbs Protein per acre in forage	lbs N per acre in forage
0	1.55	14.8b	458	73.3
40	1.75	7.7a	267	42.7
80	2.02	8.8a	358	57.3
120	2.57	9.3a	479	76.6
Treatments	NS	**	NS	NS
BLSD (.05)	--	1.9	--	--
C.V.	16.2	5.8	18.5	18.5

Maximum temperature at the two-inch depth is plotted in Figure 1. It will be noted that excessively high temperatures occurred extensively following the boot stage and throughout the filling stage.

Rainfall, irrigation and adjusted pan evaporation[1/] are plotted in Figure 2, on a 7-day interval.

Tentiometers were utilized to gauge available soil moisture. Figure 3 shows a plotting of the moisture retention curve from saturation to 0.5 bars of a fine sandy loam. It will be noted that at 0.3 bar, 50 percent of the available soil moisture is withdrawn from the soil. Obviously this 50 percent of the soil moisture is extracted by plant roots with far less effort than the last 50 percent. During periods of high temperature, accompanied with dry winds and low relative humidity, the moisture needs of small grain must be staggering.

A shallow rooted crop as wheat or oats growing on sandy soils may be extremely sensitive to dry hot surface soil conditions, particularly at critical stages of development. Irrigation at close intervals may be imperative to attain reasonable yields. On research plots it would appear irrigation might be initiated at 0.2 bar, a point when 35 percent of the available moisture is dissipated. This would be particularly true during periods of high, open pan evaporation.

To lend credence to the above, research from Kansas[2/] is relative.

Irrigated at % Moisture Depletion in Top 24 Inches	Corn Grain Yield Bu/Ac
40	160
60	112
80	50

Effects of N Sources and Irrigation Scheduling on Corn Yields, p. 123, Kansas Fertilizer Research Report of Progress - 1975.

1/ A variable factor of 0.4 to 0.75 open pan data, adjusted according to vegetative development, temperature, wind and R.H.

Figure 1. Maximum Temperature @ 2-inch Depth, Staples, Minn., 1975

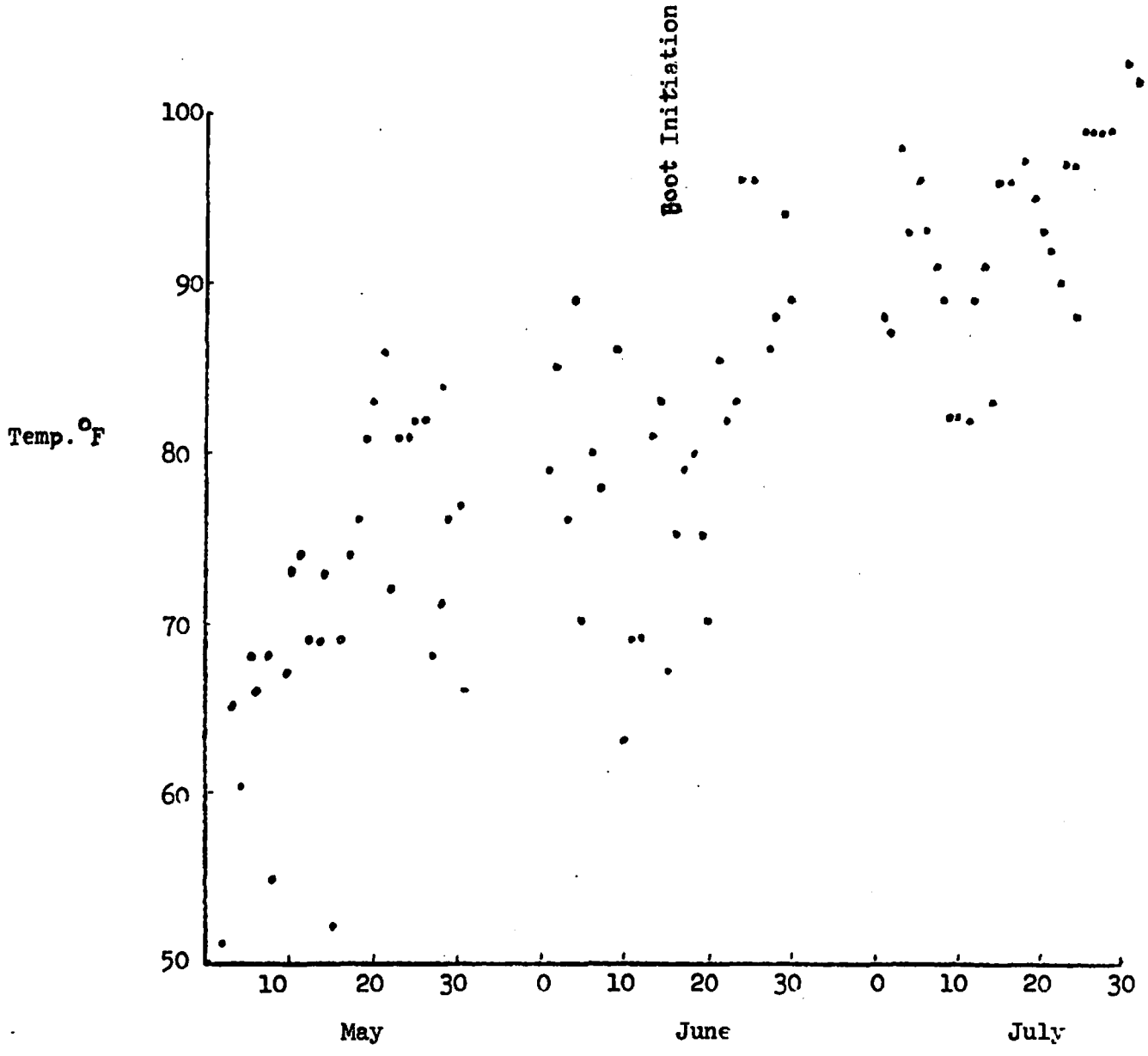


Figure 2. Rainfall, Irrigation & Adjusted Pan Evaporation, Small Grain Plots, Staples, Minn., 1975

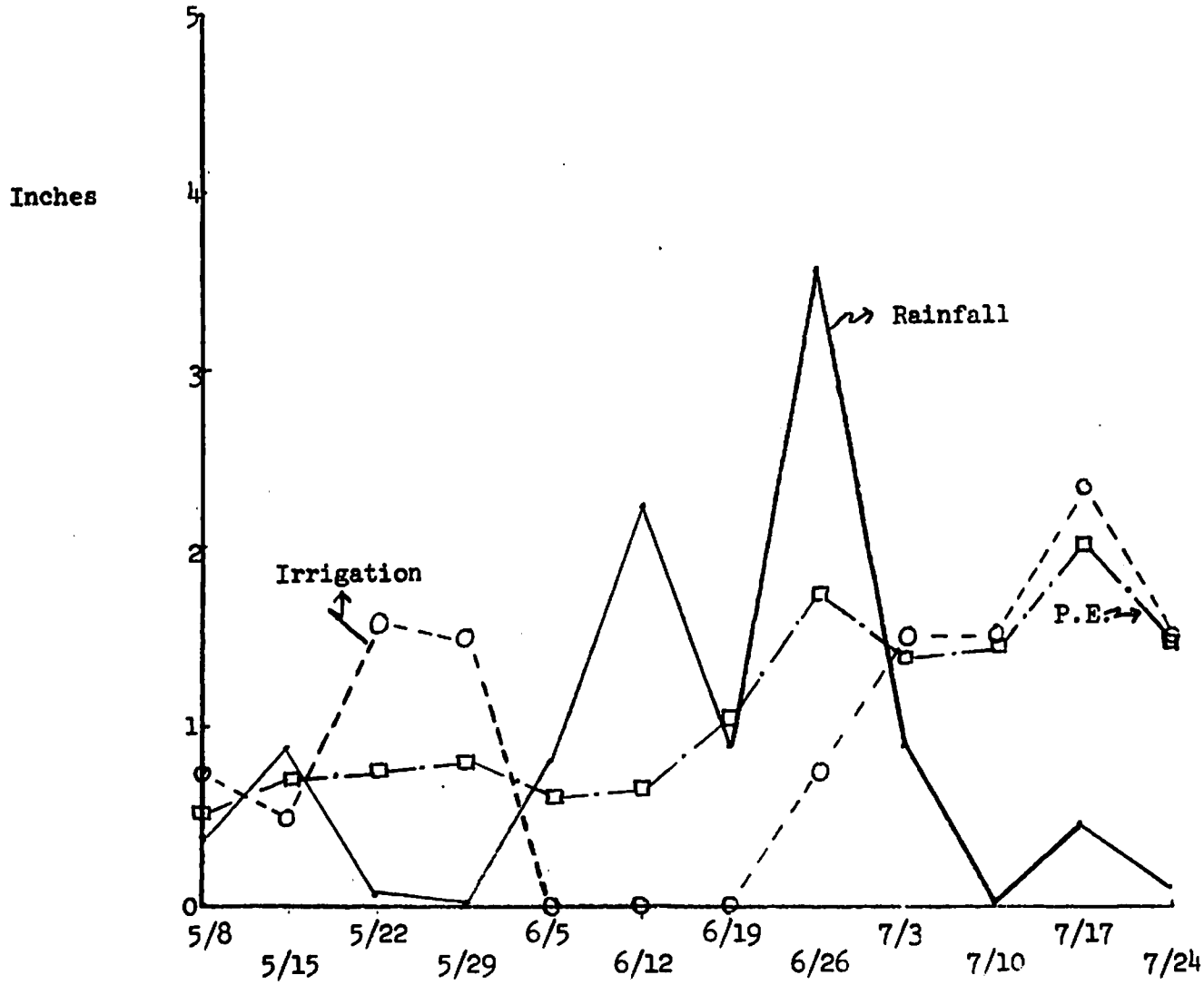
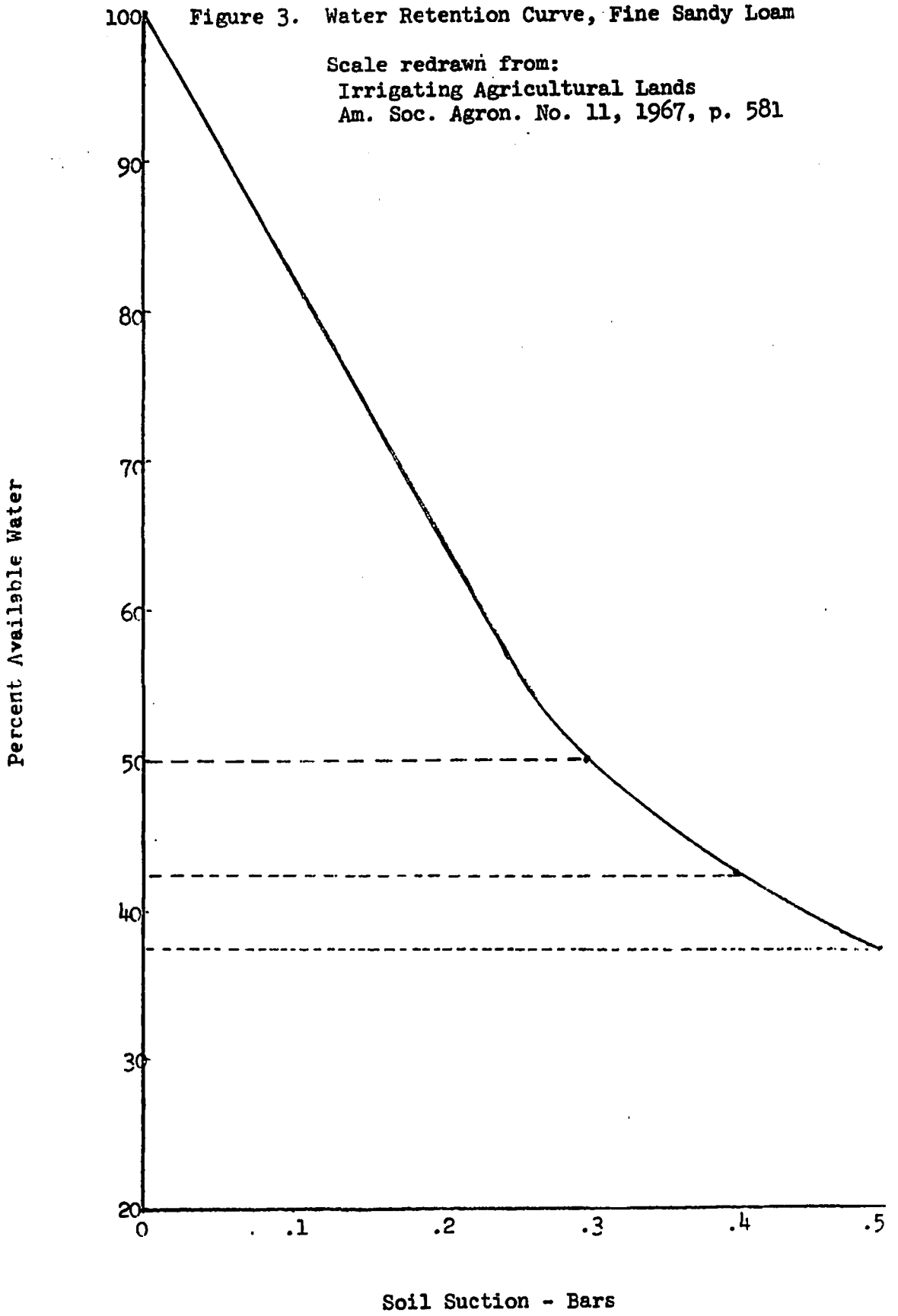


Figure 3. Water Retention Curve, Fine Sandy Loam

Scale redrawn from:
Irrigating Agricultural Lands
Am. Soc. Agron. No. 11, 1967, p. 581



WATER QUALITY STUDIES AT STAPLES, 1975

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

In an effort to better understand some observations of increased soil pH on the Staples farm, water samples were taken from pumping wells used to supply irrigation water on the station.

Water samples were analyzed for boron and hardness or mg $CaCO_3$ per liter.

Data are presented in the following tables.

Table 1. Boron content and water alkalinity from the center well, Staples Irrigation Center, 1975.

Date	PPM B	Lbs. B Per Acre ft. water	Mg $CaCO_3$/liter	Lbs. $CaCO_3$ per Acre ft. water
5/27	0.03	.08	164	445
6/24 (1)	0.04	.11	148	402
6/24 (2)	----	---	132	359
7/12 (1)	0.02	.05	155	421
7/12 (2)	----	---	182	495
8/2 (1)	0.03	.08	157	427
8/2 (2)	0.03	.08	141	383
Average		.08		419

Table 2. Boron and water alkalinity from the North well, Staples Irrigation Center.

Date	PPM B	Lbs. B per Acre ft. water	Mg $CaCO_3$/liter	Lbs. $CaCO_3$ per Acre ft. water
5/12 (1)	----	---	144	391
5/12 (2)	.06	.16	148	402
5/24	.02	.05	167	454
6/24	.01	.03	169	459
7/12	.04	.11	188	511
8/2 (1)	.04	.11	159	432
8/2 (2)	.03	.08	153	416
9/24 (1)	.06	.16	242	658
9/24 (2)	.08	.22	240	632
Average		.09		484

In late 1974, more complete water analysis was determined. These data appear in Table 3.

Table 3. Water analyses from Staples Irrigation Center sampled 11/11/74.

No.	(NO_3+NO_2)-N	Ca Mg/l	Mg Mg/l	Hardness $CaCO_3$ Mg/l	Total Alkalinity $CaCO_3$ Mg/l	pH	PO_4-P Mg/l	B Mg/l	Na Mg/l	SO_4-S PPM
1-1	2.2	76.0	20.8	276	282	7.7	0.002	.07	2.20	4.6
1-2	2.4	76.0	21.1	272	285	7.7	0.002	.07	1.90	4.5
1-3	2.6	76.2	21.2	277	280	7.4	0.001	.07	1.90	4.5
2-1	7.6	80.6	23.2	297	280	7.4	0.003	.03	2.12	4.4
2-2	7.3	42.7	22.7	200	282	7.5	0.001	.03	1.92	4.4
3-1	7.6	80.6	23.8	299	274	7.5	0.004	.03	2.11	4.4
3-2	6.9	81.3	23.7	301	277	7.4	0.002	.03	2.25	4.6
4-1	5.0	37.3	15.8	158	156	7.6	0.001	.03	1.45	4.6
4-2	6.6	37.7	22.4	186	188	7.5	0.001	.03	1.92	4.6

Typically alfalfa receives 18-inches of supplemental water via irrigation in one season. Therefore, it appears reasonable to assume that irrigation water delivers to the soil the equivalent of approximately 700 pounds of fine lime annually.

SOUTHERN EXPERIMENT STATION - WASECA
WEATHER DATA - 1975

Month	Period	Precipitation 1975	Precipitation Normal	Avg. Air Temp. 1975	Avg. Air Temp. Normal	Growing Degree Days 1975	Growing Degree Days Normal
		inches		°F			
January	1-31	2.68	.73	13.3	12.9		
February	1-28	.48	.96	13.4	17.5		
March	1-31	1.70	1.94	19.5	28.5		
April	1-30	3.96	2.48	37.1	45.6		
May	1-10	.89		52.1		52.5	
	11-20	.12		61.7		134.0	
	21-31	1.72		66.0		180.5	
	Total	2.73	3.86	60.1	57.7	367.0	323
June	1-10	1.08		60.6		127.0	
	11-20	4.60		64.2		142.5	
	21-30	1.07		75.3		246.5	
	Total	6.75	4.75	66.7	67.1	506.0	521
July	1-10	.33		74.7		239.5	
	11-20	.01		70.2		198.0	
	21-31	.02		74.2		250.0	
	Total	.36	4.02	73.1	71.4	687.5	637
August	1-10	1.89		72.2		215.5	
	11-20	.50		68.4		181.0	
	21-31	.65		69.9		216.5	
	Total	3.04	3.60	70.1	69.7	613.0	583
September	1-30	1.22	3.45	56.0	60.3	155.5	310
October	1-31	.21	1.89	50.5	50.3		44
November	1-30	4.39	1.25	36.4	32.9		
December	1-31	1.19	1.02	19.6	19.0		
Year	Jan-Dec	28.71	29.95	43.0	44.4	2329.0	2418
Growing Season	May-Aug	12.88	16.23	67.5	66.5	2173.5	2064

Notes:

1) 7.68" rain between May 29 and June 22.

2) 0.53" rain between June 23 and August 1.

3) Frost - 31° on September 13.

NITROGEN FERTILIZATION OF CORN

Waseca, 1975

G. W. Randall and W. E. Lueschen

Two field experiments were initiated in the fall of 1971 and spring of 1972 to obtain additional information on nitrogen fertilization of corn in south-central Minnesota. These studies have been continued and, hopefully, will supplement information obtained from long-term experiments initiated in 1969 by Fenster, Overdahl and Frazier. Results from 1972, 1973 and 1974 were reported in Soil Series 89, 91 and 95, respectively.

Experiment I

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

Soil test P (36 lb./A) and K (300 lb./A) were considered high; consequently, starter and broadcast P and K applications were not used. Ammonium nitrate, urea and 28% N solution were fall-applied on 10/23/74 and plowed down. Anhydrous ammonia was applied on 11/19/74. Ammonium nitrate, urea and UAN (urea-ammonium nitrate solution, 28% N) were spring-applied on 5/9/75 and disked in. The anhydrous ammonia was applied on 5/10/75. Both fall and spring soil conditions were excellent for N application. In 1974, UAN was substituted for aqua ammonia (20% N) because of the unavilability of the latter material.

Corn (Pioneer 3780) was planted at 26,000 ppA in 30" rows on May 17. An insecticide (Counter at 1 lb./A) was applied at planting. Weeds were controlled with 3 lb./A of Lasso and 2½ lb./A of Atrazine applied preemergence on May 22. Soil nitrate samples were taken to a depth of 2 feet from all 150-lb treatments on July 9. The leaf opposite and below the ear was sampled at silking and was submitted for Kjeldahl analysis. Yields were taken on October 16, by combine harvesting the center two rows from each plot.

Results

Nitrogen concentrations in the earleaf and grain (protein), yield, grain moisture and N removal with the grain were affected significantly by the N treatments in 1975 (Table 1). Because of the very wet soil conditions during June followed by the hot, dry conditions of July and August, experimental variability was high as shown by CV's of approximately 25% for yield and N removal. Soil compaction resulting in

non-uniform root growth could have been a major cause of this variability.

Table 1. Continuous corn parameters as influenced by source, rate and time of application of N at Waseca in 1975.

Treatment			Leaf	Grain			
Source	Rate	Time	N	Moisture	Yield	N	N Removal
	lb N/A		%	%	bu/A	%	lb N/A
Anhyd. Am.	75	F	1.99	19.0	52.1	1.66	40.8
"	75	S	1.99	20.1	53.4	1.64	41.0
"	150	F	2.39	21.9	64.1	1.73	50.4
"	150	S	2.19	20.7	57.3	1.74	47.0
Urea	75	F	1.89	18.6	51.9	1.50	34.6
"	75	S	1.88	20.1	52.8	1.58	38.5
"	150	F	2.09	19.7	71.7	1.57	52.4
"	150	S	2.32	20.1	69.8	1.68	53.2
Am. Nitrate	75	F	1.69	18.2	34.8	1.52	25.0
"	75	S	2.20	20.1	51.4	1.60	38.8
"	150	F	2.05	20.6	46.5	1.54	33.6
"	150	S	2.36	20.9	64.4	1.72	51.7
UAN[1/]	75	F	1.71	17.9	33.0	1.50	24.0
"	75	S	1.98	18.5	51.3	1.48	35.8
"	150	F	1.87	18.7	47.8	1.51	33.6
"	150	S	1.85	19.1	60.9	1.54	44.1
Significance:			**	**	*	**	**
CV (%) :			7.4	6.0	25.4	5.6	24.7
BLSD (.05) :			.20	1.8	23.3	.13	15.6
Individual Factors							
Source							
Anhydrous Am.			2.14	20.4	56.7	1.69	44.8
Urea			2.04	19.6	61.5	1.58	44.7
Am. Nitrate			2.07	19.9	49.3	1.59	37.3
UAN			1.85	18.5	48.2	1.51	34.4
Significance:			**	**	*	**	**
BLSD (.05) :			0.10	0.8	10.4	.06	7.3
Rate							
75 lb. N			1.91	19.0	47.6	1.56	34.8
150 lb. N			2.14	20.2	60.3	1.63	45.8
Significance:			**	**	**	**	**
Time							
Fall			1.96	19.3	50.2	1.56	36.8
Spring			2.10	19.9	57.6	1.62	43.8
Significance:			**	*	*	*	**
Interaction							
Source X Rate			*	ns	ns	ns	ns
Source X Time			**	ns	+	+	+
Rate X Time			ns	*	ns	ns	ns
Source X Rate X Time			+	ns	ns	ns	ns

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

In general, anhydrous ammonia and urea were superior to ammonium nitrate and UAN forms of N in 1975. Highest grain yields and N removal were obtained with the ammonium forms of N, regardless of the time of application, and the spring-applied ammonium nitrate and UAN treatments. Fall application of the latter two nitrogen sources reduced yields sharply.

Leaf N from UAN was significantly lower than from the other N sources. Protein levels were ranked anhydrous > urea = ammonium nitrate > UAN.

All parameters were increased significantly by both the 150-lb rate and the spring application. However, a Source X Time interaction was significant for leaf and grain N, yield and N removal. For these parameters the ammonium forms of N (82% and 45%) generally were not affected by the time of application; whereas, the nitrate forms (33% and 28%) were affected significantly.

Soil NO_3-N analyses showed marked differences among the treatments (Table 2). Spring application resulted in NO_3-N levels being approximately double over fall application, except for UAN. No reason can be given for the low values with spring-applied UAN. Nitrate levels from fall-applied anhydrous ammonia and urea were slightly higher than from ammonium nitrate or UAN.

Table 2. Effect of N source and time of application on soil NO_3-N in July, 1975.

Treatment 1/		
Source	Time	NO_3-N (0-24")
		lb/A
Anhyd. Am.	F	68
"	S	129
Urea	F	66
"	S	132
Am. Nitrate	F	54
"	S	124
UAN	F	52
"	S	60

1/ 150 lb N/A

Three-year yield averages show urea to be equal to anhydrous ammonia (Table 3). Yields from fall applications were similar to spring applications of these ammonium forms of N. The nitrate forms, however, provided a vastly different picture.

Table 3. Continuous corn yields as influenced by source, rate and time of application of N at Waseca in 1973-1975.

Treatment			Grain Yield				
						1973-75	1974-75
Source	Rate	Time	1973	1974	1975	Avg.	Avg.
	lb N/A		bu/A				
Anhyd. Am.	75	F	145.4	103.3	52.1	100.3	77.7
(82%)	75	S	143.2	100.6	53.4	99.1	77.0
"	150	F	145.8	111.1	64.1	107.0	87.6
"	150	S	146.8	112.3	57.3	105.5	84.8
Urea	75	F	136.8	80.4	51.9	89.7	66.2
(45%)	75	S	126.8	95.1	52.8	91.6	74.0
"	150	F	145.3	112.9	71.7	110.0	92.3
"	150	S	144.3	113.0	69.8	109.0	91.4
Am. Nitrate	75	F	122.7	75.6	34.8	77.7	55.2
(33%)	75	S	128.7	96.0	51.4	92.0	73.7
"	150	F	137.3	96.8	46.5	93.5	71.6
"	150	S	146.0	108.9	64.4	106.4	86.6
UAN	75	F	--	84.0	33.0	--	58.5
(28%)	75	S	--	103.0	51.3	--	77.2
"	150	F	--	103.7	47.8	--	75.8
"	150	S	--	113.0	60.9	--	87.0
Significance:			*	**	*		
CV (%)	:		7.3	9.3	25.4		
BLSD (.05)	:		17.1	13.1	23.3		

Spring application of both 28% and ammonium nitrate (33%) were far superior to the fall applications. Three-year averages show a 13 to 15 bushel annual advantage for the spring application of ammonium nitrate. Moreover, two-year averages show about the same advantage for spring-applied 28% over fall applications. Equal yields were obtained from all N sources when applied in the spring at the 150 pound rate.

Conclusion

These results would indicate that losses of nitrogen due to denitrification are very probable in south-central Minnesota. Fall application of ammonium forms of N after soil temperatures are below 50° will minimize these losses and improve fertilizer efficiency as well as yields. Fall application of nitrate forms (28% and 33%) should not be attempted.

Experiment II

Because 1974 was a dry year, there was interest in possible carry-over of N from 1974 to 1975. Research work done in a few other states has shown significant carry-over under dry conditions, resulting in reduced N recommendations for the next year. Various empirical formulas were used to arrive at these recommendations.

Nitrogen rates of 0, 100, 200, 250 and 300 lb N/A were applied annually to continuous corn grown on a Webster clay loam at Waseca from 1972 thru 1974. In 1975, to estimate carry-over from 1974, N was not applied to any of the treatments.

Results

Results from this study would indicate no carry-over of N from 1974 (Table 4). More than likely the denitrifing conditions during late May and June were responsible for the loss of any potential carry-over of nitrate-N.

Table 4. Continuous corn yields from residual N treatments at Waseca in 1975.

Total N Applied 1972-1974	Total N Applied 1975	Yield
---lb N/A---		bu/A
0	0	62.5
300	0	67.2
600	0	69.5
750	0	69.1
900	0	65.8
Significance:		ns
CV (%)	:	16.2

ZINC FERTILIZATION OF CORN

Waseca, 1975

Gyles W. Randall

Results from soil tests and plant analyses data from south-central Minnesota are indicating a number of borderline zinc (Zn) deficient soils and areas where possible yield increases may be expected from Zn fertilizers. However, the majority of field experiments with Zn have been conducted in western Minnesota. The objective, therefore, was to evaluate the response of corn to Zn sources and application methods on two south-central Minnesota soils.

EXPERIMENTAL PROCEDURES

Two randomized, complete-block experiments were established in the spring of 1975. One site was in Faribault County (Marion Twedt farm) and the other in Waseca County at the Southern Experiment Station.

The soil type at the Faribault County site was a Harpster silty clay loam. Five Zn treatments (Table 1) were broadcast applied in four replications on May 2. The chelate materials were dissolved in water and sprayed on the soil surface with a 3-gallon, stainless steel hand sprayer. After application all materials were disked in. Because of heavy rainfall corn (Pioneer 3780) was not planted until May 17. Recommended rates of N, P and K had been applied to the experimental area by the farmer after soybean harvest the previous fall.

The experiment in Waseca County consisted of seven Zn treatments (Table 1) applied to five replications on a LeSueur clay loam. The broadcast treatments were applied on May 9 and were disked in. The row treatments were applied in a band with the seed via an insecticide applicator attached to the planter. The applicator was calibrated with both Zn materials. Corn (DeKalb XL-43) was planted on May 14 at 25,000 plants per acre. Nitrogen (150 lb/A) had been fall-applied following soybeans in 1974. Starter fertilizer consisting of 140 lb 9-23-30/A was used.

Tissue samples consisting of the leaf opposite and below the ear were taken at silking from both locations. Soil samples from the 0-8" layer were taken from each replication at both sites before Zn application and from all plots just prior to harvest.