Table 2. Soil test results after crop removal in 1980.

Treatment			Depth Increment					
			0-6"	6-12"	1-2'	2-3'	3-4'	4-5'
N	P_2O_5	K_2O	Nitrate Nitrogen					
lb/A			lb/A					
0	0	0	18	11	4	8	10	6
70	45	25	32	29	9	9	14	11
50	45	55	36	26	8	17	16	11
80	45	25	35	40	12	12	12	7
50	75	25	21	32	13	21	13	7
Significance			NS	*	NS	NS	NS	NS
B.L.S.D. (.05)				19.9				
C.V. (%)			46.2	42.2	43.7	58.5	44.3	50.8

Treatment			NDSU				Minnesota		
			$NaHCO_3$-P		K		Bray P-1		
							10:1	50:1	K
N	P_2O_5	K_2O	0-6"	6-12"	0-6"	6-12"	0-6"	0-6"	0-6"
lb/A			lb/A				lb/A		
0	0	0	11	5	292	235	4	24	245
70	45	25	26	12	275	234	6	42	239
50	45	55	26	13	292	228	5	39	260
80	45	25	25	9	285	241	14	50	248
50	75	25	26	8	282	214	13	40	254
Significance			*	NS	NS	NS	NS	**	NS
B.L.S.D. (.05)			11					10	
C.V. (%)			28.8	43.6	6.5	7.3	89.6	16.4	8.8

Nitrogen Fertilization and Nitrogen Utilization by Fourteen Small Grain Varieties - Crookston, MN - 1980*

G.L. Malzer, G. Varvel and R. Busch

The semi-dwarf varieties of hard red spring wheat account for a major portion of the acreage planted to hard red spring wheat in Minnesota. The development of these wheat varieties not only provided improved physical characteristics, but also provided the potential for a plant system which might be capable of responding to higher rates of nitrogen application without lodging. The reason why some wheat varieties respond more to nitrogen fertilization than others, is not well understood, but it has been suggested that it may be related to favorable plant characteristics both above and below the ground. Trials were established in 1980 to examine some of the difference which exist between wheat varieties in their ability to provide a yield response to nitrogen fertilization and to ascertain differences in nitrogen utilization. Existing popular varieties as well as older varieties and experimental varieties were included for comparison in responsiveness to added fertilizer nitrogen as well to overall nitrogen utilization. Similar trials were conducted at Morris as well as Crookston, MN.

Experimental Procedures

Fourteen varieties of hard red spring wheat were compared at nitrogen application rates of 0,60, and 120# N/A at the Northwest Experiment Station at Crookston. Nitrogen was applied as a spring application of ammonium nitrate broadcast and incorporated. The treatments were arranged in a split plot design with nitrogen as the main effect and the 14 varieties planted within a uniformly fertilized area. All treatments were replicated four times. Experimental plots were planted into areas 4' x 20' on April 18th, utilizing a cone seeder.

Dry matter production was determined at approximately the "soft dough" stage of growth (July 9th) and samples collected for nitrogen content and calculation of nitrogen uptake. Yield grain was harvested July 23rd by harvesting 16 ft^2 of plot area. The above ground growth (grain + straw) was removed from the experimental plot and placed in a forced air dryer. After drying, the samples were weighed, thrashed, and the grain re-weighed for yield determination. Straw weight was determined by difference. Samples of both the grain and the straw were collected for determination of nitrogen content and total nitrogen removal.

General Results

The yield results obtained in 1980 were considerably lower than what has been experienced in the past, but could also be considered exceptional considering the severe lack of precipitation that was obtained at the NW Experiment Station. Yields across the experiment ranged from 22-35 bu/A with the top yielding varieties including Era, Butte, MN7125, and Kitt. Normally in years where yields are reduced because of some environmental parameter, protein contents will be increased. This was not the case in 1980. Protein contents of the grain were lower in 1980 with low yields than they were in 1979 with relatively good yields. Nitrogen fertilization significantly (.05) increased yields up to the 60# N/A application while protein content of the grain was increased up to the highest rate of nitrogen fertilizer (120# N/A). Significant (.05) differences were also obtained between varieties in every category measured. Although with some similarities, the varieties which ranked the best or worst in 1980 were not necessarily in the same order as was experienced in 1979.

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

Table 1. Influence of nitrogen fertilization and variety on yield, N content and test weight of 14 hard red spring wheat varieties.

Nitrogen Rate	Variety	Grain Yield	Grain N Content	Grain Test wt.	Forage Total Dry Matter	Forage N Content
#/A		bu/A	%	#/bu	T/A	%
0	--	25.1	2.06	58.9	1.76	0.80
60	--	29.0	2.36	59.3	2.00	0.86
120	--	30.5	2.43	59.1	2.06	0.95
Significance		**	**	**	**	**
BLSD (.05)		2.7	0.07	--	0.20	0.06
-	Coteau	28.4	2.59	59.0	2.08	0.77
-	WS 1809	24.3	2.30	58.6	1.60	0.88
-	Era	31.1	2.04	60.9	1.98	0.96
-	Mn 70170R	28.4	2.27	59.1	1.88	0.92
-	Chris	25.4	2.28	58.6	1.87	0.81
-	James	28.5	2.30	58.2	1.97	0.82
-	Waldron	28.4	2.45	58.8	1.90	0.87
-	Mn 7125	30.4	2.06	58.1	1.97	0.78
-	Butte	29.3	2.19	60.7	2.01	0.87
-	Olaf	27.5	2.44	60.0	1.98	0.95
-	Mn 7222	28.9	2.02	60.0	2.00	0.87
-	Thatcher	26.8	2.41	58.3	1.87	0.85
-	Marquis	28.0	2.37	58.8	2.07	0.87
-	Kitt	29.5	2.29	58.2	2.01	0.99
Significance		**	**	**	**	**
BLSD (.05)		3.1	0.07	1.2	0.17	0.10
0	Coteau	25.4	2.42	59.0	1.89	0.69
0	WS 1809	21.7	2.11	59.8	1.50	0.84
0	Era	26.7	1.86	60.5	1.86	0.88
0	Mn 70170R	26.4	2.04	59.0	1.64	0.92
0	Chris	24.1	2.02	59.0	1.83	0.68
0	James	24.6	2.00	57.2	1.68	0.68
0	Waldron	25.4	2.18	58.4	1.68	0.80
0	Mn 7125	29.3	1.87	57.5	1.82	0.68
0	Butte	24.5	2.02	60.8	2.00	0.76
0	Olaf	24.8	2.19	60.3	1.79	0.94
0	Mn 7222	25.2	1.83	59.3	1.68	0.85
0	Thatcher	24.8	2.13	58.0	1.76	0.79
0	Marquis	24.2	2.18	58.7	1.94	0.81
0	Kitt	24.3	2.05	57.2	1.62	0.96
60	Coteau	28.8	2.65	59.2	2.11	0.76
60	WS 1809	24.3	2.36	59.0	1.58	0.85
60	Era	31.3	2.06	61.4	2.09	0.92
60	Mn 70170R	27.3	2.32	60.3	1.88	0.87
60	Chris	25.3	2.31	58.7	1.93	0.79
60	James	29.7	2.46	58.8	2.10	0.86
60	Waldron	30.8	2.62	59.7	2.02	0.83
60	Mn 7125	29.2	2.15	57.6	1.89	0.80
60	Butte	29.4	2.24	60.8	1.91	0.92
60	Olaf	29.2	2.57	59.8	2.05	0.89
60	Mn 7222	30.5	2.07	60.2	2.11	0.86
60	Thatcher	28.0	2.53	58.5	1.93	0.80
60	Marquis	30.4	2.43	58.4	2.17	0.91
60	Kitt	31.9	2.28	58.1	2.25	1.01
120	Coteau	30.9	2.70	58.8	2.25	0.86
120	WS 1809	26.8	2.44	57.2	1.71	0.96
120	Era	35.3	2.20	60.8	1.98	1.10
120	Mn 70170R	31.6	2.45	58.1	2.11	0.98
120	Chris	26.7	2.50	58.2	1.84	0.95
120	James	31.2	2.46	58.6	2.13	0.91
120	Waldron	29.0	2.56	58.2	2.01	0.98
120	Mn 7215	32.6	2.16	59.2	2.21	0.88
120	Butte	33.9	2.31	60.5	2.12	0.93
120	Olaf	28.5	2.57	59.8	2.11	1.02
120	Mn 7222	31.0	2.16	60.5	2.21	0.90
120	Thatcher	27.8	2.56	58.5	1.94	0.96
120	Marquis	29.4	2.49	59.3	2.10	0.88
120	Kitt	32.3	2.53	59.2	2.15	1.02
Significance		NS	NS	NS	NS	NS
BLSD (.05)		--	--	--	--	--

Table 2. Influence of nitrogen fertilization and variety on straw production and nitrogen uptake by forage, straw, and grain of 14 hard red spring wheat varieties.

Nitrogen Rate	Variety	Harvest Straw		Nitrogen Removal			Grain & Straw
		Dry Matter	N Content	Forage	Straw	Grain	
#/A		T/A	%	#/A			
0		0.77	0.29	28.4	4.4	28.9	33.3
60		0.82	0.33	34.7	5.5	38.3	43.7
120		0.85	0.34	39.2	5.6	41.3	47.0
Significance		NS	**	**	**	**	**
BLSD (.05)		--	0.02	4.3	0.7	3.9	4.5
-	Coteau	0.89	0.30	32.3	5.3	41.2	46.5
-	WS 1809	0.60	0.36	28.2	4.3	31.4	35.7
-	Era	0.74	0.36	38.3	5.3	35.7	41.0
-	Mn 70170R	0.71	0.36	35.0	5.1	36.4	41.4
-	Chris	0.88	0.27	30.2	4.7	32.4	37.1
-	James	0.80	0.32	32.8	5.1	37.1	42.2
-	Waldron	0.84	0.31	33.4	5.1	39.2	44.3
-	Mn 7125	0.78	0.33	31.2	5.0	35.0	40.1
-	Butte	0.89	0.30	34.9	5.4	35.8	41.3
-	Olaf	0.82	0.34	38.1	5.6	37.7	43.3
-	Mn 7222	0.66	0.34	34.8	4.6	32.8	37.4
-	Thatcher	0.85	0.29	32.1	4.9	36.3	41.3
-	Marquis	1.04	0.28	35.9	6.0	37.1	43.1
-	Kitt	0.90	0.34	40.1	6.2	38.0	44.2
Significance		**	**	**	**	**	**
BLSD (.05)		0.10	0.03	5.8	0.7	4.3	4.7
0	Coteau	0.81	0.28	26.2	4.4	34.4	38.8
0	WS 1809	0.58	0.31	25.3	3.7	25.7	29.4
0	Era	0.75	0.32	32.8	4.8	27.7	32.5
0	Mn 70170R	0.68	0.34	30.5	4.5	30.4	34.9
0	Chris	0.92	0.24	24.7	4.4	27.3	31.7
0	James	0.71	0.28	22.8	3.9	27.5	31.4
0	Waldron	0.73	0.30	26.7	4.3	30.7	35.1
0	Mn 7125	0.75	0.30	24.5	4.5	30.6	35.1
0	Butte	0.80	0.30	30.2	4.7	27.4	32.0
0	Olaf	0.74	0.30	34.6	4.5	30.3	34.8
0	Mn 7222	0.60	0.32	28.7	3.8	25.9	29.6
0	Thatcher	0.80	0.24	27.7	4.0	29.6	33.6
0	Marquis	1.00	0.27	31.5	5.3	29.3	34.6
0	Kitt	0.90	0.30	30.9	5.5	27.8	33.3
60	Coteau	0.88	0.32	31.8	5.5	42.7	48.3
60	WS 1809	0.55	0.38	27.0	4.1	32.0	36.1
60	Era	0.67	0.38	38.1	5.2	36.2	41.4
60	Mn 70170R	0.67	0.38	32.8	5.0	35.3	40.4
60	Chris	0.83	0.27	30.7	4.4	32.7	37.1
60	James	0.81	0.35	36.3	5.8	40.8	46.6
60	Waldron	0.92	0.31	33.6	5.7	45.2	51.0
60	Mn 7125	0.74	0.35	30.0	5.0	35.2	40.2
60	Butte	0.93	0.30	34.9	5.6	36.7	42.3
60	Olaf	0.86	0.37	36.8	6.3	42.0	48.3
60	Mn 7222	0.68	0.36	36.5	4.9	35.2	40.1
60	Thatcher	0.92	0.31	31.1	5.7	39.7	45.4
60	Marquis	1.08	0.32	39.6	7.0	41.1	48.2
60	Kitt	0.91	0.36	46.3	6.5	40.7	47.2
120	Coteau	0.96	0.30	39.0	5.9	46.6	52.4
120	WS 1809	0.66	0.40	32.4	5.1	36.5	41.6
120	Era	0.81	0.36	43.8	5.8	43.3	49.2
120	Mn 70170R	0.78	0.36	41.7	5.6	43.4	49.0
120	Chris	0.88	0.30	35.3	5.3	37.1	42.4
120	James	0.88	0.33	39.3	5.7	42.8	48.6
120	Waldron	0.87	0.31	40.0	5.4	41.5	46.9
120	Mn 7125	0.85	0.33	39.2	5.6	39.4	45.0
120	Butte	0.95	0.32	39.5	6.0	43.5	49.5
120	Olaf	0.85	0.36	42.7	6.0	40.8	46.8
120	Mn 7222	0.72	0.35	39.3	5.0	37.4	42.4
120	Thatcher	0.82	0.32	37.4	5.1	39.8	44.9
120	Marquis	1.04	0.27	36.7	5.6	40.9	46.5
120	Kitt	0.89	0.37	43.1	6.6	45.5	52.2
Significance		NS	NS	NS	NS	NS	NS
BLSD (.05)		--	--	--	--	--	--

N Incorporation Study on Wheat

Gary Varvel and Harvey Meredith

Objective of Study: Compare yield differences between broadcast forms of nitrogen when incorporated versus surface application without incorporation.

Location: Crookston Experiment Station

N Source: Urea (46-0-0), ammonium nitrate (34-0-0), and urea-ammonium nitrate solution (28-0-0).

N Rate: 0, 40, and 80 pounds N per acre.

Variety: Era

Date of Planting: April 17

Nitrogen application-incorporated: April 17

Nitrogen application - nonincorporated: April 17

Previous crop: Barley

Forage Harvested: July 8

Grain Harvested: July 23

Table 1. Soil Test Data of Nitrogen Source Investigation at Crookston Experiment Station, 1980.

		Nitrate - N	
pH:	8.1	Depth, In.	Lbs/A
P:	22 [1/]		
K:	300	0-12	42
		12-24	18
		24-36	15
		36-48	14

[1/] Sodium bicarbonate extraction

Table 2. Comparison of Three Nitrogen Sources Applied in the Spring at Two Rates With and Without Incorporation on the Yield and Quality of Era Wheat at the Crookston Experiment Station, 1980.

Treatment			Forage			Grain		
Source	N Rate	Incorp.	Yield	Total N	N Uptake	Yield	Protein	Bushel Weight
			lb DM/A	%	lb/A	Bu/A	%	lbs
Check	0		3120	1.17	36.2	24.8	11.6	62.5
AN	40	+	3260	1.32	43.0	25.9	12.8	63.0
	80	+	2810	1.27	35.8	26.3	13.4	62.5
Urea	40	+	3000	1.24	37.4	26.3	13.2	63.0
	80	+	3640	1.42	51.6	29.8	12.6	62.8
UAN	40	+	2850	1.32	36.9	26.0	12.9	62.8
	80	+	3400	1.17	40.4	27.8	13.0	63.0
AN	40	-	2760	1.36	37.6	22.8	12.9	62.8
	80	-	2710	1.40	37.9	24.0	13.3	63.0
Urea	40	-	2870	1.38	39.3	23.0	12.8	62.8
	80	-	2890	1.43	41.2	27.3	13.0	62.3
UAN	40	-	3010	1.37	41.2	25.1	12.7	62.0
	80	-	3110	1.49	46.6	24.9	13.3	63.0
Significance			N.S.	**	*	*	*	N.S.
B.L.S.D. (.05)				0.13	11.9	4.4	1.0	
C.V. (%)			13.3	6.6	15.9	9.8	4.6	0.9
Source								
AN			2880	1.34	38.6	24.7	13.1	62.8
Urea			3100	1.37	42.4	26.6	13.0	62.7
UAN			3100	1.34	41.3	26.0	12.9	62.7
Significance			N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
N Rate lb/A								
40			2690	1.33	39.2	24.9	12.9	62.7
80			3100	1.36	42.3	26.7	13.1	62.8
Significance			N.S.	N.S.	N.S.	**	N.S.	N.S.
B.L.S.D. (.05)						1.5		
Incorporation								
+			3161	1.29	40.9	27.0	13.0	62.8
-			2890	1.40	40.6	24.5	13.0	62.6
Significance			*	**	N.S.	**	N.S.	N.S.
B.L.S.D. (.05)			230	0.05		1.5		

Table 3. Summary of N Source, Rate Incorporation Study, Spring Applied, Era Wheat Yields, Bu/A, Crookston Experiment Station, 1978-80.

	Am. Nitrate						Urea						28% N Soln.					
	Incorporated			Nonincorporated			Incorporated			Nonincorporated			Incorporated			Nonincorporated		
	78	79	80	78	79	80	78	79	80	78	79	80	78	79	80	78	79	80
0	27.9	31.5	24.8	27.9	31.5	24.8	27.9	31.5	24.8	27.9	31.5	31.5	27.9	31.5	24.8	27.9	31.5	24.8
40[1/]	45.5	47.5	25.9	44.0	49.7	22.8	48.2	44.9	26.3	51.0	47.2	23.0	45.4	47.5	26.0	43.5	46.5	25.1
80[2/]	58.5	49.6	26.3	60.9	47.3	24.0	59.3	46.1	29.8	60.6	48.2	27.3	59.1	47.5	27.8	60.3	48.2	24.9

[1/] 50 Lbs N applied in 1979

[2/] 100 Lbs N applied in 1979

Table 4. Temperature and Precipitation Data Ten Days Following Application of N Sources. Crookston Experiment Station, 1980.

Date	Maximum Temperature	Precipitation
4/17	73	None
4/18	80	"
4/19	80	"
4/20	89	"
4/21	96	"
4/22	96	"
4/23	64	"
4/24	61	"
4/25	69	"
4/26	70	"

Discussion: The primary factor evaluated in this study was the comparison of the three broadcast forms of nitrogen and the effect of the performance of these N sources when incorporated with the soil versus surface applied without incorporation.

The months of April and May were the driest on record, only 0.02 inch of precipitation was recorded in April and 0.33 inch was recorded at the end of May. Wheat yields were gravely affected due to the extreme drought. Minimum disturbance of the soil prior to planting and planting to the appropriate depth resulted in excellent stands and surprising yields considering the harsh environment.

Temperatures reached record highs for several days following application of N. Previous research indicated that the greatest losses of N due to ammonia volatilization occur during the first 5 to 10 days following application. Losses are enhanced with elevated temperatures and lack of precipitation. Certainly the temperature-moisture conditions were optimum to field evaluate the hypothesis of ammonia loss from N fertilizer when surface applied without incorporation. The phenomenon is enhanced in the presence of high amounts of carbonates. It will be noted the soil pH was 8.1.

Broadcasting of N fertilizers without incorporation is a common practice. Typically application of N in the spring occurs at a time when the ambient temperature is relatively cool and the probability of precipitation is high. As little as 0.1 inch of precipitation is sufficient to move the ammonium forms of N into the soil such that the ammonium is adsorbed onto clay or organic matter.

Under the extreme conditions of early 1980, the stage was set for optimum N losses due to ammonia volatilization. Although yields were quite low, there was a significant difference in yield at the 5 percent level from the N incorporated plots versus the nonincorporated (27.0 compared to 24.5 bu/A).

Considerable caution must be exercised in the interpretation of this data however. It will be noted that when N sources were compared, urea and UAN resulted in higher yields than ammonium nitrate (26.6 and 26.0 compared to 24.7). Generally, ammonium loss from ammonium nitrate is not considered much of a problem.

Soil Moisture Probabilities

Donald G. Baker and Wallace W. Nelson

There are many occasions where the amount of water within the soil, particularly at seeding time, is of great interest. In addition to the natural concern that farmers have in the condition, there is the interest that researchers have in this subject. A number of projects require information on this topic including those dealing with yield and crop growth models and farm management studies.

The 21-year record of soil moisture measurements at the Southwest Agricultural Experiment Station is now long enough that confidence can be placed in the results. They are shown in Table 1.

Table 1. Probability that plant available soil moisture in a 5-foot column of soil under corn will be within the indicated ranges.

Date	<2.5 in.	2.5-3.9 in	4.0-4.9in.	5.0-7.4in.	>7.5in.
May 3-May 16	0%	4.8%	4.8%	71.4%	19.0%
Oct.11-24	19.0%	42.9%	14.3%	23.8%	0.0%

It is interesting and important for many reasons that at corn plant time, May 3-16, the soil has contained at least 5.0 inches of plant available water in more than 90% of the years. It is also important to realize that both the probabilities and the amount of water increase eastward across the state. These probabilities can be expected to vary with crops to some extent. Although comparable data for crops other than corn are not available , it can be assumed that the probabilities and water content will decrease in the case of more extensively rooted and longer season crops such as alfalfa.

Twentyone Years Of Field Experimentation With Nitrogen Source, Placement, And Time Of Application To A Webster Loam Near Lamberton

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

(Annual reports of this experiment have been reported in Soil Series 74 through 107 and some of this information will not be included here).

The fertilizer treatments have now been annually applied to the same plot areas for 21 years. After ear corn removal and stalk cutting, the fall plow down N treatments are broadcast on their respective plots and the entire area is then plowed to an approximate 12 inch depth. The fall surface N treatments are then broadcast, with no further working of the plow area. Each plot is 20' x 77.5' and the 4 treatments replication are arranged in a randomized block.

Spring N treatments are broadcast before seedbed preparation late in April or in early May. The corn is planted in 30 inch rows at a plant population of 20,000 plant/A, using a banded starter fertilizer of 8-24-12 at a rate of 180 lbs/A over the entire experimental area, thus supplying an additional 14 lbs. N/A to all the plots. Nitrogen sidedressing treatments are broadcast in June. Nitrogen concentrations present in the leaf opposite and below the ear at silking were determined and are reported along with plot yields in table 1.

The yields obtained in 1980 were below average when considering the long term previous average for this experiment. Treatment averages in 1980 appeared to follow the trends which had been established with the long term average yields. The extremely dry conditions experienced at the S.W. Experiment Station appeared to have a considerable influence on the results obtained.

Twenty Year Average

The average grain yields for the twenty years of this experiment are shown in table 2. Only modest differences were obtained between nitrogen forms, time of application, and incorporation in the 1980 experiment. The major yield differences that were obtained in 1980 were due to the rate of nitrogen fertilization. The twenty year average would suggest that when only 40 lbs. of N/A was fall applied, urea was slightly better than ammonium nitrate with very littel difference due to incorporation.

Plowing down 80 lbs. of N/A in the fall was much more effective than the lower N rates and approached the yields that were obtained with the highest treatment of fall applied N. At the 40#N/A rate applied in the spring there was no difference between urea and ammonium nitrate. Urea applied in the fall produced similar yield as with spring applications although ammonium nitrate applied in the fall was inferior to spring application at the 40#N/A rate of application.

Side dressing N produced grain yields similar to those of the same rates of spring applied N. The heaviest side dressing treatments were equally effective as the rates plowed down the previous fall.

General Conclusions

1. Urea is as effective as ammonium nitrate for the production of corn on these medium textured non-calcareous soils.
2. Late fall surface applied N is at least equal to that plowed down, but where N fertilization rates are relatively low, spring or sidedressing N treatments appear more effective.
3. Where corn is grown annually on these soils good yields can be maintained with annual applications of 100 lbs. N/A providing adequate amounts of P and K are also supplied. At this rate of application most of the N will be removed in the grain leaving relatively small amounts to be lost to the environment.

Table 1. Average N in sixth corn leaf, grain yield at 15.5% moisture, and 20 year corn average from Webster loam fertilized annually with NH_4 NO_3 or urea.

N applied annually in lbs/A'	% N 6th Leaf	I	II	III	IV	Ave.
Check	1.82	49.8	38.2	55.2	43.4	46.5
40 NH_4 NO_3 - fpd[2]	1.86	102.7	53.7	57.1	57.1	67.5
40 - urea - fpd	2.46	46.7	68.9	74.4	70.6	65.2
40 - NH_4 NO_3 - fps[3]	2.16	81.7	68.6	61.4	67.1	69.7
40 urea - fps	1.98	59.6	57.2	77.0	61.3	63.8
80 - NH_4 NO_3 - fpd	2.60	87.5	105.4	84.6	83.6	90.3
80 - urea - fpd	2.60	76.4	90.2	98.2	82.9	84.7
160 - NH_4 NO_3 - fpd	3.00	98.4	99.5	121.6	117.7	109.3
160 - urea - fpd	2.96	120.4	85.7	105.5	103.2	103.7
40 - NH_4 NO_3 - std[4]	2.20	75.5	85.0	86.4	62.1	77.2
40 - urea - std	2.22	71.4	80.6	52.1	53.2	64.3
80 - NH_4NO_3 -std	2.56	71.9	93.4	82.7	49.8	74.4
80 - urea - std	2.60	76.6	96.0	83.3	81.6	84.4
40 - NH_4NO_3 - sd[5]	1.89	57.0	55.5	97.2	78.0	71.9
40 - urea - sd	1.98	59.5	56.4	109.0	96.9	80.4
80 - NH_4NO_3 - sd	2.21	81.6	53.4	89.2	83.5	76.9
80 - urea - sd	2.19	93.4	100.5	98.1	66.3	89.6
160 -NH_4NO_3 - sd	2.81	99.2	120.4	113.9	105.8	109.8
Significance	**					**
BLSD (.05)	0.24					20.4

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

[2]fpd -- fall plow down, [3]fps -- fall plow surface, [4]std -- spring top dress

[5]sd -- sidedress

Table 2. Yields of ear corn during 20 years on a tiled Webster loam near Lamberton with annual applications of NH_4NO_3 or urea nitrogen at different rates, times, and placement. (Average of 4 replications)

N applied annually in lbs/A[1]	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969
				Ear corn yield in bushels per acre						
Check	49.5	88.2	26.1	132.6	72.9	33.1	11.1	53.4	102.4	92.8
40 NH_4NO_3-fpd[2]	42.3	87.5	30.9	148.6	88.3	34.9	26.8	75.7	131.6	109.3
40 Urea - fpd[3]	55.1	78.2	29.1	148.8	100.3	38.8	19.8	86.9	132.5	124.5
40 NH_4NO_3-fps[3]	49.0	96.7	29.6	140.1	101.5	45.6	24.3	75.1	135.2	124.6
40 Urea - fps	62.3	101.3	37.0	140.7	84.1	57.4	30.9	87.2	134.0	136.1
80 NH_4NO_3-fpd	67.4	97.9	43.6	149.6	100.8	63.4	47.3	114.3	131.2	146.8
80 Urea - fpd	61.7	76.9	36.7	154.5	104.9	73.0	37.8	117.2	142.6	144.3
160 NH_4NO_3-fpd	69.8	97.9	46.7	147.7	100.9	70.8	38.5	127.4	140.2	158.7
160 Urea - fpd[4]	79.4	112.5	43.5	152.8	112.4	73.5	37.7	121.3	149.9	161.0
40 NH_4NO_3-std	66.2	92.0	45.4	152.2	99.8	63.4	23.7	99.8	128.0	142.0
40 Urea - std	45.4	91.1	31.4	147.6	100.6	59.8	33.8	95.0	140.5	143.4
80 NH_4NO_3-std	59.3	90.0	32.7	149.2	112.5	74.2	49.0	128.3	144.7	159.5
80 Urea - std	57.7	99.1	40.5	149.3	115.7	84.4	41.8	128.6	138.7	155.9
40 NH_4NO_3 -sd[5]	63.6	92.6	39.5	148.6	90.4	54.8	38.6	96.8	133.4	142.3
40 Urea - sd	57.7	95.6	24.9	142.3	94.1	48.4	50.4	86.1	132.2	143.3
80 NH_4NO_3 -sd	50.4	98.4	46.7	140.7	113.0	68.1	43.8	101.6	137.7	140.3
80 Urea - sd	76.9	86.4	48.2	143.8	121.4	64.7	47.3	117.0	146.9	166.2
160 NH_4NO_3-sd	40.7	97.4	77.7	151.7	109.5	77.6	51.4	120.2	141.5	148.3
Ave. annual corn yield in bu/A	58.6	93.3	39.4	147.5	101.3	60.3	37.8	101.8	135.7	140.9

[1]The entire area received and additonal 14 lbs N/A as starter fertilizer annually (8-24-12@ 180#/A).
[2]fpd -- fall plow down [3] fps -- fall plow surface [4] std -- spring topdress [5] sd -- sidedress

Table 2.(con't).

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	20 Year Ave.
Check	85.7	40.8	75.6	69.2	53.4	58.3		141.2	64.6	37.6	46.5	63.0
40 NH_4NO_3-fpd[2]	96.3	88.7	113.6	92.0	80.5	88.6	No	145.1	98.1	63.1	67.6	81.1
40 Urea-fpd	120.4	100.7	113.9	101.5	96.9	96.6		165.2	110.2	76.7	65.2	87.6
40 NH_4NO_3-fps	122.5	81.5	109.9	93.0	88.3	78.2	Yields	149.4	101.3	64.6	69.7	83.5
40 Urea-fpd	121.2	82.4	106.7	97.8	85.0	78.9		156.8	101.4	80.2	63.8	86.8
80 NH_4NO_3-fpd	134.7	108.0	143.1	121.7	103.6	89.2	Taken	156.9	128.4	94.8	90.3	100.6
80 Urea -fpd	141.4	107.8	140.1	117.9	107.2	96.9		146.0	123.6	86.2	84.7	98.7
160 NH_4NO_3-fpd	141.7	120.2	147.6	121.0	113.1	90.4		149.8	129.3	108.7	109.3	105.1
160 Urea-fpd	140.4	110.6	151.7	114.9	105.1	82.4		163.0	124.4	127.3	103.7	107.0
40 NH_4NO_3-std	125.6	84.0	117.0	104.0	82.8	88.0		160.0	97.4	86.6	77.2	91.0
40 Urea-std	118.9	94.6	116.5	97.1	94.5	89.0		165.2	103.9	74.5	64.3	90.0
80 NH_4NO_3-std	140.4	122.7	142.7	118.0	92.9	97.6		162.9	117.1	87.3	74.4	101.4
80 Urea-std	146.2	116.0	142.1	117.6	108.5	93.6		162.2	127.4	100.3	84.4	103.9
40 NH_4NO_3-sd[5]	127.1	104.5	136.0	99.1	82.7	91.8		153.8	106.8	99.2	71.9	92.8
40 Urea-sd	117.1	100.5	133.9	103.9	80.4	92.6		165.4	104.8	94.2	80.4	92.1
80 NH_4NO_3-sd	127.7	97.6	124.7	109.4	87.6	95.3		163.2	110.6	106.3	76.9	96.3
80 Urea-sd	140.5	124.4	149.8	124.0	95.6	90.1		162.8	126.7	118.1	89.6	105.7
160 NH_4NO_3-sd	136.9	104.2	150.0	117.1	105.5	91.3		160.3	126.0	148.0	109.8	107.1
Ave. annual corn yield in bu/A	127.0	99.4	128.6	106.6	92.4	88.3		157.2	111.2	91.9	79.4	94.1
Significance											**	**
C.V. (%)											18.2	10.3
BLSD (.05)											20.4	5.4

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

Nitrate Correlation Study With Corn Following Corn, Soybeans and Wheat - Lamberton, MN - 1980

G.L. Malzer and W.W. Nelson

The rates of fertilizer nitrogen recommended for corn production in Minnesota are currently based upon yield goal and previous cropping history. In many respects depending on the climate conditions, these recommendations have the potential of being too high or too low. Nitrate nitrogen correlation studies were started in 1976 in S.W. MN to determine if residual nitrates could be used as a predictive tool in fertilizer recommendations. Adjustments in fertilizer recommendations are currently made on the basis of previous cropping history. For this reason, three separate experiments were established at the SW Experiment Station to evaluate the importance of previous crop in respect to residual nitrate nitrogen and fertilizer nitrogen response.

Experimental Procedures

Three separate experiments were established utilizing corn with previous cropping histories of corn, soybeans, and wheat. Six different rates of nitrogen fertilizer (none, 40,80,120,160 and 240 #N/A) were applied as spring applications of urea. The six nitrogen rates replicated six times in the corn following corn and corn following soybeans, and four times with corn following wheat. The fertilizer was applied on April 29th and incorporated by field cultivator, Corn (Pioneer 3780) was planted on April 30th at 26,000 seeds/A. A tank mix of Eradicane and Bladex was used for weed control.

Leaf samples from opposite and below the leaf at mid-silking were obtained for Kjeldahl nitrogen. Yields were taken by combine and adjusted to 15.5% moisture.

General Results

Corn grain yields during 1980 were severely restricted due to limited moisture at the S.W. experiment station. In spite of the lowered yields significance yield increase due to nitrogen fertilization were obtained in two out of three of the experiments. No nitrogen response was observed with the corn following soybeans while responses up through approximately 80 # N/A were obtained from corn following corn and corn following wheat. It is highly possible the overall yields as well as nitrogen response may be reflection of soil mositure differences between the previous cropping histories as well as a lack of nitrogen. Similar relationship have been noted with other trials conducted throughout SW Minnesota. Further research in the area of moisture vs. previous crop would be warranted to verify the observations noted.

Table 1. Influence of nitrogen rates on leaf N content and grain yield on corn following corn, soybean and wheat at Lamberton, MN - 1980.

	Corn/Corn		Corn/Soybeans		Corn/Wheat	
Treatments	Leaf N	Yield	Leaf N	Yield	Leaf N	Yield
#N/A	%	Bu/A	%	Bu/A	%	Bu/A
Check	1.57	45.5	2.42	101.7	1.83	84.1
40	2.02	61.8	2.47	101.3	1.95	102.2
80	2.26	86.1	2.51	98.0	2.42	122.5
120	2.34	82.9	2.66	105.5	2.63	124.9
160	2.62	88.0	2.78	106.2	2.68	122.8
240	2.69	93.1	2.70	104.5	2.76	127.7
Significance	**	**	**	NS	**	**
BLSD (.05)	0.21	16.1	0.16	-	0.17	13.5

Table 2. Residual nitrate nitrogen from locations following corn, soybean, wheat

depth	Residual NO_3 -N		
	corn/corn	corn/soybeans	corn/wheat
ft	#/A		
0-1	10	19	46
1-2	4	7	16
2-3	4	8	22
3-4	8	15	39
4-5	10	19	45

WEST CENTRAL EXPERIMENT STATION - MORRIS

WEATHER SUMMARY - 1980

		Precipitation			Air Temperature			Soil (10 cm) Temperature	
Month	Period	1980	94-yr. av.	Dev. from av.	1980	94-yr. av.	Dev. from av.	1980	10-yr. av.
January	1-31	1.17	.68	+ .49	11.1	8.0	+3.1	15.5	20.7
February	1-29	.63	.67	- .04	11.9	12.6	-0.7	17.6	23.9
March	1-31	1.09	1.09	0	21.9	26.7	-4.8	23.7	29.2
April	1-10	.13	.58	- .45	42.0	37.9	+4.1	38.2	
	11-20	.02	.65	- .63	44.6	44.4	+0.2	45.1	
	21-30	0	1.08	-1.08	56.4	48.2	+8.2	57.4	
Total or av.		.15	2.31	-2.16	47.7	43.5	+4.2	46.9	41.4
May	1-10	.05	.78	- .73	56.8	51.9	+4.9	61.2	
	11-20	.34	.95	- .61	52.8	55.8	-3.0	57.2	
	21-31	1.44	1.25	+ .19	70.1	60.1	+10.0	72.5	
Total or av.		1.83	2.98	-1.15	60.3	56.1	+4.2	64.0	57.1
June	1-10	5.03	1.26	+3.77	62.0	63.1	-1.1	61.8	
	11-20	.89	1.27	- .38	64.8	66.5	-1.7	70.4	
	21-30	.77	1.38	- .61	68.2	68.2	0	66.2	
Total or av.		6.69	3.91	+2.78	65.0	66.0	-1.0	68.3	69.3
July	1-10	.16	1.48	-1.32	70.4	70.0	+0.4	77.5	
	11-20	1.87	1.03	+ .84	74.0	71.3	+2.7	80.2	
	21-31	.37	1.03	- .66	67.7	71.5	-3.8	77.4	
Total or av.		2.40	3.54	-1.14	70.6	71.0	-0.4	78.3	76.7
August	1-10	.31	1.05	- .74	69.7	70.3	-0.6	76.7	
	11-20	1.67	.90	+ .77	65.6	69.2	-3.6	70.8	
	21-31	.96	.98	- .02	67.5	66.9	+0.6	71.6	
Total or av.		2.94	2.93	+ .01	67.6	68.7	-1.1	73.0	73.9
September	1-30	2.32	2.19	+ .13	56.9	59.1	-2.2	60.7	61.5
October	1-31	1.23	1.62	- .39	43.5	47.3	-3.8	45.8	47.8
November	1-30	.13	.96	- .83	34.1	29.7	+4.4	34.8	33.6
December	1-31	.18	.68	- .50	15.2	15.5	-0.3	19.7	23.4
April-August Growing Season		14.01	15.67	-1.66	62.3	61.1	+1.2	66.2	63.8
January-December Annual		20.76	23.56	-2.80	42.1	42.0	+0.1	45.8	46.7

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. 1980 Operations

In 1980 the variety was Trojan TXS99. Counter was applied at 1 lb/acre (active ingredient) at planting on May 1. Lasso @ 2.5 lbs/acre plus Bladex @ 2.2 lbs/acre were applied broadcast on May 2. Silage yields were taken on September 22 and grain yields on October 10. Atrazine @ 1.5 lbs/acre plus booster concentrate @ 1 qt/acre were applied on June 9.

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

Treatment	1980 yield	1966-80 yield
Silage, low fertility	6.70	5.63
Silage, high fertility	6.92	6.04
Grain, low fertility	6.94	5.60
Grain, high fertility	6.95	5.87

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

	1980 yield	1966-80 yield
Grain, low fertility	101.44	90.96
Grain, high fertility	106.79	93.68

V. Check Yields

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

	1980 yield	1966-80 yield
Grain (0 + 0 + 0)	36.56 Bu/A	50.38 Bu/A
Silage (0 + 0 + 0)	3.44 Tons/A	3.74 Tons/A

VI. Discussion

A. In 1980 there were no significant differences in silage yields but the high fertility plots again yielded slightly more than the low fertility plots.

B. The 15-year average yields show very little difference between silage and grain plots, but there is still a slight advantage for the higher fertility level.

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 at three rates and the effects were compared against check plots. Treatments and results from previous years are given in Soil Series 91, 95, 97, 99, 103, 105, and 107. The last manure application was made in the fall of 1978, but fertilizer has been applied to the fertilized check each year.

I. Planting Information

The plots were planted to Pioneer 3901 on April 29, 1980. Counter @ 8.8 lbs/acre (1 lb/acre active ingredient) was applied in the row to the entire area at planting. Starter fertilizer consisting of 154 lbs/acre of 10-26-26 was applied to the fertilized treatment. Nitrogen in the form of urea had been applied on November 5, 1979, prior to plowing to provide 110 lbs/acre of N. Lasso (2.5 lbs/acre) and Bladex (2.2 lbs/acre) were applied broadcast on April 30, 1980. Atrazine (1.5 lbs/acre) plus booster concentrate (1 qt/acre) were applied on June 9, 1980.

II. Soil Sampling and Analysis

The plots were sampled in the fall of 1980 to a depth of 4 feet for NO_3-N analyses, but the results are not yet available.

III. Plant Tissue Analysis

A. 1979 Grain Samples (Table 1)

In general, higher manure rates increased the N content of the grain. In all cases the N content of the grain from the manured treatments was equal to or higher than that from the fertilized check.

B. 1980 Samples

1. Ear leaf samples at silking (Table 2)

The nutrient concentration of many elements in the ear leaves at silking was significantly affected by the manure treatments. In general, the manure treatments increased the N, P and K levels and decreased the Ca and Mg levels. The effects on Cu and Mn were significant but not related directly to manure application.

2. Grain samples (Table 1)

The effect of the treatments on grain N content was almost identical to that observed in 1979.

IV. Growth and Yield Measurements

A. Early plant height and dry weight - All manure treatments except LB1 were significantly taller and heavier than the fertilized treatment. With both solid and liquid beef manure, there was some trend toward larger plants with increasing manure rates.

B. Grain yield - The only manure treatment significantly higher yielding than FE was LB3. All of the other manure treatments except SB2 were higher yielding than FE.

C. Silage yield - All manure treatments except LB1 and LB2 were significantly higher yielding than the fertilized treatment.

V. Summary

The 1980 cropping season was the second since manure had been applied. It appears that even the lowest rates of each manure were sufficient for yields equal to or higher than the fertilized check.

Table 1. N content of corn grain samples, 1979 and 1980.

Year	Treatment CK	FE	SB1	SB2	SB3	LB1	LB2	LB3	Treatment Significance	5% BLSD
	% N									
1979	1.21	1.68	1.73	1.85	1.77	1.68	1.72	1.75	**	.12
1980	1.14	1.48	1.60	1.70	1.79	1.46	1.52	1.62	**	.18

Table 2. Summary of analysis of corn leaves at silking - 1980.

Treatment	N	P	K	Ca	Mg	Fe	Zn	Cu	Mn	B
	%					ppm				
CK	2.45	.26	1.61	.50	.49	94	17.5	4.1	71	5.2
FE	2.84	.27	1.76	.60	.51	99	23.0	5.2	104	5.5
SB1	2.94	.33	2.33	.48	.33	104	15.2	6.0	103	5.3
SB2	2.96	.39	2.35	.52	.30	106	15.7	5.1	114	5.5
SB3	2.97	.47	2.69	.41	.24	109	14.7	3.9	87	4.9
LB1	2.84	.31	1.84	.57	.42	98	18.6	5.5	111	5.5
LB2	2.81	.35	2.18	.49	.34	104	15.2	5.1	108	5.4
LB3	2.86	.34	2.12	.53	.35	109	16.1	5.6	97	5.3
Significance:	*	**	**	**	**	+	+	**	*	NS
BLSD (.05):	.31	.08	.17	.07	.06	-	-	0.5	29	-

Table 3. Summary of plant measurements - 1980.

Treatment	Early plant height	Early plants (10) dry weight	Grain: Grain moisture at harvest	Grain: Yield @ 15.5% M.	Silage: Dry matter at harvest	Silage: Silage yield (D.M.)	Silage: Ear wt. ÷ silage wt.
	inches	grams	%	Bu/A	%	lb/A	%
CK	28.0	71.7	21.2	68.6	54.6	8335	56.8
FE	32.2	107.0	20.0	115.7	48.3	13481	59.8
SB1	39.4	173.0	18.4	121.6	53.0	16189	55.2
SB2	40.2	189.3	19.7	111.5	45.3	15440	57.1
SB3	40.0	181.3	20.1	124.5	43.3	15921	55.3
LB1	34.0	121.7	18.7	123.1	51.3	14477	61.5
LB2	36.6	146.7	18.0	124.7	50.0	14337	59.5
LB3	40.1	183.3	18.0	135.3	45.2	15956	59.0
Significance:	**	**	NS	**	**	**	*
BLSD (.05):	2.0	19.9	-	14.4	5.2	1246	3.7

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, 103, 105, and 107. 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. Pioneer 3901) were planted in each plot on April 29, 1980. Counter @ 8.8 lbs/acre (1 lb/acre active ingredient) was applied in the row at planting to all plots. Starter fertilizer consisting of 154 lbs/acre of 10-26-26 was applied to the fertilized treatment only. Nitrogen in the form of urea was applied to the fertilized plots to provide 110 lbs/acre of N on November 5, 1979. Lasso (2.5 lbs/acre) and Bladex (2.2 lbs/acre) were applied broadcast on April 30, 1980. Atrazine (1.5 lbs/acre) and booster concentrate (1 qt/acre) were applied on June 9, 1980.

II. Soil Sampling and Analysis

The soils were sampled to a depth of 4 feet in the fall of 1980 for NO_3-N analysis but the results are not yet available.

III. Plant Tissue Analysis

A. 1979 Harvest Samples (Table 1)

The N contents of the grain from the fertilized and beef manure plots were not significantly different, but grain from the hog manure treatment was significantly lower than from the liquid beef treatment.

B. 1980 Samples

1. Corn leaves at silking

The nutrient concentrations in the ear leaves at silking in 1980 are given in Table 2. There were significant effects of at least some type of manure as compared to the fertilized treatment in the N, P, K, Ca, Mg, Fe, Zn, and Cu levels. The levels of P, K, and Cu were generally higher in the manured plots and Ca and Mg were generally lower.

2. Grain Samples at Harvest (Table 1)

The results in 1980 were identical to those in 1979 described above.

IV. Growth and Yield Measurements (Table 3)

A. Early plant height and dry matter - The liquid beef manure produced the largest plants followed by solid beef manure. The liquid beef manure plants were almost identical in height to the fertilized plants but were slightly heavier.

B. Grain yield - There were no significant differences between the fertilized and manured treatments but the hog manure treatment was the lowest yielding.

C. Silage yields - As with grain yield, there were no significant differences between fertilized and manured treatments, but the liquid hog manure treatment was again the lowest.

V. Summary

The effects of the manure treatments applied in 1970 and 1971 still show up in most plant measurements. Plant and grain analysis and yield checks show that the liquid hog manure treatment is starting to lose its effect as compared to the other two manure treatments.

Table 1. N content of corn grain, 1979 and 1980.

Year	Treatment* CK	FE	SB	LB	LH	Treatment Significance	BLSD 5%	C.V. %
	% N							
1979	1.10	1.76	1.73	1.82	1.67	**	.10	3.6
1980	1.08	1.45	1.51	1.53	1.42	**	.10	4.1

* CK = CHECK, FE = FERTILIZED, SB = SOLID BEEF MANURE, LB = LIQUID BEEF MANURE, LH = LIQUID HOG MANURE

Table 2. Summary of analysis of corn leaves at silking - 1980.

Treatment	N	P	K	Ca	Mg	Fe	Zn	Cu	Mn	B
	%					ppm				
CK	2.10	.24	1.56	.54	.47	95	16.7	4.5	83	5.7
FE	2.83	.29	1.74	.59	.50	99	20.2	4.2	86	5.4
SB	2.71	.33	2.21	.48	.28	101	18.3	5.7	101	5.5
LB	2.81	.38	2.32	.51	.29	117	15.4	5.2	89	5.3
LH	2.59	.33	2.11	.50	.41	97	21.4	5.3	79	5.5
Significance	**	**	**	**	*	**	*	*	NS	NS
BLSD (.05)	.27	.04	.28	.03	.18	9	4.0	1.1	-	-

Table 3. Summary of plant measurements - 1980.

Treatment	Early plant height	Early plants(10) dry weight	Grain: Grain moisture at harvest	Grain: Yield @ 15.5% M.	Silage: Dry matter at harvest	Silage: Silage yield (D.M.)	Silage: Ear wt. ÷ silage wt.
	inches	grams	%	Bu/A	%	lbs/A	%
CK	26.6	64.7	22.2	44.6	56.0	6070	53.8
FE	35.1	127.0	21.4	119.8	47.2	15254	57.0
SB	39.1	157.7	16.8	119.9	56.4	15255	58.7
LB	40.3	184.3	19.0	118.8	51.6	14168	59.5
LH	35.6	140.3	17.8	106.0	53.7	12382	63.6
Significance	**	**	**	**	**	**	NS
BLSD (.05)	2.9	34.6	2.0	14.1	4.0	3616	-

Nitrogen Fertilization and Nitrogen Utilization by Eight Small Grain Varieties - Morris, MN. - 1980

G.L. Malzer, S. Evans, and R. Busch

The semi-dwarf varieties of hard red spring wheat accounts for a major portion of the acreage planted to hard red spring wheat in Minnesota. These short statured varieties not only provided improved physical characteristics, but also provided the potential for a system which might be capable of responding to higher rates of nitrogen application without lodging. The difference that exists between wheat varieties in their ability to utilize soil and fertilizer nitrogen is not well understood. A portion of the differences which exists may be due to the genetic ability of the plant because of some favorable plant characteristic either above or below the soil surface. If selection of plant genotypes can be made for more effective nitrogen uptake and utilization, advancements may be made in increasing present yield levels as well as improving the over all protein content of the grain. Trials were established in 1980 to examine some of the differences which exist between wheat varieties in their response to fertilizer nitrogen and their ability to utilize existing soil nitrogen. Existing popular varieties as well as older varieties and experimental varieties were included for comparison. Similar trials were conducted at Crookston as well as Morris, MN.

Experimental Procedures

Eight varieties of hard red spring wheat were compared at nitrogen application rate of 0,60 and 120# N/A at the West Central Experiment Station at Morris. Nitrogen was applied as spring applications of ammonium nitrate broadcast and incorporated. The treatments were arranged in a split plot design with nitrogen as the main effect and the eight varieties planted within a uniformly fertilized area. All treatments were replicated four times. Experimental plots were planted into areas 4' x 20' on April 17th.

Total plant dry matter was measured at approximately the "soft dough" stage of growth (July 3rd) and samples collected for nitrogen content and calculation of nitrogen uptake. Yield grain was harvested on July 31 by harvesting 16 ft.^{2} of the plot area. The above ground growth (straw & grain) was removed from the experimental plot area, allowed to air dry in a forced air dryer. The samples were then weighed, thrased and the grain reweighed for yield determination. Straw weights were determined by difference. Samples of straw and grain were collected and analyzed for nitrogen content and determination of nitrogen removal.

General Results

The 1980 yield results obtained from Morris in 1980 were excellent. This, in spite of the early dry spring which caused considerable problems with emergence and stand uniformity. Grain yields ranged from 30-54 bu/A with positive response to nitrogen fertilization up to the 60# N/A rate of application. Although yield responses were obtained only up to the 60 pound rate of nitrogen application significant increases were obtained in grain protein and many other nitrogen uptake characteristics to the highest rate of nitrogen fertilization (120# N/A). Nitrogen fertilization significantly decreased test wt with each increment of application. Averaged over all nitrogen rates, the highest yielding varieties included MN 70170R, MN 7222, Era and Coteau. Significant differences (.05) between varieties were not only obtained with yield but also with other nitrogen utilization parameters. Of the four highest yielding varieties above, Coteau had the highest overall protein content. Total nitrogen removal by the above ground portion was however the highest with MN 70170R and Coteau while WS 1809 utilized the lowest total quantity of nitrogen. Results would suggest varietal differences not only with total nitrogen removal, but also differences in the ability of the various plant systems to translocate nitrogen into the grain. Both considerations should be evaluated in the attempt to develop plant systems with both high yields and high protein characteristics.

Table 1. Influence of nitrogen fertilization and variety on yield, N content, and test weight, of eight hard spring wheat varieties.

Nitrogen Rate	Variety	Grain Yield	Grain N content	Grain Test wt.	Forage Total Dry Matter	Forage N content
#/A		bu/A	%	#/bu	T/A	%
0	-	39.5	2.53	58.0	1.87	1.30
60	-	49.8	2.60	56.4	2.44	1.53
120	-	49.0	2.75	55.4	2.49	1.72
Significance		**	**	**	**	**
BLSD (.05)		3.7	0.07	0.9	0.22	0.08
-	Coteau	48.1	2.85	58.7	2.40	1.49
-	WS 1809	36.0	2.64	53.3	1.86	1.58
-	Era	48.8	2.39	57.0	2.34	1.56
-	Mn 70170R	52.0	2.55	57.6	2.31	1.60
-	Chris	42.2	2.75	57.8	2.29	1.44
-	James	46.8	2.64	56.9	2.35	1.54
-	Waldron	45.8	2.84	56.7	2.42	1.49
-	Mn 7222	49.2	2.33	54.7	2.15	1.43
Significance		**	**	**	**	**
BLSD (.05)		2.6	0.09	0.9	0.12	0.10
0	Coteau	38.4	2.70	58.9	1.98	1.24
0	WS 1809	29.7	2.52	56.5	1.96	1.34
0	Era	40.0	2.27	59.0	1.93	1.30
0	Mn 70170R	47.3	2.37	60.0	1.94	1.36
0	Chris	37.3	2.71	58.0	1.90	1.26
0	James	38.9	2.62	57.5	1.90	1.32
0	Waldron	40.9	2.87	57.0	2.03	1.37
0	Mn 7222	43.7	2.18	56.9	1.80	1.22
60	Coteau	52.4	2.86	58.5	2.60	1.50
60	WS 1809	40.1	2.69	53.6	2.10	1.71
60	Era	51.8	2.52	56.4	2.51	1.50
60	Mn 70170R	56.9	2.42	57.0	2.49	1.62
60	Chris	45.1	2.72	57.9	2.45	1.40
60	James	52.1	2.54	56.6	2.59	1.56
60	Waldron	47.8	2.73	56.3	2.49	1.48
60	Mn 7222	52.5	2.30	54.7	2.27	1.46
120	Coteau	53.6	2.98	58.6	2.61	1.72
120	WS 1809	38.1	2.71	49.9	2.02	1.68
120	Era	54.8	2.38	55.5	2.60	1.87
120	Mn 70170R	51.9	2.87	55.6	2.49	1.83
120	Chris	44.4	2.82	57.4	2.52	1.64
120	James	49.4	2.77	56.7	2.55	1.74
120	Waldron	48.8	2.93	56.6	2.74	1.64
120	Mn 7222	51.4	2.51	52.3	2.38	1.61
Signifiance		NS	**	**	NS	NS
BLSD (.05)		--	0.91	1.8	--	--

Table 2. Influence of nitrogen fertilization and variety on straw production and nitrogen uptake of forage, straw, and grain of eight hard red spring wheat varieties.

Nitrogen Rate	Variety	Harvest Straw		Nitrogen Removal			
		Dry Matter	N content	Forage	Straw	Grain	Grain & Straw
#/A		T/A	%	#/A			
0	-	1.46	0.45	48.7	13.1	55.6	68.7
60	-	2.05	0.57	74.5	23.2	72.0	95.2
120	-	2.25	0.75	85.7	33.5	75.1	108.6
Significance		**	**	**	**	**	**
BLSD (.05)		0.22	0.09	8.3	4.2	6.2	8.9
-	Coteau	2.08	0.52	72.5	22.0	77.0	99.0
-	WS 1809	1.62	0.72	59.6	24.3	53.3	77.5
-	Era	1.83	0.59	74.7	22.5	65.4	87.9
-	Mn 70170R	1.93	0.66	75.0	26.8	74.2	101.0
-	Chris	2.03	0.50	66.7	20.8	64.9	85.7
-	James	2.09	0.54	73.2	23.1	69.0	92.1
-	Waldron	2.09	0.54	72.9	23.0	72.8	95.8
-	Mn 7222	1.70	0.66	62.5	23.5	64.1	87.6
Significance		**	**	**	**	**	**
BLSD (.05)		0.11	0.07	7.2	6.1	4.8	6.7
0	Coteau	1.59	0.43	49.2	13.7	58.0	71.6
0	WS 1809	1.18	0.56	39.1	13.1	42.0	55.1
0	Era	1.39	0.46	50.3	13.1	50.4	63.5
0	Mn 70170R	1.48	0.46	53.1	13.9	62.7	76.6
0	Chris	1.66	0.39	47.9	13.0	56.4	69.4
0	James	1.50	0.43	50.1	12.8	56.7	69.5
0	Waldron	1.64	0.44	55.8	14.3	65.6	80.0
0	Mn 7222	1.25	0.45	44.2	11.2	53.1	64.3
60	Coteau	2.27	0.53	78.3	24.2	83.8	108.0
60	WS 1809	1.66	0.66	71.8	21.8	60.2	82.0
60	Era	1.90	0.58	75.6	21.9	72.8	94.7
60	Mn 70170R	2.02	0.66	80.9	26.6	76.8	103.4
60	Chris	2.15	0.46	60.1	19.7	68.4	88.1
60	James	2.40	0.55	80.8	26.3	73.8	100.1
60	Waldron	2.18	0.50	73.3	22.1	73.0	95.1
60	Mn 7222	1.82	0.62	66.2	22.8	67.3	90.0
120	Coteau	2.37	0.59	90.1	28.2	89.1	117.4
120	WS 1809	2.04	0.93	68.0	37.8	57.6	95.4
120	Era	2.20	0.73	98.1	32.5	73.0	105.5
120	Mn 70170R	2.28	0.88	91.0	39.8	83.1	122.9
120	Chris	2.28	0.65	83.1	29.7	69.8	99.6
120	James	2.37	0.64	88.9	30.3	76.4	106.7
120	Waldron	2.46	0.66	89.6	32.7	79.8	112.5
120	Mn 7222	2.02	0.91	77.0	36.6	72.0	108.6
Significance		NS	+	NS	+	NS	NS
BLSD (.05)		--	0.14	--	6.9	--	--

Influence of Nitrogen Fertilization On Forage Production And Nitrogen Utilization By Three Small Grain Varieties

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 reasons 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 it's 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 assess 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 the 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 applied as a spring preplant incorporated treatment.

Dry matter production was determined at three different times during plant growth and analyzed for nutrient composition. Grain was harvested on July 31 by hand harvesting 30 ft^2 of plot area. The above ground growth (straw & grain) was removed from the experimental plot area, allowed to air dry in a forced air dryer. The samples were then weighed, thrashed and the grain reweighed for yield determination. Straw weight was determined by difference. Samples of straw and grain were collected and analyzed for nitrogen content and determination of nitrogen removal. Soil samples were obtained at the four sampling above (May 27, June 17, July 3, and July 31) 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 root samples were obtained.

General Results

The 1980 growing season was characterized by being extremely warm and dry during the first 4-6 weeks. This created numerous problems including poor germination and uneven stands. At the Morris location rainfall was obtained in early June to recharge the soil moisture in the profile to a substantial depth. The final results obtained from this experiment were excellent even when considering the questionable early environmental conditions. Forage yield, grain yield and nitrogen utilization characteristics of the three varieties tested are included in Table 1. Forage dry matter production at the first sampling was increased when nitrogen was applied with Era but not with the other varieties. Increase in dry matter production due to nitrogen fertilization were observed with the other varieties at subsequent samplings, while the responses obtained with Era deminished with time. Nitrogen concentration of the forage was not influenced by nitrogen fertilization or variety at the first sampling but positive increases were obtained with later samplings. No variety differences in nitrogen concentration in the forage was obtained with the controls, but variety differences were obtained when nitrogen fertilizer was added. Only MN 7125 provided a significant (.05) yield response to applied nitrogen, although the other varieties also reflected a positive trend.

Nitrogen removal in the grain and straw reflected the nitrogen treatments, with relatively little difference between varieties at either the low or high nitrogen fertility.

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	0.25	1.32	2.21	3.32	1.64	0.99
Chris	120	0.27	1.56	3.56	3.35	2.56	1.52
MN7125	0	0.25	1.11	2.46	3.28	1.51	1.02
MN7125	120	0.29	1.81	3.51	3.36	2.52	1.67
Era	0	0.25	1.17	2.36	3.12	1.70	1.12
Era	120	0.40	1.51	2.80	2.84	2.88	1.80
Significance		*	**	*	NS	**	**
BLSD (.05)		0.11	0.33	1.04	--	0.28	0.21

		Forage N Removal			Grain Yield	Straw Yield	Harvest N Content		Harvest N Removal		Test wt
		1	2	3			Grain	Straw	Grain	Straw	
		------#/A-------			bu/A	T/A	------	-----	-----#/A----		#/bu
Chris	0	16.6	43.3	43.5	37.9	1.78	2.51	0.34	57.1	12.1	54.9
Chris	120	18.0	80.0	108.3	47.7	2.77	2.85	0.81	81.9	44.8	55.3
MN7125	0	16.3	33.4	50.0	43.9	1.40	2.09	0.46	55.3	12.9	56.4
MN7125	120	19.7	91.3	117.1	57.0	2.33	2.56	0.87	87.7	40.5	52.8
Era	0	15.4	38.4	52.8	49.2	1.46	2.15	0.45	64.2	13.3	57.8
Era	120	22.2	87.2	104.4	57.8	2.44	2.63	0.81	91.6	39.8	52.4
Significance		**	**	**	**	**	**	**	*	**	NS
BLSD (.05)		3.12	11.5	38.0	10.0	0.32	0.39	0.11	26.7	7.8	--

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Use Of N-Serve As A Nitrification Inhibitor In Fall Vs. Spring Nitrogen Application Programs For Corn Production in West Central Minnesota

G.L. Malzer and S. Evans

A considerable interest has developed over the last several years concerning the use of N-Serve as a nitrification inhibitor with ammonium forming fertilizers on fine textured soils of Minnesota. On many of these fine textured soils, depending on the climatic conditions encountered and internal soil drainage, losses of nitrate nitrogen may occur through denitrification. If this loss occurs a portion of the plant available nitrogen is lost, and yield reductions may develop. With the normally cool wet spring conditions which are encounted on most of these soils, there may also be a considerable advantage in time management, associated with earlier nitrogen fertilization. This condition exists provided that nitrogen losses are not severe in the interm period. If nitrification inhibitors are capable of minimizing the production of nitrate nitrogen with fall nitrogen applications, they may have the advantage of minimizing potential nitrate nitrogen losses as well as increasing the length of time that would be available in the fall to apply nitrogen (prior to 50-55° soil temperatures).

Experimental Procedures

An experiment consisting of four replications of fourteen treatments was established at the West Central Experiment Station at Morris MN for the 1980 growing season. The treatments consisted of a control, three times of nitrogen application (1-Sept 20, 1979, 2-Oct 29, 1979, and 3-May 2, 1980), and two rates of nitrogen fertilization (40 or 80 # N/A) with all N combinations with and without N-Serve at 0.5 # a.i./A. An additional spring treatment of 120 # N/A without N-Serve was also included in the experiment. Corn (Dekalb XL12) was planted on May 6th at a seeding rate of 22,000 seeds/A. Weed control was accomplished with a tank mix of Lasso (2½ # a.i./A) plus Bladex (2#a.i./A).

Leaf samples were collected from opposite and below the ear at silking and Kjeldahl nitrogen determined. Total dry matter production was determined on September 17th by hand harvesting 50 ft^2. Ears were separated from the stalks, field weights obtained, and samples removed for moisture determination and Kjeldahl nitrogen analysis for calculation of nitrogen removal. Corn grain yields were collected by machine harvesting two rows 55 ft. long from each plot on October 9th, subsamples were taken for moisture determination.

General Results

Corn grain yields at the West Central Experiment Station were quite good in 1980. Yield responses to nitrogen fertilization were obtained up through the 80 pound/acre rate of application. Time of nitrogen application, as well as, use of a nitrification inhibitor (N-Serve) provided relatively few differences in the parameters measured. This would suggest that net nitrogen losses to the extent of reducing yields were not great during the fall of 1979 or spring of 1980. This information follows the responses that have been obtained in the past three years with timing of N application and use of nitrification inhibitors at the West Central Experiment Station. The results would therefore suggest that nitrogen losses in this area on similar soils are relatively small. It would also suggest (within the constraints of the experiment) that there is considerable flexibility with fall nitrogen management programs and that perhaps the 50-55° F temperature recommendations currently being utilized may not be as critical as what might be observed in South Central Minnesota.

Table 1. Influence of nitrogen rate of application, time of application and the use of N-Serve as a nitrification inhibitor on leaf N content, grain yield, yield grain N content, dry matter production and nitrogen removal on corn from Morris, MN - 1980

Treatments						Dry Matter Production			Dry Matter N-Content		Dry Matter N-Removal		
N Rate	Time	Inh.	Leaf N	Grain Yield	Yield Grain N	Grain	Stover	Total	Grain	Stover	Grain	Stover	Total
#/A		0.5#ai/A	%	Bu/A	%	T/A			%		lbs/A		
Check		No	2.14	89.9	1.15	2.61	3.22	5.83	1.12	0.59	58.7	38.1	96.8
40	1	No	2.66	119.2	1.37	3.54	3.62	7.17	1.37	0.72	97.4	51.7	149.1
40	1	Yes	2.69	125.8	1.36	3.63	3.91	7.54	1.32	0.64	96.3	50.7	147.1
80	1	No	2.90	135.3	1.53	3.83	3.93	7.76	1.53	0.78	117.5	61.6	179.1
80	1	Yes	2.92	122.4	1.44	3.78	3.81	7.58	1.51	0.73	114.2	55.3	169.5
40	2	No	2.84	122.6	12.8	3.36	3.68	7.05	1.33	0.65	89.7	48.2	138.0
40	2	Yes	2.75	123.3	1.41	3.42	3.63	7.04	1.30	0.75	89.3	54.8	144.1
80	2	No	2.85	125.5	1.42	3.52	3.90	7.42	1.44	0.72	101.6	56.4	158.0
80	2	Yes	2.87	131.3	1.47	3.63	3.83	7.46	1.47	0.72	106.9	55.9	162.8
40	3	No	2.78	122.0	1.36	3.37	3.69	7.07	1.34	0.67	90.8	49.5	140.3
40	3	Yes	2.75	126.0	1.49	3.63	3.72	7.35	1.44	0.71	104.4	52.7	157.1
80	3	No	2.93	128.9	1.52	3.84	4.04	7.88	1.57	0.79	120.4	63.5	183.8
80	3	Yes	2.85	130.5	1.51	3.75	3.92	7.67	1.51	0.82	113.3	64.8	178.1
120	3	No	3.14	133.3	1.57	3.88	4.10	7.98	1.51	0.89	117.1	72.7	189.8
Significance			**	**	**	**	*	**	**	*	**	**	**
BLSD(.05)			0.16	12.7	0.11	0.42	0.48	0.78	0.11	0.17	13.1	13.7	23.1
N-Rate													
40			2.75	123.1	1.38	3.49	3.71	7.20	1.35	0.69	94.7	51.3	145.9
80			2.89	129.0	1.48	3.73	3.90	7.63	1.51	0.76	112.3	59.6	171.9
Significance			**	*	**	*	*	**	**	*	**	**	**
BLSD(.05)			0.09	5.6	0.07	0.18	0.16	0.41	0.05	0.06	8.0	7.1	13.6
Inhibitor													
No			2.83	125.6	1.42	3.58	3.81	7.39	1.43	0.72	102.9	55.2	158.1
Yes			2.80	126.5	1.45	3.64	3.80	7.44	1.43	0.73	104.1	55.7	159.8
Significance			NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
BLSD(.05)			-	-	-	-	-	-	-	-	-	-	-
Time													
1			2.79	125.7	1.43	3.70	3.82	7.52	1.44	0.72	106.4	54.8	161.2
2			2.83	125.7	1.40	3.48	3.76	7.25	1.39	0.71	96.9	53.8	150.7
3			2.83	126.8	1.47	3.65	3.84	7.49	1.46	0.75	107.2	57.6	164.8
Significance			NS	NS	+	NS	NS	NS	*	NS	*	NS	+
BLSD (.05)			-	-	0.06	-	-	-	0.05	-	7.5	-	11.6

SOIL TEST LAB COMPARISON

West Central Experiment Station - Morris

S. D. Evans and W. E. Jokela

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

In the fall of 1979 a large composite soil sample was taken. This sample was dried thoroughly, mixed and sub-divided and sent to five different laboratories for a complete analysis. Recommendations were requested for corn at a yield goal of 110 Bu/A and spring wheat at a yield goal of 55 Bu/A. In the spring of 1980 samples were taken to a depth of 2 feet in the 1980 wheat area and again sent to the five laboratories for NO_3-N analysis and N recommendations. After receiving the soil tests and recommendations (Tables 1 and 2), the fertilizer treatments were calculated with (1) an adjustment for soil buildup over a period of years (LAB C) and (2) an adjustment for wheat only to convert drill recommendations to broadcast recommendations (LABS A and E).

General

The experiment was set up as a randomized complete block with 4 replications on each crop. Two blocks, each with 24 plots, are adjacent to one another and will alternate between wheat and corn. The plot size is 15 feet by 40 feet. Row spacing on the corn is 30 inches.

Wheat

The P, K and S treatments for wheat were applied broadcast by hand in a dry form on April 23. The micronutrients were dissolved in water and sprayed onto the plots the same day. Since NO_3-N analyses were not available, N was applied as urea to supply 30 lb/A of N. All plots were then worked with a field cultivator and Era wheat was seeded @ 1 3/4 Bu/A. After receiving the NO_3-N readings, the remainder of the recommended N was applied as ammonium nitrate on May 13. On May 16 bromoxynil (.25 lb/A) and MCPA ester (.25 lb/A) were applied for weed control. The upper 4-5 leaves from 20-25 plants were collected on June 16 prior to flowering for nutrient analysis. The plots were harvested with a plot combine on July 31 (Rep I) and August 4 (Reps II, III and IV). Samples of grain were saved for protein analysis.

Corn

The N, P, K and S treatments for corn were applied broadcast by hand in a dry form on May 8. The micronutrients were dissolved in water and sprayed onto the plots the same day. All plots were then worked with a field cultivator and planted to corn on May 9. The variety was Trojan TXS 99 and was planted at 22,000-23,000 seeds per acre. There was no starter fertilizer used. An insecticide, Counter, was applied in the row at 8.8 lb/A (1 lb/A active ingredient). Herbicides used were Lasso @ 2.5 lb/A and Bladex @ 2.2 lb/A on May 12 and 2,4-D LV ester @ .33 lb/A on June 9. Early plant heights were taken on June 19 and ear leaf samples were collected from 10 plants on July 18. The plots were harvested with a plot combine on October 10. Samples of grain were saved for protein analysis.

Results and Discussion of Wheat Trial

As shown in Table 1, the soil test and fertilizer recommendations varied greatly with laboratory. All of the commercial labs recommended sulfur and three recommended at least one micronutrient. There were also wide variations in N, P and K recommendations.

The leaf analysis of the wheat (Table 3) showed significant effects on N, Ca and Mn. LAB D consistently shows up with low concentrations of these elements and in some cases is not significantly different from the check. LABS A, B, C and E are not significantly different.

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

Table 1. Soil test results and the suggested fertilizer program for wheat in 1980.

Test	Soil Test Results[1]				
	LAB A	LAB B	LAB C	LAB D	LAB E (UM)
pH	8.1	7.4	7.7	7.7	7.5
Phosphorus (Bray 1)	7-L	10-L	-	12-M	9
($NaHCO_3$)	-	34-M	6-L	-	-
Potassium	126-H	142-M	140-L	135	110
Organic matter (%)	3.8	3.6-H	3.6-H	M	H
Calcium	8000	3260-H	4900-VH	3600-M	-
Magnesium	1040	570-VH	670-VH	620-H	-
Sodium	118	-	21-M	-	-
Sulfur	5-L	8-M	9-L	1-VL	8
Iron	27.3-H	17-H	23.3-H	4-H	-
Manganese	12.3-VH	8-L	6.2-ADQ	10-H	-
Zinc	1.93-H	1.8-M	0.7-L	4.8-ADQ	1.6
Copper	0.85-H	0.6-L	0.7-ADQ	2.6-L	-
Boron	-	0.9-M	0.6-L	-	-
ENR (lb/A)	60	72	-	-	-
Nitrate nitrogen (lb/A)	60(0-2 ft)	11-M	5-VL	72	61(0-2 ft)
C.E.C. (meq/100 g)	24.9	21.4	30.5	-	-
Soluble salts (mmhos/cm)	0.3	-	0.15	-	0.6

Nutrient	Suggested Fertilizer Program[2]				
	LAB A	LAB B	LAB C	LAB D	LAB E (UM)
Nitrogen	75	80	90	28	60
Phosphorus (P_2O_5)	48[3]	60	78[4]	34	45[3]
Potassium (K_2O)	25[3]	85	130[4]	80	23[3]
Sulfur	2	10	24	40	-
Zinc	-	2	3	-	-
Manganese	-	2	-	-	-
Copper	-	0.5	-	2	-
Boron	-	-	1.0	-	-

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

[2] All values indicate pounds of nutrient suggested per acre for a yield goal of 55 bushels of wheat per acre.

[3] Values specified for drill application so were increased by 50% and applied broadcast.

[4] Values include maintenance plus 1/3 of suggested buildup, both applied in 1980, with remaining 2/3 of buildup to be applied in 1981 and 1982.

Table 2. Soil test results and the suggested fertilizer program for corn in 1980.

Test	Soil Test Results[1]				
	LAB A	LAB B	LAB C	LAB D	LAB E (UM)
pH	8.1	7.6	7.7	7.7	7.5
Phosphorus (Bray 1)	7-L	8-L	-	12	9
($NaHCO_3$)	-	30-M	6-L	-	-
Potassium	126-H	131-M	140-L	135	110
Organic matter (%)	3.8	2.9-M	3.6-H	M	H
Calcium	8000	2900-H	4900-VH	3600-M	-
Magnesium	1040	554-VH	670-VH	620-H	-
Sodium	118	-	21-M	-	-
Sulfur	5-L	6-L	9-L	1-VL	8
Iron	27.3-VH	15-L	23.3-H	4-H	-
Manganese	12.3-VH	7-L	6.2-ADQ	10-H	-
Zinc	1.93-H	1.7-M	0.7-L	4.8-ADQ	1.6
Copper	0.85-H	0.5-L	0.7-ADQ	2.6-H	-
Boron	-	1.2-M	0.6-L	-	-
ENR (lb/A)	60	74	-	-	-
Nitrate-Nitrogen (lb/A)	144	19-M	2-VL	152	147
C.E.C. (meq/100 g)	24.9	19.5	30.5	-	-
Soluble salts (mmhos/cm)	0.3	-	0.15	-	0.6

Nutrient	Suggested Fertilizer Program[2]				
	LAB A	LAB B	LAB C	LAB D	LAB E (UM)
Nitrogen	75	125	105	150	90
Phosphorus (P_2O_5)	100	75	92[3]	85	100
Potassium (K_2O)	50	115	158[3]	140	30
Sulfur	20	14	16	40	-
Zinc	-	1.5	7.5	-	-
Manganese	-	2	-	-	-
Copper	-	0.5	-	2	-
Boron	-	-	1.0	-	-

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

[2] All values indicate pounds of nutrient suggested per acre for a yield goal of 110 bushels of corn per acre.

[3] Values include maintenance plus 1/3 of suggested buildup, both applied in 1980, with remaining 2/3 of buildup to be applied in 1981 and 1982.

There were no significant differences in wheat yield, but LAB D again showed up with a low protein percentage.

The fertilizer cost and return over fertilizer are given in Table 6.

Results and Discussion of Corn Trial

As with wheat, the soil test values and fertilizer recommendations for corn (Table 2) varied greatly. All of the commercial labs again recommended sulfar and three recommended at least one micronutrient.

The ear leaf nutrient concentrations (Table 4) showed significant treatment effects on P, Ca, Fe and Zn. The only significant difference in P is between the check and LAB A. With Ca and Fe the effect was significant only at the 10% level, with the check being lowest in both cases. With Ca there was a significant difference between LAB B and E, but with Fe the five labs were not significantly different. The Zn concentration with LAB B and check were almost identical. The only significant difference at the 5% level was between LAB D and check.

There were no significant differences in corn grain yield. However, the check treatment was considerably lower in yield than all other treatments.

The fertilizer cost and return over fertilizer are given in Table 6.

General

Fertilizer recommendations from the five labs varied greatly, but application of these rates did not result in significantly different yields. With both corn and wheat, the only element where there appeared to be a relation between application and tissue concentration was nitrogen. In almost all cases micronutrient applications did not increase tissue concentrations. The only element where application resulted in a higher level (but still non-significant) was boron in the wheat leaves on LAB C plots (1 lb/A of B applied). Fertilizer costs for both wheat and corn were lowest with LAB E (UM).

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

	Nutrient Concentration of Upper 4 Leaves Prior to Flowering									
LAB	N	P	K	Ca	Mg	Fe	Zn	Cu	Mn	B
	%					ppm				
A	4.02	.268	2.38	.779	.336	92	35.3	2.7	62	24.2
B	4.23	.280	2.10	.758	.319	86	29.6	2.8	58	23.2
C	4.28	.301	2.54	.789	.346	99	37.2	3.0	68	32.3
D	3.42	.287	2.65	.637	.290	90	31.0	2.7	54	23.7
E (UM)	4.18	.286	2.42	.743	.359	96	36.4	3.1	62	26.6
Check	3.42	.274	2.65	.561	.259	81	28.6	2.3	50	25.0
Significance:	**	NS	NS	*	NS	NS	NS	NS	+	NS
BLSD (.10):	.13	-	-	.149	-	-	-	-	11	-
BLSD (.05):	.21	-	-	.179	-	-	-	-	-	-
CV (%):	3.7	15.3	12.8	14.8	16.5	11.9	15.4	13.4	13.3	18.3

Table 4. Effect of suggested fertilizer applications on the leaf nutrient concentration of corn.

LAB	Ear Leaf Nutrient Concentrations									
	N	P	K	Ca	Mg	Fe	Zn	Cu	Mn	B
	%					ppm				
A	3.14	.328	1.92	.651	.558	114	18.6	5.1	82	5.3
B	3.02	.309	1.79	.662	.520	111	16.7	4.1	80	5.4
C	3.14	.320	2.02	.592	.496	108	19.8	5.0	81	5.6
D	3.22	.309	1.97	.635	.446	107	20.4	5.1	84	5.4
E (UM)	3.10	.322	2.06	.575	.487	110	19.6	5.4	82	5.6
Check	2.86	.290	1.87	.562	.448	100	16.6	4.6	66	5.0
Significance:	NS	*	NS	+	NS	+	**	NS	NS	NS
BLSD (.10):	-	.022	-	.076	-	8	2.0	-	-	-
BLSD (.05):	-	.037	-	-	-	-	3.3	-	-	-
CV (%):	1.8	5.0	8.5	8.6	13.9	5.4	8.0	16.4	13.4	6.6

Table 5. Effect of suggested fertilizer applications on corn and wheat growth and yield.

LAB	Corn					Wheat	
	Early Plant Height	Broken Stalks	Final Population	Corn Grain Yield	Corn Grain Moisture	Wheat Grain Yield	Wheat Grain Protein
	in	%	ppAx10^{-3}	Bu/A	%	Bu/A	%
A	22.8	1.6	19.9	118.9	22.9	48.7	16.0
B	24.2	2.7	18.4	116.8	21.5	48.1	15.2
C	24.1	2.9	19.4	120.4	22.5	48.5	16.0
D	24.2	1.9	19.2	118.7	22.4	49.0	13.7
E (UM)	23.9	1.8	17.7	115.7	22.2	50.7	15.4
Check	23.1	2.8	19.9	107.9	23.4	50.2	13.9
Significance:	NS	NS	**	NS	NS	NS	**
BLSD (.05):	-	-	0.9	-	-	-	1.5
CV (%):	6.5	61.0	3.3	6.4	5.0	7.7	6.2

Table 6. Economic return over fertilizer costs.

LAB	Wheat			Corn		
	Value of Crop @ $4/Bu	Fertilizer Cost*	Return over Fertilizer	Value of Crop @ $3/Bu	Fertilizer Cost*	Return over Fertilizer
	$/A			$/A		
A	194.80	30.45	164.35	356.70	46.45	310.25
B	192.40	43.70	148.70	350.40	58.20	292.30
C	194.00	62.36	131.64	361.20	67.75	293.45
D	196.00	35.80	160.20	356.10	75.27	280.83
E (UM)	202.80	23.01	179.79	347.10	42.10	305.00
Check	200.80	0	200.80	323.70	0	323.70

* Values used ($/lb) were as follows: N = $0.15, P_2O_5 = $0.25, K_2O = $0.12, S= $0.21, Cu = $2.40, Zn = $0.90, Mn = $0.71, B = $1.52

ALFALFA AND RED CLOVER POTASSIUM TRIALS

Staples, Minnesota 1980

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

Alfalfa and red clover trials at Staples were first established 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 the time because lime in the irrigation water had raised the pH of all plots above 7. In the last 4 years, pH in the trial area is 7.5 or higher.

After 1974 only the potassium trials on alfalfa and red clover were 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. Red clover stand failed in 1979, since then only the alfalfa trial was continued. The experiment will not continue after 1980.

Yield and soil test results

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

Potassium soil test 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. The 120 pounds treatment was increased to 180, and the 240 pound treatment was increased to 360 for 1978. This increase in potassium rates has been reflected in increases of K test up to 287 pounds of K from one of the 360 pound treatments. The upward trend does not appear to continue from the 360 pounds of K_2O treatments in 1979. Table 1b shows 0 to 3 inch tests over the 300 level only from one 360 pound treatment, and averages for the 0 to 6 inch depth do not go above 300 pounds of K_2O treatment yield about .3 ton of alfalfa more than the 180 pounds annual treatment, with a soil test ranging between 100 and 138 pounds of K.

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, nor has there been an advantage to split applications.

Yield 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 yeilded approximately 2 tons per acre and show K deficiency symptons. Low K tests after high K treatments occur at the Becker farm also. The high K treatments and low K tests would be a good thesis problem especially since yield increases from soil test above 120 pounds of K are not very large.

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 and 1979, 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. The third cutting in 1979 was taken late in September.

Table 1a. Potassium treatments effect on red clover and alfalfa yields, 1972 through 1976.

	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%
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%

Table 1b. Potassium treatment effect on red clover and alfalfa yield in 1978, 1979, and 1980 after K_2O increase.

	K_2O in lb/A annual and time of application							
1978 Cutting	None	June 360	Oct. 360	June 180	Oct. 180	June 180+ Oct. 180	significance	
	tons/acre 15% moisture							
Alfalfa								BLSD (.05)
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	**	-
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	-

*Red clover stand failed

Table 1b. con't.

1979 Cutting	None	June 360	Oct. 360	June 180	Oct. 180	June 180+ Oct. 180	significance	
				tons/acre 15% moisture				
Alfalfa								
1	.58	1.58	1.64	1.41	1.45	1.50	**	.20
2	1.17	1.62	1.59	1.56	1.53	1.70	**	.41
3	.51	.93	.95	.88	.88	.84	**	.21
total	2.26	4.13	4.18	3.85	3.86	4.04	**	.32
Red Clover Discontinued								
1980								
Alfalfa								
1	.99	2.48	2.48	1.86	2.18	2.46	**	.29
2	.37	1.02	1.06	.91	.96	1.10	**	.23
3	.74	1.27	1.20	1.22	1.14	1.26	**	.21
total	2.10	4.77	4.37	3.99	4.28	4.82		

Table 2a. Exchangeable potassium soil tests according to potash treatment, 1972 through 1976. Soil sampled in September each year.

	Soil Test K lbs/A						
	None	June 240	Oct. 240	June 120	Oct. 120	June 120+ Oct. 120	
Alfalfa							
1972	92	258	322	160	165	185	Avg. pH-7.6 (1978)
1973	85	290	210	150	140	195	Avg. P Alf=47 R.C.=72 (1978)
1974	60	175	240	95	75	200	
1975	48	178	160	75	63	135	
1976	40	210	145	68	68	128	
1977**							
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	
1977**							

*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. Treatment of K_2O in 1978 were increased from 120 to 180 pounds of K_2O per acre and the 240 pound treatment was increased to 360 (data in Table 1b).

Table 2b. Soil test K from 1978, 1979, and 1980.

	Soil test K lbs/A							
	None	June 360	Oct. 360	June 180	Oct. 180	June 180+ Oct. 180		
Alfalfa								
1978	54	287	216	123	91	212		
1979								
0-3"	55	317	249	180	116	261	**	38
3-6"	44	275	303	96	84	206	**	40
Avg(0-6")	50	296	276	138	100	233		
1980	34	375	309	108	88	268		

Table 2b. con't.

	Soil test K lbs/A					
	None	June 360	Oct. 360	June 180	Oct. 180	June 180+ Oct. 180
Red clover						
1978	58	300	170	138	86	210
1979	No crop after 1978					

Phosphorus & pH averages for all plots

1978 P Alf = 47
R. C. = 72
pH Alf = 7.6
R.C. = 7.6

1979 P 0-3" = 37
3-6" = 33
pH = 7.5

1980 P 0-6" = 31
pH = 7.5

Table 2c. Potassium (%) in alfalfa and red clover tops, 1972 through 1976.

Plant Analysis

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	1.76b	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	2.66	2.47b	3.05c	5%
1977-None							

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

Table 2c. con't.

	K_2O treatment and dates of application							
	None	June 360	Oct. 360	June 180	Oct. 180	June 180 Oct. 180	significance	BLSD 5%
Alfalfa								
1978-1st 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
1979-1st cut	1.34	3.14	3.04	2.42	2.54	3.08	**	.19
2nd cut	1.49	3.17	3.20	2.68	2.51	3.24	**	.21
3rd cut	0.86	2.09	2.03	1.87	1.60	2.06	**	.12
1980-1st cut	0.98	2.48	2.47	2.11	2.13	2.48	**	.30
2nd cut	1.59	3.35	3.26	2.86	3.01	3.39	**	.22
3rd cut	1.18	2.33	2.32	2.09	1.98	2.39	**	.14
	Sufficiency levels for alfalfa 2.5%							
Red Clover								
1978-1st 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
1979-None								
1980-None								

Table 3. Plasma emission spectrograph analysis of alfalfa, Staples 1980.

1st cut		%				ppm					
lbs, K_2O/A	Time	P	K	Ca	Mg	Al	Fe	Mn	Zn	Cu	B
0	--	.37	.98	2.53	.44	32	128	48	24	4	50
360	June	.38	2.48	1.64	.29	38	149	46	26	3	46
360	Oct.	.38	2.47	1.60	.29	37	140	47	27	3	51
180	June	.36	2.11	1.85	.33	45	136	45	24	4	51
180	Oct.	.37	2.13	1.93	.34	35	129	49	26	3	47
360	½ June ½ Oct.	.38	2.48	1.66	.30	37	127	47	26	4	53
signif.		ns	**	**	**	ns	ns	ns	ns	ns	ns
BLSD (.05)		-				-	-	-	-	-	-
C.V.		5.8	4.6	8.4	7.8	22.3	16.9	10.3	9.3	20.1	10.0
2nd cut											
lbs, K_2O/A	Time										
0	--	.48	1.59	2.25	.46	26	165	49	30	9	55
360	June	.49	3.35	1.67	.35	27	166	44	38	8	52
360	Oct.	.48	3.26	1.68	.34	32	180	48	36	8	52
180	June	.48	2.86	1.82	.39	28	162	52	35	8	54
180	Oct.	.50	3.01	1.78	.41	27	169	46	36	7	51
360	½ June ½ June	.49	3.39	1.57	.35	29	171	44	37	8	48
signif.		ns	**	**	**	ns	ns	ns	**	ns	ns
BLSD (.05)		--				--	--	--		--	--
C.V.		4.9	7.8	5.3	5.6	12.4	7.9	13.4	5.8	9.6	8.9

Table 3. con't.

3rd cut		%				ppm					
lbs, K_2O/A	Time	P	K	Ca	Mg	Al	Fe	Mn	Zn	Cu	B
0	--	.39	1.18	3.21	.59	34	188	53	21	5	69
360	June	.33	2.33	2.36	.27	39	219	42	20	5	67
360	Oct.	.33	2.32	2.43	.26	39	217	44	20	5	68
180	June	.34	2.09	2.61	.32	41	211	48	21	5	74
360	Oct.	.34	1.98	2.78	.27	40	226	46	21	5	75
	½ June ½ Oct.	.33	2.39	2.33	.27	42	213	45	21	5	67
signif.		**	**	**	**	**	*	*	ns	ns	ns
BLSD (.05)		.02	.14	.15	.05	4	25	7	-	-	-
C.V.		4.9	5.0	4.2	9.7	6.5	6.9	8.5	5.6	9.2	7.3

BARLEY FERTILIZATION TRIALS UNDER IRRIGATION*

M.J. O'Leary, J.N. Lensing and M. Wiens

Studies to evaluate nitrogen fertilization of irrigated malting barley were continued in 1980. These studies were initially started because conditions that usually exist when soils are irrigated in Minnesota indicate a potential of malting barley production with high yields and acceptable malting characteristics. The irrigated soils of Minnesota are predominantly coarse testured types, low in organic matter and consequently low in a supply of native soil nitrogen. Because of this fact there is the possibility of optimum nitrogen fertilizer management to produce acceptable yields of grain with desirable malting characteristics. Experiments in 1980 were located at Staples, and Westport, Minnesota, on Estherville sandy loam soils. Varietal response to various nitrogen rates and timing of nitrogen application were the main objectives of these studies.

Experimental Procedures

Two experiments were conducted at Staples. In order to evaluate the performance of malting barley varieties at various nitrogen rates a split plot design replicated four times was used. Varieties were treated as main plots and nitrogen rates as subplots. Six varieties, three presently grown commercially and three experimental, were used at nitrogen rates of 0, 45, 90, and 135, pounds per acre. Nitrogen was applied as ammonium nitrate with 2/3 applied preplant and 1/3 at tillering stage.

The time of nitrogen application experiment was conducted using two varieties, each receiving treatments of nitrogen at various times. Each variety was tested in a randomized complete block replicated four times. One treatment received no nitrogen, all other treatments 90 lbs N/A as ammonium nitrate.

Experimental areas at Staples received 60 lbs. K_2O/A applied broadcast and plowed down. Preplant nitrogen treatments were broadcast and incorporated. Plot areas were packed and then planted at 96 lbs./A of seed on April 18. 20 lbs. P_2O_5/A was applied with the seed. Weeds were controlled with an application of Brominal + (¼ lbs. ai/A) at the four leaf stage. A total of 9.75 inches of water was applied by irrigation with an additional 6.2 inches received as rainfall. The crop in 1979 was barley.

A variety by nitrogen rate trial was also conducted at Westport utilizing a split plot design with varieties as main plots and nitrogen rates as subplots. Four varieties, Manker, Larker, Morex and M-32 (experimental), were compared at nitrogen rates of 0, 40, 80, and 120 lbs. N/A. Nitrogen was applied as urea. Plot area was then disced twice and planted at 96 lbs./A of seed on April 21. Brominal + (¼ lb. ai/A) was applied at four leaf stage for weed control. Eight inches of water was applied by irrigation with an additional 13.5 inches received as rainfall. 1979 crop was adzuki beans.

*This project was supported in part by funds from the Malting Barley Improvement Association.

Results

Variety by Nitrogen Rate - Staples

Very good yields were obtained in 1980 as a result of good growing conditions and the absence of barley leaf diseases. Differences in yield, test weight and % plump due to variety were highly significant (Table 1). Yield and % plump did not show the same response for all varieties. Yield response to nitrogen rates showed all varieties responding quite well to 45 and 90 lbs. N/A. Not all varieties showed a yield increase with 135 lbs. N/A. Percent plump showed a tendency to be lowest at the high nitrogen rate.

Time of Application Trial - Staples

This trial was designed to evaluate the effects various application schemes of nitrogen had on irrigated malting barley. The addition of nitrogen significantly increased yields for the variety Manker but there was no difference in application scheme (Table 2a). There were significant differences in % protein and % plump due to application scheme. Nitrogen applied 2/3 preplant and 1/3 early boot resulted in significantly higher values for % protein and % plump compared to other treatments.

Yields for M-32 were increased significantly with the application of nitrogen (Table 2b). Application split into 3 increments (trt. E) produced a significant increase in yield compared to 2/3 preplant and 1/3 early boot. Treatment D resulted in significantly higher % plump than any of the other treatments. Neither addition of nitrogen or scheme of application had significant effects on % protein.

Variety by Nitrogen Rate - Westport

There was a significant varietal difference in test weight and % plump (Table 3). Significant differences in % protein, test weight and % plump were shown between nitrogen rates. A bacterial leaf blight infection was quite severe and no doubt had considerable impact on grain yield and quality. Larker showed the most resistance to this disease.

Table 1. Effect of variety and nitrogen rate on yield, test weight, percent plumpness and percent protein of Barley grain, Staples, 1980.

Treatment		Yield	Test wt.	Plump	Protein
		bu/A	lbs./bu	%	%
Variety					
M - 32		62.2	47.5	69.1	10.2
M - 34		75.9	49.5	85.2	10.2
M - 36		74.1	50.8	81.6	9.9
Larker		69.8	49.5	71.9	9.6
Manker		73.0	50.2	72.2	10.2
Morex		69.5	47.5	75.1	10.2
signficance		**	**	**	ns
BLSD (.05)		5.7	1.5	2.2	-
lbs. N/A					
0		33.4	48.9	76.5	9.4
45		65.8	49.5	79.1	9.1
90		89.3	48.9	74.9	10.5
135		94.5	49.4	72.9	11.2
significance		**	ns	**	**
BLSD (.05)		3.5	-	1.8	.4
Variety	lbs. N/A				
M - 32	0	30.6	47.7	73.2	9.4
M - 32	45	54.0	49.4	74.8	9.3
M - 32	90	83.0	46.8	66.5	10.4
M - 32	135	81.2	46.2	61.8	11.8
M - 34	0	36.1	48.8	79.5	9.5
M - 34	45	66.7	49.3	88.8	8.9
M - 34	90	95.6	49.7	87.0	10.7
M - 34	135	105.0	50.1	85.8	11.5
M - 36	0	34.6	50.8	81.0	9.4
M - 36	45	72.8	51.0	86.2	9.3
M - 36	90	90.2	50.5	78.5	9.9
M - 36	135	98.8	50.9	80.8	11.0
Larker	0	34.2	49.9	74.0	9.1
Larker	45	58.9	49.9	72.8	8.3
Larker	90	89.4	48.4	72.5	10.1
Larker	135	96.6	49.9	68.2	10.9
Manker	0	32.4	49.0	73.5	9.2
Manker	45	70.8	49.9	71.5	9.2
Manker	90	92.2	50.3	73.2	11.1
Manker	135	96.7	51.5	70.8	11.2
Morex	0	32.1	47.2	78.0	9.6
Morex	45	71.9	47.4	80.8	9.3
Morex	90	85.4	47.8	71.5	11.0
Morex	135	88.5	47.7	70.2	11.1
significance		+	ns	**	ns
BLSD (.05)		11.2	-	4.9	-
C.V.		9.6	2.7	4.4	8.6

Table 2a. Effect of time of nitrogen application on Manker barley yield, test weight, percent plumpness and percent protein, Staples, 1980.

Treatment*	Yield bu/A	Test wt. lbs./bu	Plump %	Protein %
A 0 - N	25.5	49.4	64.0	8.6
B 90 ppl	82.3	50.5	70.2	8.4
C 60 ppl + 30 T	84.6	50.4	65.8	9.2
D 60 ppl + 30 EB	82.1	52.2	84.2	12.2
E 40 ppl + 30 T + 20 EB	88.3	51.2	71.2	10.4
significance	**	*	**	**
BLSD (.05)	9.4	1.9	6.3	1.3
C.V.	9.2	2.2	6.0	9.1

Table 2b. Effect of time of nitrogen application on M - 32 barley yield, test weight, percent plumpness and percent, Staples, 1980.

Treatment*	Yield bu/A	Test wt. lbs./bu	Plump %	Protein %
A 0 - N	24.3	49.2	68.0	9.6
B 90 ppl	71.8	47.6	72.8	9.6
C 60 ppl + 30 T	69.9	45.7	69.5	10.2
D 60 ppl + 30 T	65.4	49.5	85.0	11.2
E 40 ppl + 30 T + 20 EB	73.0	48.9	69.3	10.6
significance	**	+	**	ns
BLSD (.05)	6.7	2.9	3.8	-
C.V.	7.8	4.1	3.7	10.6

*Treatment Code

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

Table 3. Effect of variety and nitrogen rate on yield, test weight, percent plumpness and percent protein of barley grain, Westport, 1980.

Treatment		Yield bu/A	Test wt. lbs./bu	Plump %	Protein %
Variety					
Manker		70.8	44.6	49.1	12.0
Larker		78.3	44.4	75.1	11.4
Morex		74.1	42.9	65.7	11.6
M - 32		76.6	41.2	54.4	11.7
significance		ns	*	**	ns
BLSD (.05)		-	1.8	9.5	-
lbs. N/A					
0		70.5	44.2	72.0	10.4
40		77.4	43.3	60.1	11.5
80		76.4	42.6	57.8	12.1
120		75.5	42.9	54.3	12.7
significance		ns	*	*	**
BLSD (.05)		-	1.2	11.1	.6
Variety	lbs. N/A				
Manker	0	64.3	46.0	59.7	10.6
Manker	40	77.6	45.0	53.3	11.3
Manker	80	70.2	44.4	48.7	12.2
Manker	120	71.3	42.9	34.7	13.7
Larker	0	79.6	44.7	81.7	10.0
Larker	40	78.1	45.1	73.0	11.1
Larker	80	78.6	44.0	79.0	11.8
Larker	120	77.1	43.6	66.7	12.7
Morex	0	68.9	44.1	77.0	10.1
Morex	40	72.1	42.5	64.3	11.5
Morex	80	80.3	42.4	58.3	11.9
Morex	120	75.1	42.6	63.0	12.7
M - 32	0	69.4	42.0	69.7	11.1
M - 32	40	81.7	40.6	49.7	11.9
M - 32	80	76.4	39.7	45.3	12.4
M - 32	120	78.7	42.7	53.0	11.5
significance		ns	ns	ns	ns
C.V.		10.2	3.1	20.8	7.1

Fertilizer Nitrogen Uptake by Irrigated Potatoes

A.C. Caldwell, G.C. Buzicky, Mel Wiens

Irrigated potatoes require substantial amounts of N to obtain good yields. However, most irrigated potatoes are grown on sandy soils and any N not taken up by the plant or immobilized in the soil will likely find its way into the aquifer. There is little information locally on the efficiency of fertilizer N use by potatoes, but this deficiency in knowledge can be lessened if the amount of N absorbed by potatoes is measured using 15-N labelled fertilizer. There have been some reports that potatoes have responded more to ammonium rather than nitrate forms of N. If there is this perference a greater uptake of ammonium by the potato might be shown by labelling the fertilizer with 15-N.

Objectives

1. To determine N derived from fertilizer and amount recovered by the plant by labelling the fertilizer with 15-N.
2. To determine if there is any difference in utilization of the labelled ammonium or nitrate-N fertilizer source by the potato.

Procedure

A one year trial was conducted at the Staples Irrigation Center in 1980 to investigate the previously stated objectives. Burbank Russet potatoes were planted on April 30 in 36" rows with 10" spacings. On April 28, phosphorus, potassium and sulfur were applied at rates of 44,352 and 73 lbs/A respectively. Nitrogen treatments consisted of zero, 300 lbsN/A as ammonium chloride and 300 lbsN/A as calcium nitrate. The nitrogen was applied in three 100 lbN/A splits. The first split was applied at planting, the second on June 9 and the final split was put on with the hilling operation on June 23. A completely randomized design with four replications was used.

Within each nitrogen treated plot, small subplots (10' x 3') recieved fertilizer nitrogen that was tagged with 5% atom enriched 15-N. Tuber and vines were harvested from these subplots to determine the fertilizer nitrogen recovered by the plant. The 15-N subplots were also sampled in the fall to determine the amount of fertilizer nitrogen immobilized in the upper 12 inches of soil.

Weed control consisted of 4 lbs a.i./A Eptam applied preplant and incorporated. Insectide and fungicide applications were made after irrigation, on a weekly basis, from late June through late July. A total of 11.4 acre - inches of water was applied by irrigation in addition to the 15.0 acre-inches of rainfall recieved during the growing season.

The above ground portion of the plant was harvested for maximum vegtative growth on August 1. Vines were chopped on September 9 and tubers were harvested for yield on Sept 23.

Results

The data in Table 1 indicates a significant difference between the two fertilizer nitrogen forms with ammonium chloride appearing most beneficial. The overall appearance of the NH_4 treated plots was better after the third nitrogen application was made. Possible explantions for the response to the ammonium source are:1) the persistance of ammonium in the rooting zone as opposed to the leaching of the nitrates or, 2) a true preference of potatoes for the ammonium ion. As expected, there was also a significant difference between the check and the nitrogen treated plots. Data concerning fertilizer nitrogen distribution and efficiency is not available at this time since 15-N analysis has not been completed.

Table 1. Effect of nitrogen source and application on Russet Burbank plant yield, N content and N removal at Staples, 1980.

Trmt	'New' Yield	Tuber Yield	Max Veg. Yield	Tuber D.M.	Tuber N	Max. Veg. N	Tuber	Max Veg.
	----cwt./A----		------lbs/A--		-----%----		--lbsN/A	Rem'd--
Check	175	238	696	5486	1.00	2.22	55.3	15.4
$Ca(NO_3)_2$	277	467	2209	11117	1.31	3.04	145.3	67.7
NH_4Cl	286	568	2680	12300	1.44	3.49	176.7	93.5
Signifiance	**	**	**	**	*	**	**	**
BLSD (.05)	33	37	219	1038	.25	44	28.8	13.9
C.V.	8.1	5.2	7.1	6.5	11.4	8.8	13.7	14.3

Table 2. Effect of nitrogen source and application on analysis of the maxium vegetative growth of Russet Burbank potatoes at Staples, 1980.

Trmt	P	K	Ca	Mg	Nutrient Al	Fe	Na	Mn	Zn	B
	----------%---------				----------ppm----------					
check	.19	5.06	2.74	.72	553	1898	87	64	23	30
$Ca(NO_3)_2$	.16	4.80	2.20	1.12	450	1232	64	58	15	23
NH_4Cl	.23	5.44	1.77	0.91	477	1062	66	183	24	25
Significance	**	NS	**	**	NS	**	+	**	**	**
BLSD (.05)	.02	-	.24	.16	-	321	23	45	5	1.7
C.V.	7.2	7.0	6.3	9.9	18.8	13.5	17.4	26.4	12.2	3.9

Influence Of Nitrogen Rate, Timing Of Application And Use of Nitrification Inhibitors On Irrigated Corn - Staples - 1980

G.L. Malzer, T. Graff, J. Lensing and M. Wiens

Nitrogen management on the coarse textured irrigated soils of Minnesota is a major decision that corn producers must consider. Nitrogen fertilizer application is essential for top yield on these soils. Likewise, large amounts of fertilizer nitrogen may be lost due to leaching if the nitrogen fertilizer is applied too early. To minimize these losses, nitrogen application are often made in split applications through the irrigation system or as a late sidedressing treatments. These often add to the cost of production and require a reasonable amount of timeliness to avoid yield reductions. Commerical availability of chemical additives know as nitrification inhibitors also offer some potential in minimizing nitrogen losses and may add flexibility into the overall nitrogen management program. A trial was established in 1978 to evaluate the significance of nitrogen rates, timing of nitrogen applications and use of nitrification inhibitors.

Experimental Procedures

Nine treatments were replicated four times and arranged in a randomized complete block design. The treatments were established on a Sverdrup sandy loam at the CMDIR station at Staples, MN. Potassium (225 # k_2O/A) and Phosphorus (30 # P_2O_5) were broadcast and incorporated prior to planting. The treatments included a check, two nitrogen rates, (80 and 160 # N/A as urea), two methods of application (single vs split) and two nitrification inhibitors (N-Serve-Dow Chemical Co.) and Dwell (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 2 (preplant), June 16 (8 leaf stage), July 15 (12-leaf stage) and on July 22 (tasseling) in a ratio of 1/6,1/6,3/6,1/6 respectively.

Nitrification inhibitors treatments were applied with the single nitrogen application treatments as coatings on to area (0.5 # ai/A) for both N-Serve and Dwell. The preplant nitrogen applications were broadcast over the plot area and immediately incorporated by discing. Corn (Pioneer 3978) was planted on May 2 in 30 inch rows at a population of 28,000 seeds/A. Weed control was obtained using a combination of chemicals (Atrazine - 2 # ai/A and Lasso 3#ai/A). Irrigation of the plot area was started on May 6 and concluded on September 8 with a total of 12.75 inches of water being applied through irrigation. An additional 15.05 inches were obtained through precipitation during the growing season.

Leaf samples from opposite and below the ear at silking were collected on July 22, dried and analyzed for Kjeldahl nitrogen. Total dry matter production was not taken because of head smut infestation at the station. Yields were obtained on November 3 by harvesting 2 rows 20 feet long and yields were adjusted to 15.5% moisture.

General Results

As was mentioned above only limited information was obtained from this location in 1980 because of the detection of head smut at the experimental farm. This research trial was at one time during the growing season guaranteened and scheduled to be destroyed. Yield samples were allowed and the results obtained were similar to those that have been found in the past. Grain yields ranged from 74 to 140 bu/A due to nitrogen treatment Loss of fertilizer nitrogen due to leaching of nitrate nitrogen from early (preplant) nitrogen application appeared to reduce yields at both nitrogen rates by approximately 12 bu/A. No nitrification inhibitor response was obtained at the lower rate of nitrogen application. The use of nitrification inhibitors with preplant applications of the higher rate of nitrogen approximated the yields that were obtained with the split nitrogen combination.

Table 1. Influence of nitrogen rate, timing of nitrogen application, and nitrification inhibitors on leaf nitrogen concentration, and grain yield of corn under irrigation. - Staples, MN - 1980.

Treatments				
N-Rate	No. of Appl.	Inhibitor	leaf N	Grain Yield
#/A			%	bu/A
0	-	-	2.19	74.0
80	1	-	2.54	121.9
80	1	N-Serve	2.70	122.2
80	1	Dwell	2.67	124.2
80	4	-	3.11	133.6
160	1	-	2.81	127.3
160	1	N-Serve	2.93	136.5
160	1	Dwell	3.02	139.8
160	4	-	3.06	136.0
Significance			**	**
BLSD(.05)			0.13	15.4

SOUTHERN EXPERIMENT STATION - WASECA
WEATHER DATA - 1980

Month	Period	Precipitation 1980	Precipitation Normal	Avg. Air Temp. 1980	Avg. Air Temp. Normal	Growing Degree Days 1980	Growing Degree Days Normal
		---inches----		------°F-----			
January	1-31	1.71	.73	14.2	12.9		
February	1-28	1.26	.96	13.9	17.5		
March	1-31	0.97	1.94	24.1	28.5		
April	1-30	2.37	2.48	45.4	45.6		
May	1-10	0.01		56.6		113.5	
	11-20	0.79		51.4		65.5	
	21-31	1.74		70.3		216.0	
	Total	2.54	3.86	59.8	57.7	395.0	319
June	1-10	1.77		63.2		124.0	
	11-20	0.70		65.1		172.0	
	21-30	0.87		70.2		197.0	
	Total	3.34	4.75	66.2	67.1	493.0	519
July	1-10	0.07		71.3		208.0	
	11-20	0.17		76.7		244.0	
	21-31	0.27		67.4		196.5	
	Total	0.51	4.02	71.8	71.4	648.5	646
August	1-10	4.22		70.1		180.5	
	11-20	3.42		66.0		178.0	
	21-31	2.05		67.0		186.5	
	Total	9.69	3.60	67.6	69.7	545.0	604
September	1-30	5.14	3.45	58.0	60.3	220.5	337
October	1-31	1.63	1.89	43.3	50.3	0.0	35
November	1-30	0.12	1.25	35.2	32.9		
December	1-31	0.83	1.02	18.4	19.0		
Year	Jan-Dec	30.11	29.95	43.2	44.4	2302.0	2460
Growing Season	May-Sep	21.22	19.68	64.7	65.3	2302.0	2425

Notes:

1) Highest temp. on July 12 -- 96°
2) Highest 24-hour precipitation on September 21 -- 3.00"
3) Only 2.08" rain between June 8 and August 2, greatest rainfall event = 0.85" on June 28
4) Second lowest June and July rainfall on record (1934 had 2.51")
5) 49% of 1980 precipitation occurred in 55-day period between August 2 and September 25
6) Frost on September 17

HIGH PHOSPHORUS AND POTASSIUM RATES FOR CONTINUOUS CORN

1980

G. W. Randall, S. D. Evans and W. W. Nelson

EXPERIMENTAL PROCEDURES

Ten P and K treatments (Table 1) were applied at three branch experiment stations (Southern Experiment Station, Waseca; Southwest Experiment Station, Lamberton; and West Central Experiment Station, Morris) in Minnesota. A randomized, complete-block design with four replications was used. The 50-pound rates were estimated to be "maintenance" rates, and the 0, 100 and 150-pound rates provide the response curves for each element. Treatment 5 and 8 receive P and K, respectively, every third year for the duration of the experiment. Treatments 9 and 10, applied in the fall of 1973, did not receive P and K again until the fall of 1978 when the treatments were resumed at Waseca because P appeared to be limiting. These two treatments were resumed at Morris in 1979 for the same reason. All other treatments have been applied annually.

Table 1. Phosphorus and potassium treatments applied in the high P and K rate study in Minnesota.

Trt No.	Application Year (Fall) 1973,'76,'79	1974,'75,'77,'78
	----------lb P_2O_5 + K_2O/A----------	
1	0 + 0	0 + 0
2	0 + 100	0 + 100
3	50 + 100	50 + 100
4	100 + 100	100 + 100
5	150 + 100	0 + 100
6	100 + 0	100 + 0
7	100 + 50	100 + 50
8	100 + 150	100 + 0
9[1/]	150[2/] + 100	0 + 0[3/]
10[1/]	100 + 150[2/]	0 + 0[4/]

[1/] Neither P nor K was applied in 1976.

[2/] The 150-lb rate was not applied at Lamberton or Waseca in 1979 but was applied at Morris.

[3/] 150 + 100 applied at Waseca in 1978.

[4/] 100 + 150 applied at Waseca in 1978.

The P and K materials were broadcast on cornstalks and plowed down at all locations in the fall of 1979. Phosphorus was applied as CSP (0-46-0) and K as muriate of potash (0-0-60). Zinc was applied at a rate of 18 lb Zn/A as $ZnSO_4$ prior to field cultivation on April 30 at Waseca. Starter fertilizer was not used.

Specific experimental procedures used at each of the stations are presented in Table 2. Management practices providing for optimum yields were employed at each location. Nitrogen rates were slightly higher than optimum. Planting rate was increased at Waseca in 1980.

RESULTS AND DISCUSSION

Soil samples were taken at the end of the 1980 growing season. Responses to the treatments were quite similar to those obtained in 1979. Soil test P was affected significantly at all three locations (Table 3). There appeared to be an almost linear response to P application rates. Soil test P was always lowest with treatments 1 and 2, which received no P. Intermediate P levels were found with treatment 3 (50 lb P_2O_5 annually) and treatment 5 (150 lb P_2O_5 every third year). Highest soil test P values were associated with the annual 100 lb P_2O_5 treatments at all locations. Use of the 1:50 soil to Bray P_1 solution ratio on the calcareous Aastad soil at Morris indicates high amounts of extractable P in this soil; over twice that indicated by the 1:10 ratio. Soil test P levels with all treatments at Lamberton were substantially lower than in 1979 and 1978.

Soil test K was influenced (P=.01) by the K treatments at all locations (Table 3). The response to the annual K applications was not as pronounced as with P. Similar to P all soil test K values for Lamberton were substantially lower than in 1979. Soil pH was not related to the P and K treatments.

Table 2. Experimental procedures for the high P and K rate study on continuous corn at the three branch stations in 1980.

Variable	Lamberton	Morris	Waseca
Planting date	4/29	4/29	4/30
Row spacing	30"	30"	30"
Planting rate	25,000	25,000	32,000
Hybrid	Pioneer 3780	Pioneer 3901	Pioneer 3732
Nitrogen rate	180#	110#	200#
Herbicide	2½# Eradicane + 1½# Bladex/A (Bdct)	2½# Lasso + 2 1/5# Bladex/A (Bdct)	3½# Lasso + 3# Atrazine/A (Bdct)
Insecticide	1# Furadan/A	1.3# Counter/A	1# Dyfonate/A
Harvest date	10/9	10/10	10/10

Table 3. Soil test values as influenced by seven year's application of P and K treatments.[1/]

Treatment No.	Description[2/]	pH La	pH Mo	pH Wa	P La	P M_{10}	P M_{50}	P Wa	K La	K Mo	K Wa
	lb P_2O_5+K_2O/A				lb/A						
1	0 + 0	6.0	7.7	5.8	26	10	32	24	154	384	204
2	0 + 100	6.1	7.7	5.9	21	9	30	22	214	471	239
3	50 + 100	6.6	7.6	5.6	30	32	90	40	204	460	233
4	100 + 100	6.1	7.7	5.9	48	59	154	59	210	471	264
5	150 + 100	6.3	7.7	5.8	46	40	118	42	218	451	236
6	100 + 0	6.0	7.6	5.9	50	59	147	59	157	388	218
7	100 + 50	6.1	7.7	5.9	48	47	131	52	190	395	203
8	100 + 150	6.2	7.5	5.7	48	63	158	48	191	413	212
9	150 + 100	6.4	7.6	5.8	24	30	80	31	165	393	229
10	100 + 150	6.1	7.7	6.0	32	19	60	34	158	389	225
Significance:[3/]		NS	NS	NS	**	**	**	**	**	**	**
BLSD(.05) :					8	8	18	10	36	49	32
CV(%) :		4.9	22.	4.2	16.	16.	14.	18.	13.	7.9	8.9

1/ Samples were taken in October before the 1980 treatments were applied.

2/ Rates applied in fall of 1979 for 1980 crop. The 150-lb rates in treatments 9 and 10 were not applied at Lamberton or Waseca.

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

Approximately 5-6 weeks after planting, ten plants randomly selected from each plot were measured, harvested, dried and weighed to determine early plant growth. Early plant weight and height were increased significantly (P=.01) by the treatments at Lamberton and Waseca (Table 4). Although definite trends toward increased plant weight and height appeared with P additions at Morris, significant (P=.05) effects were not noted due to the variability. Both plant weight and height were generally lowest with the check treatment (no. 1) and the 0 P_2O_5 treatment (no. 2) indicating that the growth response was due primarily to P. Early weight was increased by the 50 and 100 lb P_2O_5 rates over the 0 P_2O_5 rate (no. 2) by 10 and 22% at Lamberton, 8 and 25% at Morris, and 9 and 34% at Waseca, respectively. No effect of K was noticed on either early plant weight or height.

Table 4. Early plant growth as influenced by high P and K rates at the three experimental sites in 1980.

Treatment		Weight			Height		
No.	Description	La	Mo	Wa	La	Mo	Wa
	lb P_2O_5+K_2O/A	g/dry plant			-------inches-------		
1	0 + 0	5.1	6.2	5.2	30.4	25.2	26.8
2	0 + 100	6.2	6.8	6.4	29.5	25.9	26.7
3	50 + 100	6.8	7.4	7.0	32.1	27.6	28.8
4	100 + 100	7.6	8.5	8.6	32.4	28.8	29.7
5	150 + 100	7.4	8.2	8.0	32.9	28.3	30.0
6	100 + 0	8.2	7.7	8.3	32.1	27.5	30.3
7	100 + 50	8.0	7.6	8.8	32.4	27.4	30.6
8	100 + 150	7.9	8.2	9.0	32.4	28.8	31.5
9	150[1/] + 100	6.0	7.4	7.4	30.6	27.3	28.6
10	100 + 150[1/]	7.4	7.4	7.9	32.0	26.9	28.6
	Significance:	**	NS	**	**	+	**
	BLSD(.05) :	1.2		1.1	1.4		1.5
	CV(%) :	12.	14.	10.	3.0	5.9	3.7

[1/] The 150-lb rate was not applied at Lamberton or Waseca.

The small plants were chemically analyzed with the results from all locations shown in Table 5. Concentrations of P, K, Ca and Mg were affected significantly (P=.10) by the treatments at all locations. Whole plant P and K were consistently increased by the P and K treatments while Ca and Mg were generally decreased by the K additions. The response to K rate was more linear than was the P response except at Lamberton. Zinc and Cu concentrations were depressed by increasing P rates at Morris and Waseca.

Analysis of the leaf opposite and below the ear at silking indicated significant effects of the P and K treatments at all locations (Table 6). At Morris and Waseca, both leaf P and K were increased linearly (P=.01) with increasing rates of P and K while leaf Mg was reduced by the K treatments. None of the nutrients were affected by the P treatments at Lamberton. However, applied K did increase leaf K while reducing Ca and Mg. Leaf Zn concentrations were reduced by the P treatments at Morris and Waseca.

Planting populations were thinned to uniform stands at all locations in 1980. Significant differences in final plant population were not found at any of the three sites (Table 7). Barren stalks resulting from the moisture stress at pollination were high at Lamberton but were not influenced by the P and K treatments. Grain moisture an indication of maturity at harvest was affected inconsistently by the treatments at Waseca (Table 7) but was not at Lamberton and Morris.

The influence of the seven years of P and K application on silage and grain yields for all three locations is given in Table 8. Silage yields were not increased significantly (P=.10) by the P and K treatments at Lamberton or Waseca. At Morris silage yields were improved significantly; primarily by the P treatments. Grain yields were not affected significantly at the 90% level at any of the locations due to experimental variability. However, a strong trend toward a response to P was shown with 13 to 19 bu/A yield increases at Morris and 7 to 21 bu/A increases at Waseca with the 50 and 100 lb P_2O_5/A treatments. A weak trend toward a yield response to K was observed at Waseca. The 50 lb K_2O/A treatment showed approximately a 9 bu/A advantage over the 0 lb K_2O/A treatments. These results again demonstrate the difficulty of assessing treatment benefits when yield differences are highly economical but not statistical.

Table 5. Effect of high P and K rates on the nutrient concentrations in the small whole plants at the three experimental sites in 1980.

Treatment No.	Description	P	K	Ca	Mg	Fe	Mn	Zn	Cu	B
	lb P_2O_5+K_2O/A	%				ppm				
						Lamberton				
1	0 + 0	.39	4.34	.58	.48	306	75	49	7.8	9.0
2	0 + 100	.40	5.22	.50	.39	347	70	49	8.0	9.0
3	50 + 100	.41	4.86	.49	.37	304	66	36	8.2	9.6
4	100 + 100	.42	5.06	.51	.36	337	76	43	6.9	9.5
5	150 + 100	.44	5.51	.55	.42	322	72	44	6.6	8.3
6	100 + 0	.44	4.60	.65	.51	326	84	51	6.4	8.8
7	100 + 50	.43	5.50	.59	.44	295	79	49	6.3	8.1
8	100 + 150	.43	5.11	.59	.41	350	77	43	6.5	9.0
9	0 + 100	.42	5.12	.56	.44	300	70	48	7.7	8.9
10	100 + 0	.42	5.04	.61	.45	310	76	45	6.9	8.6
	Significance:	+	+	**	**	NS	NS	NS	**	NS
	BLSD(.05) :			.07	.07				.8	
	CV(%) :	6.2	10.	8.3	10.	12.	13.	16.	7.5	10.
						Morris				
1	0 + 0	.32	3.52	.50	.46	565	77	46	8.2	7.0
2	0 + 100	.31	4.14	.45	.37	690	78	41	7.6	6.8
3	50 + 100	.37	4.18	.52	.36	750	85	36	7.8	7.5
4	100 + 100	.39	4.22	.51	.38	679	79	35	7.4	7.3
5	150 + 100	.36	4.10	.49	.39	620	80	37	7.6	7.2
6	100 + 0	.40	3.28	.61	.51	678	84	34	7.7	7.2
7	100 + 50	.39	3.92	.54	.42	591	79	35	7.6	7.3
8	100 + 150	.40	3.90	.54	.42	786	82	32	7.2	7.3
9	150 + 100	.36	3.65	.52	.45	644	80	36	7.6	7.6
10	100 + 150	.35	3.68	.53	.42	778	86	38	8.2	7.2
	Significance:	**	**	**	**	*	NS	**	NS	NS
	BLSD(.05) :	.02	.43	.04	.03	171		6		
	CV(%) :	4.0	7.4	5.9	5.8	14.	5.8	10.	6.0	5.6
						Waseca				
1	0 + 0	.34	3.64	.50	.42	390	71	47	9.1	7.7
2	0 + 100	.34	4.77	.41	.31	326	60	46	9.3	7.6
3	50 + 100	.38	4.54	.43	.31	348	66	45	8.8	7.6
4	100 + 100	.39	4.53	.48	.33	361	68	39	7.4	7.3
5	150 + 100	.38	4.42	.47	.32	344	69	39	8.1	7.5
6	100 + 0	.44	3.27	.60	.48	370	76	38	7.6	7.7
7	100 + 50	.40	4.09	.53	.40	326	67	39	7.7	7.5
8	100 + 150	.39	4.16	.52	.38	354	71	42	7.8	7.5
9	0 + 100	.37	4.06	.48	.38	376	69	46	9.3	7.8
10	100 + 0	.39	4.07	.50	.37	363	68	43	8.8	7.6
	Significance:	**	**	**	**	NS	NS	**	**	NS
	BLSD(.05) :	.03	.40	.03	.03			6	.7	
	CV(%) :	4.9	7.0	4.5	6.9	15	9.8	8.8	6.0	4.6

Table 6. Effect of high P and K rates on the nutrient concentrations in the corn leaf at the three experimental sites in 1980.

Treatment No.	Description	P	K	Ca	Mg	Fe	Mn	Zn	Cu	B
	lb P_2O_5+K_2O/A	----------%----------				----------ppm----------				
						Lamberton				
1	0 + 0	.22	2.02	.84	.64	128	82	27	7.6	22.7
2	0 + 100	.23	2.63	.75	.46	130	62	26	6.9	22.2
3	50 + 100	.24	2.60	.76	.47	126	68	23	6.7	20.9
4	100 + 100	.24	2.44	.75	.46	123	74	22	6.1	22.1
5	150 + 100	.24	2.65	.77	.49	128	66	21	6.1	20.4
6	100 + 0	.24	1.98	.89	.65	124	79	21	5.8	21.4
7	100 + 50	.23	2.42	.79	.50	126	80	25	6.1	22.7
8	100 + 150	.24	2.34	.80	.52	116	80	23	4.8	21.7
9	0 + 100	.22	2.27	.80	.53	122	66	25	5.8	22.9
10	100 + 0	.23	2.12	.87	.60	128	65	20	5.6	21.9
	Significance:	NS	**	**	**	NS	NS	NS	**	NS
	BLSD(.05) :		.16	.07	.06				.9	
	CV(%) :	5.4	5.0	5.8	7.6	4.9	21.	17.	9.8	8.6
						Morris				
1	0 + 0	.26	1.57	.60	.50	151	100	30	5.3	6.1
2	0 + 100	.26	1.95	.50	.38	147	83	31	4.6	6.8
3	50 + 100	.29	1.83	.67	.47	158	92	24	4.5	6.0
4	100 + 100	.30	1.95	.62	.49	149	94	21	4.8	6.3
5	150 + 100	.30	1.88	.63	.48	148	100	22	4.3	6.3
6	100 + 0	.30	1.61	.70	.62	146	101	20	5.0	6.0
7	100 + 50	.29	1.76	.62	.53	146	90	20	4.3	5.7
8	100 + 150	.29	1.79	.62	.49	148	90	22	3.8	5.6
9	150 + 100	.29	1.55	.68	.59	151	94	24	4.0	6.1
10	100 + 150	.28	1.77	.59	.49	146	86	24	4.1	6.0
	Significance:	**	**	**	**	NS	NS	**	**	NS
	BLSD(.05) :	.03	.20	.09	.08			4	0.3	
	CV(%) :	7.1	8.2	10.	11.	6.3	11.	11.	10.	13.
						Waseca				
1	0 + 0	.24	1.44	.60	.54	139	75	34	4.6	10.8
2	0 + 100	.24	1.92	.51	.42	142	56	32	5.9	9.6
3	50 + 100	.25	1.90	.54	.42	135	65	27	4.6	10.0
4	100 + 100	.27	1.86	.57	.44	141	64	25	4.4	9.4
5	150 + 100	.26	1.78	.57	.46	140	69	25	4.6	9.6
6	100 + 0	.28	1.36	.60	.56	146	73	24	4.2	8.9
7	100 + 50	.27	1.65	.57	.48	143	67	25	4.4	8.9
8	100 + 150	.28	1.72	.60	.48	144	70	26	4.0	9.8
9	0 + 100	.26	1.68	.56	.49	136	62	27	4.7	9.1
10	100 + 0	.25	1.72	.57	.48	140	63	25	5.5	9.7
	Significance:	**	**	*	**	NS	NS	**	**	NS
	BLSD(.05) :	.02	.13	.07	.03			5	.8	
	CV(%) :	5.9	5.6	6.8	5.2	6.4	14.	12.	12.	11.

Table 7. Population and grain moisture at harvest as influenced by high P and K rates in 1980.

Treatment No.	Treatment Description	Final Population La	Final Population Mo	Final Population Wa	Barren stalks La	Grain Moisture La	Grain Moisture Mo	Grain Moisture Wa
	lb P_2O_5+K_2O/A	plants/A x 10^{-3}			%	----------%----------		
1	0 + 0	24.3	18.4	26.8	28	25.8	18.6	25.0
2	0 + 100	23.8	19.1	27.5	32	24.8	19.8	25.4
3	50 + 100	23.9	18.8	28.2	30	25.2	18.3	24.4
4	100 + 100	23.9	19.9	27.1	27	23.4	17.9	24.6
5	150 + 100	23.7	19.2	27.2	26	23.5	19.1	24.4
6	100 + 0	23.3	19.6	27.8	29	23.7	16.5	23.7
7	100 + 50	23.6	19.5	28.0	33	23.5	17.8	24.1
8	100 + 150	24.0	18.6	26.6	29	22.8	16.9	24.6
9	150[1/] + 100	24.1	20.1	27.3	30	24.2	17.9	25.1
10	100 + 150[1/]	22.7	19.2	27.0	21	23.7	17.0	25.1
	Significance:	NS	NS	NS	NS	NS	NS	+
	CV(%) :	3.4	4.5	3.2	24.	6.1	10.	3.0

[1/] The 150-lb rate was not applied at Lamberton or Waseca.

Table 8. Corn, silage and grain yields as influenced by high P and K rates in Minnesota in 1980.

Treatment No.	Treatment Description	Silage Yield La	Silage Yield Mo	Silage Yield Wa	Grain Yield La	Grain Yield Mo	Grain Yield Wa
	lb P_2O_5+K_2O/A	-------T DM/A-------			---------bu/A---------		
1	0 + 0	5.32	6.70	7.39	80.8	107.1	136.8
2	0 + 100	5.13	6.56	7.08	87.6	108.5	129.9
3	50 + 100	5.40	7.52	7.46	85.7	123.8	146.4
4	100 + 100	5.91	7.66	6.93	87.0	127.0	143.8
5	150 + 100	5.74	7.30	7.32	86.6	120.8	150.8
6	100 + 0	5.71	7.37	7.64	88.1	127.3	137.4
7	100 + 50	5.60	7.24	7.30	81.7	126.7	145.7
8	100 + 150	5.68	7.62	7.19	89.4	121.5	143.0
9	150[1/] + 100	5.38	7.36	6.76	81.0	120.1	143.1
10	100 + 150[1/]	5.95	7.27	7.23	94.2	126.1	146.9
	Significance:	NS	+	NS	NS	NS	NS
	CV(%) :	8.3	6.8	11.	10.	9.0	9.3

[1/] The 150-lb rate was not applied at Lamberton or Waseca.

LIQUID AND DRY STARTER FERTILIZERS FOR CORN IN SOUTH-CENTRAL MINNESOTA

Waseca, 1980

G. W. Randall

Row-applied starter fertilizers have been used for over 30 years in corn production. As greater amounts of P and K fertilizers have been broadcast-applied and soil tests have increased over the last decade, row applications have declined in popularity because of less direct yield response and greater time and labor required for this method of application. Within the last five years liquid starter fertilizers have become extremely competitive with dry materials and in some cases have replaced dry fertilizers; largely because of ease and speed of handling. The purpose of this study was to determine (1) the influence of starter fertilizer on early corn growth, nutrient uptake and corn yield and (2) the relative effectiveness of dry vs liquid starter fertilizer methods.

EXPERIMENTAL PROCEDURES

Five starter fertilizer treatments and a check with no starter fertilizer (Table 1) were applied in a randomized, complete-block design with six replications on a Nicollet clay loam soil (Aquic Hapludoll). Soil test of this site averaged: pH = 5.7, Bray 1 extractable P = 71 lb/A and exchangeable K = 325 lb/A. Corn that had been moldboard plowed was the previous crop. Nitrogen as urea was broadcast-applied at a rate of 170 lb N/A and incorporated with a field cultivator prior to planting.

Corn (Pioneer 3780) was planted on May 7 at a rate of 27700 plants/A with a 4-row John Deere 7000 Max-Emerge planter. This planter was used to apply the dry material in a 2 x 2 band and the liquid in the row with the seed. The 9-23-30 and 7-25-5 were obtained from local fertilizer dealers while the 9-18-9 was supplied by Na-Churs. Based on Na-Churs recommendation liquid Zn chelate (6% Zn) was added to the 9-18-9 treatments at a rate of 3/4 pint/A. Cytozyme a cytokinen containing material was added to the 7-25-5 because of claims by the distributor that this material aided liquid starter fertilizers. Furadan at a rate of 1 lb/A (active) was band-applied to control root worms. Lasso (3 qts/A) and atrazine (2½ lb/A) were applied to control weeds.

Ten randomly selected plants from the outside 2 rows of these 4-row plots were sampled on June 18 for early plant growth measurements and for nutrient analysis. Leaf samples opposite and below the ear were taken at silking (July 28) for analysis. Silage yields were obtained at physiological maturity (Sep 24) by harvesting 15' of one of the outside rows. Grain yields were determined by combine harvesting the center two rows of each plot with a JD 3300 modified plot combine. Moisture and protein analyses were determined on those samples.

RESULTS

Although temperatures in the six-week period after planting were slightly warmer and drier than normal, significant differences in early plant weight were noticed (Table 1). The liquid materials resulted in larger plants compared to no addition of starter fertilizer. The dry material did not influence plant weight but did result in slightly higher P and Mn concentrations. None of the liquid treatments increased the nutrient levels above those of the control. The addition of Zn did not influence the small plant Zn concentration.

Nutrient uptake, the product of nutrient concentration times small plant weight (dry matter), was influenced by the treatments (Table 2). The higher levels of K, Ca, Mg, Fe, Mn and B were associated with the larger dry matter accumulations found with the liquid materials. Uptake of P, Zn and Cu were not affected by the starter fertilizers.

Rainfall was extremely limited and temperatures very hot in the six-week period prior to silking. As a result the plants were under severe stress at pollination. This stress may have influenced the leaf nutrient concentration (Table 3). Leaf N and P were noticeably low considering the N and P treatments and the P soil test. Nutrient concentrations in the earleaf were not influenced by the starter fertilizer treatments under these conditions.

Table 1. Influence of starter fertilizer on the nutrient concentration in the small whole corn plants at Waseca in 1980.

Treatment Material	Rate	Small plant weight	Nutrient P	K	Ca	Mg	Fe	Mn	Zn	Cu	B
		g DM/plt.	----------%----------				----------ppm----------				
No Starter		5.1	.35	4.51	.56	.30	251	67	54	6.7	7.9
9-23-30(dry)	140 lb/A	5.2	.38	4.72	.56	.29	248	80	57	6.3	7.8
9-18-9 (liq)	3.5 gal/A[1]	6.0	.35	4.58	.56	.29	271	67	50	6.0	8.3
9-18-9 (liq)	5 gal/A[1]	5.9	.34	4.62	.55	.29	260	66	50	6.0	7.9
7-25-5 (liq)	5 gal/A	6.4	.34	4.56	.54	.29	262	68	57	6.3	8.1
7-25-5 (liq)	5 gal/A	6.7	.34	4.58	.54	.29	258	64	51	5.6	8.0
+ 4 oz. cytozyme											
Significance:[2]		**	+	NS	NS	NS	NS	**	NS	NS	NS
BLSD(.05) :		.9						7			
CV(%) :		12.	7.8	5.6	4.2	3.7	9.7	8.9	20.	14.	5.5

[1] Also contained 3/4 pt. Zn chelate/A.

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

Table 2. Influence of starter fertilizer on the nutrient uptake in the small whole corn plants at Waseca in 1980.

Treatment Material	Rate	Uptake P	K	Ca	Mg	Fe	Mn	Zn	Cu	B
		----------mg/plant----------								
No Starter		17.9	229	28	15.2	1.3	.33	.28	.034	.040
9-23-30(dry)	140 lb/A	20.1	246	29	15.0	1.3	.41	.31	.032	.041
9-18-9 (liq)	3.5 gal/A[1]	21.1	273	34	17.2	1.6	.40	.29	.036	.050
9-18-9 (liq)	5 gal/A[1]	20.2	275	33	17.1	1.5	.39	.30	.036	.047
7-25-5 (liq)	5 gal/A	22.1	290	34	18.4	1.6	.43	.37	.040	.052
7-25-5 (liq)	5 gal/A	22.2	306	36	19.4	1.7	.43	.34	.037	.053
+ 4 oz. cytozyme										
Significance:		NS	*	**	**	*	*	NS	NS	**
BLSD(.05) :			48	5	2.5	.3	.07			.008
CV(%) :		15.	14.	12.	12.	16.	13.	27.	14.	13.

[1] Also contained 3/4 pt. Zn chelate/A.

Table 3. Influence of starter fertilizer on the nutrient concentrations in the corn ear leaf at Waseca in 1980.

Treatment Material	Rate	Nutrient N	P	K	Ca	Mg	Fe	Mn	Zn	Cu	B
		----------%----------					----------ppm----------				
No Starter		2.0	.20	2.65	.68	.34	125	49	28	4.0	10.3
9-23-30(dry)	140 lb/A	2.0	.20	2.68	.71	.34	123	54	33	4.7	10.4
9-18-9 (liq)	3.5 gal/A[1]	2.0	.20	2.61	.73	.36	126	46	29	4.4	10.5
9-18-9 (liq)	5 gal/A[1]	2.0	.20	2.73	.71	.35	134	50	30	4.9	9.6
7-25-5 (liq)	5 gal/A	2.0	.20	2.58	.72	.34	128	52	33	4.0	11.5
7-25-5 (liq)	5 gal/A	2.0	.20	2.70	.71	.35	124	49	29	4.6	10.6
+ 4 oz. cytozyme											
Significance:		NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
CV(%) :		10.	5.7	7.0	9.6	6.2	9.3	13.	18.	18.	11.

[1] Also contained 3/4 pt. Zn chelate/A.

There have been reports of reduced plant stand when applying these liquid fertilizer materials with the seed. The data shown in Table 4 indicate no effect of any treatment on plant population. Silage and grain yields were extremely variable and were not large primarily because of the very dry conditions. As a result neither silage nor grain yield was affected by the starter fertilizer treatments. No explanation can be given for the apparent yield reduction with the 7-25-5 material. Grain moisture was highest when no starter was used and was decreased significantly by the liquid materials. Grain protein was not affected by the starter treatments.

Table 4. Influence of starter fertilizer on corn population, silage yield, grain yield, grain moisture and grain protein at Waseca in 1980.

Treatment		Final	Silage	Grain		
Material	Rate	population	yield	Yield	Moist.	Protein
		x 10^{-3}	T DM/A	bu/A	--------%	--------
No Starter		24.1	6.04	97.9	26.2	10.6
9-23-30(dry)	140 lb/A	23.8	6.33	96.2	25.9	10.8
9-18-9 (liq)	3.5 gal/A[1/]	24.0	5.97	96.6	25.3	10.9
9-18-9 (liq)	5 gal/A[1/]	23.9	5.71	92.5	25.2	10.7
7-25-5 (liq)	5 gal/A	24.4	5.47	82.6	25.4	11.1
7-25-5 (liq)	5 gal/A + 4 oz. cytozyme	24.7	6.10	83.5	25.3	11.1
Significance:		NS	NS	NS	*	NS
BLSD(.05) :					.7	
CV(%) :		4.6	13.	17.	2.1	5.0

1/ Also contained 3/4 pt. Zn chelate/A.

SUMMARY

Under these high soil test P and K conditions early plant growth was enhanced by the liquid fertilizer materials. However, nutrient concentrations in the small plants were generally not affected by the starter fertilizers or by the addition of zinc or cytozyme to the liquid materials. Nutrient concentrations in the earleaf at silking were not influenced by the starter fertilizer treatments. Plant population, silage yield, grain yield and grain protein were not affected by the starter treatments. Grain moisture was lower with the liquid materials.

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ROTATION NITROGEN STUDY

Waseca, 1980

Gyles W. Randall

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

EXPERIMENTAL PROCEDURES

The crop sequences (continuous corn, corn-soybean, corn-wheat and corn-wheat + alfalfa) were begun in 1974 on a Webster clay loam. Each N plot within each crop sequence is 15' wide (6 rows) by 50' long. Rates of N (0, 40, 80, 120, 160 and 200 lb N/A) were applied as anhydrous ammonia on April 24. Wheat received 50 lb N/A as urea before planting. Broadcast P and K of 120 + 200 lb P_2O_5 and K_2O/A was applied in the fall of 1979 before moldboard plowing all plots. Row P and K (0 + 30 + 45 lb N + P_2O_5 + K_2O/A) was applied to the corn at planting.

Corn (Pioneer 3780) was planted in 30" rows at 27,700 ppA on April 28. Furadan was applied to all corn plots at 1 lb/A to control rootworms. Era wheat and Hodgson soybeans were planted on April 25 and May 15, respectively.

Weeds were chemically controlled along with one cultivation of the corn. A combination of 4 qt Lasso plus 3½ lb Bladex/A was applied preemergence to corn. Soybeans received 3½ qt Lasso plus 5 qt Amiben/A applied preemergence.

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

RESULTS

Grain yield, leaf N and grain N (protein) all showed significant response to fertilizer N regardless of the previous crop (Table 1). Grain yield response to N ranged from 40 bu/A following wheat interseeded with alfalfa to 55 bu/A following wheat. When no N was added yields were lowest following corn, intermediate following wheat and highest following soybeans or wheat + alfalfa. Yields were maximized at 160, 120-160, 120 and 80 lb N/A when corn, soybeans, wheat, or wheat + alfalfa were the preceding crops, respectively. At the 200 lb/A rate corn yields were

37, 28 and 37 bu/A higher following soybeans, wheat or wheat + alfalfa as compared to continuous corn.

When no N was added, leaf and grain N were highest following wheat + alfalfa and lowest following corn or wheat. At the 200 lb/A rate differences in leaf and grain N were not found among the previous crops. Leaf N was maximized at the 200, 120, 160 and 120 lb/A rates following corn, soybeans, wheat or wheat + alfalfa, respectively. Grain N was maximized at approximately the 160, 120, 120 and 120 lb/A rates for the same previous crops.

Table 1. Leaf N, corn yield and grain N in 1980 following various crops at Waseca.

N rate	Previous Crop			
	Corn	Soybeans	Wheat	Wheat + Alfalfa
lb N/A				
		Yield (bu/A)		
0	60.9	100.6	80.4	104.2
40	77.4	118.8	110.6	123.2
80	91.1	129.7	127.7	145.5
120	99.0	134.2	131.2	146.6
160	105.2	134.0	133.6	134.8
200	107.4	144.6	135.9	144.8
		Leaf N (%)		
0	1.29	1.42	1.24	1.86
40	1.55	2.04	1.70	2.02
80	1.86	2.16	2.04	2.32
120	2.18	2.39	2.41	2.59
160	2.35	2.48	2.38	2.46
200	2.51	2.42	2.56	2.58
		Grain N (%)		
0	1.18	1.21	1.10	1.36
40	1.35	1.33	1.22	1.37
80	1.37	1.52	1.36	1.54
120	1.64	1.66	1.67	1.61
160	1.69	1.70	1.77	1.68
200	1.70	1.67	1.66	1.65

N Rate, Source-Incorporation Study

Gyles Randall and Harvey Meredith

Objective of Study: Determine yield differences between soil incorporated broadcast nitrogen versus surface application without incorporation.

Location: Waseca Experiment Station

N Source: Urea (46-0-0), ammonium nitrate (34-0-0), and urea-ammonium nitrate solution (28-0-0).

N Rate: 0, 75, and 150 pounds N per acre.

Hybrid: Pioneer 3780, 105-day relative maturity

Starter Fertilizer: 140 pounds/A of 0-23-30

Date of Planting: May 7

Nitrogen application - incorporated: May 5

Nitrogen application - nonincorporated: May 20.

Herbicide: Lasso-Bladex

Previous crop: corn

Table 1. Temperature and Precipitation Data, Waseca Experiment Station May 20-31, 1980.

	Maximum Ambient Temperature, °F	Precipitation, In.
20	76	20
21	78	21
22	84	22
23	86	23
24	87	24
25	85	25
26	89	26
27	89	27
28	90	28
29	93	29 .29
30	77	30 1.14
31	68	31 .48

Table 2. Yield of Corn Grain, Waseca Experiment Station, 1980.

Lbs N/A	Yield - Bu/A					
	Am. Nitrate		Urea		28% Soln.	
	I	N	I	N	I	N
0	- - - - - - - - - - - -		-55.6	- - - - - - - - - - - -		
75	94.0	84.4	93.9	97.0	77.8	86.9
150	98.8	99.3	99.4	100.4	87.0	93.0

BLSD (.05) = 15.4
CV (%) = 15

Table 3. Nitrogen Content of the 6th Leaf of Corn at Silking, Waseca Experiment Station, 1980.

Lbs N/A	Percent N					
	Am. Nitrate		Urea		28% Soln.	
	I	N	I	N	I	N
0	- - - - - - - - - - - 1.39 - - - - - - - - - - - -					
75	1.77	1.74	1.81	1.86	1.69	1.63
150	2.13	2.13	2.00	2.13	1.90	1.95

BLSD (.05) = .16
CV (%) = 8.3

Soil pH: The pH of the surface soil varied between 5.4 to 5.6

Final Population: Final stand count varied between 25,500 to 27,200, statistically nonsignificant.

Table 4. Individual Factors Considered for Significance.

N Rate Lb/A	% Leaf N	Bu/A Yield	Grain Moisture %
75	1.75	89.0	25.9
150	2.04	96.3	26.1
Sig.	**	*	NS
N Source			
Am. Nitrate	1.94	94.1	26.0
Urea	1.95	97.7	25.9
28% N Soln.	1.79	86.2	26.2
Sig.	**	**	NS
BLSD (.05)	.08	7.3	
Incorporation			
No	1.91	93.5	26.2
Yes	1.88	91.8	25.9
	NS	NS	NS

Discussion: Because of the high temperature and dry surface conditions following application of the broadcast forms of nitrogen, one would expect a severe test case for volatilization of ammonia both from urea and urea-ammonium nitrate solution.

The driest June and July since 1934 coupled with excessively high temperatures resulted in extensive moisture stress and lower yields than expected.

Nitrogen was applied on the incorporation plots just prior to planting and incorporated. N was broadcast on the unincorporated plots following planting so as not to disturb the soil or incorporate in any way.

At the higher rate the N solution plots yielded lower than either urea or ammonium nitrate. Tissue N at silking followed the same trend.

There were no significant differences between the incorporated and non-incorporated treatments.

It will be noted from Table 1 that hot dry conditions prevailed from May 20 forward following application of the N on the soil surface without incorporation. The first five to ten days are likely the most critical. The average high temperature over this period was 85.7 ^{o} F. For the first eight days following N application, May 20-28, there was no precipitation recorded. Surely a valid test. Yet the data show that there was no difference in yield between the incorporated N treatments and the treatments which were left on the surface without incorporation.

Table 5. NO_3-N of N Rate, Source, Incorporation Study, Waseca Experiment Station, Soil Sampled Spring 1980.

Depth, feet	Replication No.						Mean
	1	2	3	4	5	6	
0-1	32	34	24	22	42	42	33
1-2	10	12	10	9	15	11	11
2-3	10	10	9	11	11	10	10
3-4	12	13	10	16	14	16	14
4-5	24	19	16	26	16	24	21
	88	88	69	84	98	103	89