Analyses of the whole plant samples taken at the soft dough stage are shown in Table 3. The results were similar to those obtained from the early plant sampling, P levels increased and Zn levels decreased with added P while K levels increased and B levels decreased with added K.

Table 3. Effect of high P and K rates on the elemental analyses of whole plant samples of spring wheat at the soft-dough stage.

Treatment			Elemental Analyses								
No.	P_2O_5	K_2O 1/	N	P	K	Ca	Mg	Mn	Zn	Cu	B
	- - lb/A - -		- - - - - - - - % - - - - - - - -					- - - - - - ppm - - - - -			
1	0	0	1.64	.23	1.18	.13	.19	31	16	1.8	2.9
2	0	100	1.75	.22	1.27	.14	.16	25	14	1.6	2.6
3	50	100	1.58	.21	1.40	.16	.16	24	12	1.5	2.7
4	100	100	1.60	.25	1.25	.12	.17	29	12	1.5	2.3
5	0	100	1.67	.23	1.38	.14	.17	28	12	1.8	2.3
6	100	0	1.46	.22	1.16	.13	.17	27	12	1.4	2.9
7	100	50	1.59	.24	1.24	.14	.16	27	12	1.5	2.0
8	100	0	1.55	.24	1.30	.14	.15	26	12	1.3	1.9
9	0	0	1.63	.25	1.22	.13	.16	28	14	1.6	2.1
10	0	0	1.68	.24	1.20	.13	.18	29	12	1.6	2.4
Significance			N.S.	*	*	N.S.	N.S.	N.S.	**	N.S.	**
B.L.S.D. (.05)				.03	0.18				1		0.6
C.V. (%)			11.0	7.0	8.0	18.3	10.8	11.1	7.6	15.0	15.6

Grain yield, protein, test weight, forage yield, and P and K uptake values are shown in Table 4. Grain and forage yields increased with added P and K, but the increases were not large. Phosphorus and potassium uptake increased significantly as P and K were added, but the lower P and K rates appeared sufficient for maximum uptake. Test weight and protein were not affected by the treatments.

Table 4. Effect of high P and K rates on grain yield, protein, test weight, forage yield, and P and K uptake of spring wheat.

Treatment			Grain			Forage		
							Uptake	
No.	P_2O_5	K_2O	Yield	Protein	Test Weight	T.D.M. Yield	P	K
	- - lb/A - -		Bu/A	%	lb/Bu	- - - - - lb/A - - - - -		
1	0	0	51.7	12.1	58.9	6793	15.3	80.6
2	0	100	58.5	12.4	58.4	7544	16.2	96.3
3	50	100	59.6	11.9	59.0	7519	15.8	105.9
4	100	100	58.1	12.0	58.5	7550	19.5	97.5
5	0	100	56.6	12.1	58.4	7447	17.3	103.4
6	100	0	53.3	11.9	58.1	7752	17.2	90.2
7	100	50	56.3	12.2	58.2	7924	19.2	98.6
8	100	0	58.0	12.2	57.4	7538	18.4	98.2
9	0	0	58.7	12.3	59.1	7573	18.5	92.7
10	0	0	57.0	12.4	58.4	7096	16.7	84.2
Significance			+	N.S.	N.S.	+	*	*
B.L.S.D. (.05)							3.0	15.8
C.V. (%)			6.2	2.1	1.6	6.1	10.1	9.9

+, * - Indicates significance at the 10% and 5% levels respectively.

The effect of the treatments on soil test P and K levels in the 0-6 inch sample obtained by the University of Minnesota and North Dakota State University soil testing labs is shown in Table 5. Soil test P and K were significantly affected by the treatments according to both labs. A high correlation of soil test P levels with added P was obtained with both the Bray P-1 (50:1) and $NaHCO_3$ extractants, but not with the Bray P-1 (10:1). Exchangeable K was also significantly affected by the treatments according to both labs, but the results from the N.D.S.U. lab correlated with the added K much better than the results from the U of M lab.

Table 5. Effect of high P and K rates on soil test P and K levels.

Treatment			University of Minnesota			North Dakota State Univ.	
			Bray P-1		Exchangeable	$NaHCO_3$	Exchangeable
No.	P_2O_5	K_2O	10:1	50:1	K	P	K
	- - lb/A - -		- lb/A -				
1	0	0	18	26	235	11	205
2	0	100	34	27	267	13	251
3	50	100	43	36	267	20	234
4	100	100	36	39	262	25	249
5	0	100	45	38	288	23	246
6	100	0	34	40	248	30	218
7	100	50	44	42	249	27	220
8	100	0	53	43	277	28	260
9	0	0	47	39	254	23	230
10	0	0	33	34	238	18	216
Significance			+	**	+	**	**
B.L.S.D. (.05)				7		6	30
C.V. (%)			36.6	14.0	9.3	20.7	8.1

+, ** - Indicates significance at the 10% and 1% levels respectively.

RESIDUAL EFFECTS OF PHOSPHORUS ON SPRING WHEAT

G. E. Varvel and R. K. Severson

Phosphorus soil test levels vary widely in soils of the Red River Valley and the effects of applied P fertilizer on these soils for an extended period of time has not been determined. This study was designed to determine the effects of P fertilizer applied one time at various rates over a period of years on a low P testing soil.

Experimental Procedure:
Phosphorus fertilizer was broadcast and incorporated in the fall of 1979. Six rates of P in a randomized, complete block design with 4 replications were used. Solar wheat was planted on April 15, 1981 and harvested Aug. 10, 1981. Whole plant samples were taken at mid-tillering (June 8, 1981) to determine nutrient levels in the plant and at maturity (July 17, 1981) to determine forage yields, elemental analyses of the forage, and nutrient uptake. Soil samples were taken immediately after crop removal (Aug. 10, 1981) to determine the residual effects of the applied P on soil test measurements.

Results:
The effects of the P fertilizer were variable with respect to grain yield and test weight (Table 1). Grain yield tended to increase while test weight decreased (Table 1). A highly significant increase in forage yield, P uptake, and K uptake was obtained (Table 1) but the increase in K uptake was mainly due to the significant increase in forage yield.

The effects of the P fertilizer on elemental analyses of the plant were essentially the same with respect to the samples taken at mid-tillering and maturity. Phosphorus significantly increased P levels and decreased Zn levels in the plant at both sampling dates (Tables 2 and 3). Phosphorus also significantly increased Mg levels at mid-tillering (Table 2) and Mn levels of the plant at maturity (Table 3). The significant differences in Mn levels in the plant at mid-tillering (Table 2) appear unrelated to the treatments.

Soil test measurements taken after crop removal are shown in Table 4. Soil test P levels in the 0-6" depth were significantly increased according to the $NaHCO_3$ method. No other differences were obtained.

Table 1. The residual effect of phosphorus applied in the fall of 1979 on grain yield, test weight, protein, forage yield, and nutrient uptake of spring wheat in 1981.

P_2O_5	Grain			Forage		
		Test		T.D.M.	Uptake	
Rate	Yield	Weight	Protein	Yield	P	K
lb/A	Bu/A	lb/Bu	%	- - - - - - -	lb/A	- - - - - -
0	52.9	57.2	14.9	6374	10.9	63.4
40	58.2	57.1	14.8	6869	12.3	71.7
80	57.7	55.0	14.8	7541	15.1	86.9
120	55.0	54.2	15.1	7706	15.2	88.5
160	57.2	55.5	14.9	8436	16.9	93.8
200	54.4	54.8	15.3	7742	17.6	86.8
Significance	+	*	N.S.	**	**	**
B.L.S.D. (.05)		2.3		878	3.7	17.5
C.V. (%)	4.8	2.5	4.0	7.7	15.8	13.3

Table 2. The residual effect of phosphorus applied in the fall of 1979 on elemental analyses of early plant samples of spring wheat taken at mid-tillering in 1981.

P_2O_5 Rate	Elemental Analyses							
	P	K	Ca	Mg	Mn	Zn	Cu	B
lb/A	%				ppm			
0	0.28	4.11	0.34	0.31	65	25	6	3
40	0.30	4.18	0.34	0.31	60	24	6	3
80	0.34	4.13	0.42	0.33	62	26	6	3
120	0.37	4.35	0.35	0.36	61	23	6	3
160	0.36	4.21	0.35	0.35	65	20	6	3
200	0.39	4.04	0.34	0.39	66	20	5	3
Significance	**	N.S.	N.S.	**	*	*	N.S.	N.S.
B.L.S.D. (.05)	0.05			0.04	4	4		
C.V. (%)	8.9	5.1	18.3	7.2	4.0	11.4	2.8	7.2

Table 3. The residual effect of phosphorus applied in the fall of 1979 on elemental analyses of whole plant samples of spring wheat taken at maturity in 1981.

P_2O_5 Rate	Elemental Analyses							
	P	K	Ca	Mg	Mn	Zn	Cu	B
lb/A	%				ppm			
0	0.17	0.99	0.13	0.17	27	17	1.3	2
40	0.18	1.04	0.14	0.17	26	16	1.3	2
80	0.20	1.15	0.19	0.18	28	14	1.4	3
120	0.20	1.14	0.17	0.19	26	12	1.3	2
160	0.20	1.11	0.18	0.18	28	10	1.2	3
200	0.23	1.12	0.16	0.20	31	11	1.3	2
Significance	*	N.S.	N.S.	N.S.	**	**	N.S.	N.S.
B.L.S.D. (.05)	0.04				3	3		
C.V. (%)	12.0	8.3	19.7	12.8	5.7	13.8	15.8	13.2

Table 4. The residual effect of phosphorus applied in the fall of 1979 on soil test measurements taken after crop removal in 1981.

P_2O_5 Rate	N.D.S.U.						U of M			
	pH		$NaHCO_3$ P		Exchangeable K		pH	Bray P1 10:1	Bray P1 50:1	Exchangeable K
	0-6"	6-12"	0-6"	6-12"	0-6"	6-12"	0-6"	0-6"	0-6"	0-6"
lb/A			lb/A					lb/A		
0	8.1	8.3	14	4	266	198	7.9	21	28	296
40	7.9	8.0	12	5	278	228	7.9	28	31	295
80	7.9	8.0	17	6	293	240	7.9	18	25	272
120	8.0	8.1	21	5	279	225	7.9	26	26	298
160	8.1	8.2	22	5	271	214	7.8	29	31	291
200	8.0	8.2	22	5	269	206	7.9	25	32	290
Significance	N.S.	N.S.	*	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
B.L.S.D. (.05)			8							
C.V. (%)	1.7	1.6	26.4	39.8	6.3	9.4	1.4	60.6	19.7	10.2

RESIDUAL EFFECTS OF POTASSIUM ON SPRING WHEAT

G. E. Varvel and R. K. Severson

Potassium levels in soils of the Red River Valley have historically been quite high and the need for K fertilizer on these soils has been limited. In spite of these high levels, large amounts of K fertilizer are applied annually on these soils. This study was initiated in the spring of 1980 to determine if additional K was needed for small grain production in this area.

Experimental Procedure:
This study was designed to determine the residual effects of K that had been applied in the previous year. Six rates of K had been applied and incorporated on April 21, 1980. A randomized, complete block design with 4 replications was used. Morex barley was planted on April 14, 1981 and harvested July 27, 1981. Whole plant samples taken July 10, 1981 were used to determine forage yields and nutrient uptake. Soil samples were taken on Aug. 10, 1981 after crop removal to determine residual levels in the soil.

Results:
Potassium fertilizer applied in 1980 caused few differences in spring barley yield or quality in 1981 (Table 1). Protein levels were significantly different, but they seemed to have no relationship to the treatments (Table 1).

Forage analyses are shown in Table 2. Potassium levels in the plant were significantly increased, but no other differences were obtained.

Soil test measurements taken after crop removal in 1980 were not affected by the treatments (Table 3). Potassium levels in the 0-6" depth tended to increase, but the increase was not significant.

Table 1. The effect of potassium applied in 1980 on barley grain yield, test weight, protein content, plump and thin kernels, forage yield, and nutrient uptake in 1981.

K_2O	Grain					Forage		
		Test		Plump	Thin	T.D.M.	Uptake	
Rate	Yield	Weight	Protein	Kernels	Kernels	Yield	P	K
lb/A	Bu/A	lb/B	%			lb/A		
0	59.8	44.9	11.7	79.5	4.9	5962	12.3	62.9
50	59.5	44.9	11.0	69.2	4.8	6095	12.5	74.4
100	60.2	44.4	12.0	69.5	6.3	6493	12.6	73.8
150	61.3	44.9	11.2	70.9	4.3	6060	11.9	71.1
200	67.4	45.4	11.2	74.3	3.8	6274	11.3	79.4
250	59.8	45.6	10.7	76.7	3.6	5935	10.2	78.2
Significance	N.S.	N.S.	*	N.S.	N.S.	N.S.	N.S.	N.S.
B.L.S.D. (.05)			0.9					
C.V. (%)	11.3	2.0	4.7	12.2	4.6	13.5	20.0	13.9

Table 2. The effect of potassium applied in 1980 on the elemental analyses of spring barley forage at maturity in 1981.

K_2O Rate	Elemental Analyses							
	P	K	Ca	Mg	Mn	Zn	Cu	B
lb/A	%				ppm			
0	0.20	1.06	0.30	0.24	25	12	3	5
50	0.20	1.21	0.32	0.24	24	12	2	5
100	0.19	1.14	0.33	0.24	24	12	3	4
150	0.20	1.18	0.31	0.23	23	12	2	4
200	0.18	1.28	0.27	0.24	21	10	2	4
250	0.17	1.31	0.29	0.24	21	10	2	5
Significance	N.S.	**	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
B.L.S.D. (.05)		0.15						
C.V. (%)	14.0	7.5	12.7	14.4	14.9	12.8	19.9	31.5

Table 3. The effect of potassium applied in 1980 on soil test measurements taken after crop removal in 1981.

K_2O Rate	pH		$NaHCO_3$ P		Exchangeable K	
	0-6"	6-12"	0-6"	6-12"	0-6"	6-12"
lb/A			lb/A			
0	8.2	8.3	12	7	228	210
50	8.2	8.2	9	7	235	214
100	8.2	8.3	11	8	231	208
150	8.2	8.2	8	6	233	210
200	8.2	8.4	9	6	246	213
250	8.3	8.3	8	5	248	210
Significance	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
C.V. (%)	1.1	1.2	29.9	33.3	5.2	8.4

PHOSPHORUS AND POTASSIUM FERTILITY STUDIES ON OILSEED SUNFLOWER

G. E. Varvel and R. K. Severson

Fertilizer response data for oilseed sunflower in Minnesota, especially with respect to phosphorus and potassium is limited in nature and amount. These studies were designed to generate additional information on P and K response to improve current fertilizer recommendations.

Experimental Procedure:
Three locations were used for P experiments (1, 2, and 4) and 2 locations were used for K experiments (3 and 5). Six rates of P or K were applied and incorporated on April 24, 1981 in each experiment. Blanket applications of 100 lb K_2O/A were made over the P experiments and 80 lb P_2O_5/A over the K experiments. A randomized, complete block design with 4 replications was used for all experiments. Oilseed sunflower was seeded at all locations around May 1, 1981 in 30-inch rows. Different varieties were used at each location.

Whole plant samples were taken at various times throughout the growing season to determine the effect of the fertilizer treatments on crop growth, nutrient content, and removal. Leaf samples were also taken to determine the effect of the fertilizer treatments at pollination.

Seed yield and harvest population were taken at maturity. Oil content and elemental analyses of the seed were measured to determine the effects of the treatments.

Soil test results for each experiment are shown below:

Experiment	pH	NO_3-N	$NaHCO_3$ P	Exchangeable K
		lb/A-2'	lb/A	lb/A
1	7.5	173	24	283
2	7.7	148	20	248
3	7.5	118	18	280
4	7.6	174	19	229
5	7.5	170	15	240

Results:
Experiment 1. Above ground dry matter yields, elemental analyses, and nutrient uptake are shown in Tables 1 and 2 for the June 25 and Aug. 13 sampling dates. No significant differences were obtained at either date.

Elemental analyses of leaf samples taken Aug. 13 are shown in Table 3. The phosphorus treatments significantly affected P levels in the leaf, but the levels didn't increase with respect to the treatments.

Seed yield, oil content, elemental analyses of the seed, and nutrient removal by the seed are shown in Table 4. The phosphorus treatments had no affect on any of the variables.

Experiment 2. Above ground dry matter yields, elemental analyses, and nutrient uptake are shown in Tables 5-7 for the June 25, Aug. 13, and Sept. 16 sampling dates. The phosphorus treatments significantly increased P uptake at the Aug. 13 and Sept. 16 dates (Tables 6 and 7), but no other differences were obtained.

Elemental analyses of leaf samples taken Aug. 13 are shown in Table 8. No differences were obtained.

Seed yield, oil content, elemental analyses of the seed, and nutrient removal by the seed are shown in Table 9. No differences were obtained.

Experiment 3. Above ground dry matter yields, elemental analyses, and nutrient uptake are shown in Tables 10 and 11 for the June 25 and Aug. 13 sampling dates. The potassium treatments had no affect on any of the variables at either date.

Elemental analyses of leaf samples taken Aug. 13 are shown in Table 12. No differences were obtained.

Seed yield, oil content, elemental analyses of the seed, and nutrient removal by the seed are shown in Table 13. The potassium treatments had no affect on any of the variables.

Experiment 4. Elemental analyses of leaf samples taken Aug. 13 are shown in Table 14. The phosphorus treatments significantly affected K and Cu levels in the leaf.

Seed yield, oil content, elemental analyses of the seed, and nutrient removal by the seed are shown in Table 15. No differences were obtained.

Experiment 5. Elemental analyses of leaf samples taken Aug. 13 are shown in Table 16. The potassium treatments significantly increased K levels in the leaf.

Seed yield, oil content, elemental analyses of the seed, and nutrient removal by the seed are shown in Table 17. No differences were obtained.

Conclusions:
Plant analyses, seed yield, seed analyses, and oil content data from these experiments indicate that no response to either P or K was obtained. These results would have been predicted based upon the soil test levels for each of the experiments. All of the locations tested in the medium to high range for P and K where the probability of response is very low. Even though no fertilizer response was obtained, the data provides information on dry matter accumulation, nutrient content, and nutrient removal by the seed for oilseed sunflower. These results are shown in Tables 18 and 19.

Table 1. The effect of phosphorus on the elemental analyses, dry matter yield and nutrient uptake of oilseed sunflower in experiment 1 (approximate height-10 inches).

P_2O_5	Elemental Analyses									T.D.M.	Uptake		
Rate	N	P	K	Ca	Mg	Mn	Zn	Cu	B	Yield	N	P	K
lb/A	%					ppm				lb/A			
0	4.12	.49	5.35	2.58	1.14	83	27	10	57	419	17	2.0	22.2
40	4.05	.46	5.14	2.69	1.18	87	29	11	59	556	22	2.5	28.6
80	4.16	.57	5.13	2.50	1.26	84	30	10	58	545	23	3.1	28.0
120	4.29	.57	5.45	2.53	1.19	92	29	11	57	521	22	3.0	28.6
160	4.22	.47	5.48	2.52	1.10	85	30	11	57	466	20	2.2	25.3
200	4.06	.50	5.33	2.58	1.07	77	27	9	57	511	21	2.7	28.2
Significance	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
C.V. (%)	6.2	19.2	17.2	9.0	20.5	18.9	21.9	23.3	6.2	15.1	13.9	28.9	29.8

Table 2. The effect of phosphorus on the elemental analyses, dry matter yield, and nutrient uptake of oilseed sunflower in experiment 1 (90% pollinated).

P_2O_5	Elemental Analyses									T.D.M.	Uptake		
Rate	N	P	K	Ca	Mg	Mn	Zn	Cu	B	Yield	N	P	K
lb/A	%					ppm				lb/A			
0	2.14	.32	2.43	1.61	1.26	41	22	10	50	6701	143.9	21.4	160.8
40	2.17	.29	2.34	1.79	1.33	45	24	12	52	7323	158.5	21.3	169.5
80	2.23	.36	2.12	1.80	1.34	43	23	9	50	7014	156.1	25.1	149.2
120	2.17	.33	2.20	1.62	1.25	48	22	10	49	6913	149.5	22.4	155.0
160	2.12	.32	2.47	1.76	1.25	42	23	11	54	7406	156.7	23.8	182.8
200	2.21	.35	2.38	1.78	1.25	39	25	10	49	6935	153.4	24.2	165.5
Significance	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
C.V. (%)	5.9	18.0	23.0	8.8	16.1	15.4	12.9	19.4	8.4	7.9	8.0	17.9	24.4

Table 3. The effect of phosphorus on the elemental analyses of leaf samples of oilseed sunflower in experiment 1.

P_2O_5 Rate	Elemental Analyses N	P	K	Ca	Mg	Mn	Zn	Cu	B
lb/A	%					ppm			
0	3.56	.38	2.75	2.87	1.56	64	28	19	99
40	3.33	.33	2.51	2.93	1.51	62	32	22	93
80	3.27	.42	2.50	3.15	1.51	60	29	17	94
120	3.49	.35	2.76	2.73	1.55	65	28	21	83
160	3.64	.37	3.07	2.93	1.37	61	31	23	113
200	3.52	.41	2.65	3.12	1.45	59	30	18	92
Significance	N.S.	*	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
B.L.S.D. (.05)		0.08							
C.V. (%)	8.1	11.3	29.1	11.4	22.0	20.6	16.7	26.0	18.1

Table 4. The effect of phosphorus on seed yield, oil content, elemental analyses of the seed, and nutrient removal by the seed of oilseed sunflower in experiment 1.

P_2O_5 Rate	Seed Yield	Oil	Elemental Analyses N	P	K	Ca	Mg	Fe	Mn	Zn	Cu	B	Nutrient Removal N	P	K
lb/A	lb/A	%	%					ppm					lb/A		
0	2280	49.6	2.61	0.60	0.90	0.18	0.37	40	21	47	14	11	59.5	13.8	20.5
40	2260	49.7	2.36	0.57	0.87	0.18	0.35	40	21	46	13	11	53.1	12.8	19.5
80	2270	49.2	2.58	0.62	0.91	0.18	0.36	38	20	45	13	11	58.4	14.0	20.6
120	2260	49.6	2.62	0.59	0.86	0.17	0.36	38	21	40	12	11	59.1	13.3	19.4
160	2300	49.0	2.45	0.60	0.92	0.18	0.36	43	22	46	13	12	56.5	13.8	21.3
200	2140	48.5	2.68	0.63	0.92	0.19	0.37	40	21	46	12	12	57.7	13.6	19.9
Significance	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
C.V. (%)	7.0	2.4	9.9	12.2	8.0	3.6	7.8	7.8	7.0	11.7	12.7	4.1	11.7	15.7	12.6

Table 5. The effect of phosphorus on the elemental analyses, dry matter yield, and nutrient uptake of oilseed sunflower in experiment 2 (approximate height-10 inches).

P_2O_5 Rate	Elemental Analyses N	P	K	Ca	Mg	Mn	Zn	Cu	B	T.D.M. Yield	Uptake N	P	K
lb/A	%					ppm					lb/A		
0	3.89	.46	4.44	2.49	1.79	84	29	11	51	500	20	2.3	22.0
40	3.77	.46	4.74	2.14	1.72	71	30	9	49	573	22	2.6	27.2
80	3.63	.45	4.88	2.57	1.71	88	29	9	51	536	19	2.4	26.2
120	3.78	.46	4.41	2.40	1.87	76	27	8	49	507	19	2.3	22.7
160	3.69	.45	4.62	2.59	1.79	83	29	8	49	596	22	2.7	27.4
200	3.77	.49	4.78	2.38	1.79	77	29	12	52	612	23	3.0	29.1
Significance	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
C.V. (%)	5.7	5.0	12.7	9.8	13.8	21.3	10.4	27.1	5.5	15.1	16.6	17.3	17.3

Table 6. The effect of phosphorus on the elemental analyses, dry matter yield, and nutrient uptake of oilseed sunflower in experiment 2 (90% pollinated).

P_2O_5 Rate	Elemental Analyses									T.D.M. Yield	Uptake		
	N	P	K	Ca	Mg	Mn	Zn	Cu	B		N	P	K
lb/A	%					ppm				lb/A			
0	1.92	.24	2.33	1.55	1.54	32	24	10	48	5971	115.0	14.6	140.0
40	1.83	.26	2.56	1.44	1.53	32	22	11	49	6652	121.7	17.3	169.5
80	1.60	.24	2.05	1.51	1.55	32	20	10	46	6729	108.5	16.0	139.6
120	1.91	.28	2.16	1.41	1.42	29	21	9	47	6937	132.2	19.4	150.2
160	1.71	.28	2.17	1.52	1.48	29	22	9	47	6967	119.1	19.7	151.6
200	1.60	.26	2.42	1.45	1.51	30	19	10	47	6440	104.0	16.7	156.7
Significance	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	*	N.S.
B.L.S.D. (.05)												3.8	
C.V. (%)	11.2	8.4	21.6	7.6	7.5	13.9	13.1	15.3	5.2	6.6	14.1	10.8	23.4

Table 7. The effect of phosphorus on the elemental analyses, dry matter yield, and nutrient uptake of oilseed sunflower in experiment 2 at maturity.

P_2O_5 Rate	Elemental Analyses									T.D.M. Yield	Uptake		
	N	P	K	Ca	Mg	Mn	Zn	Cu	B		N	P	K
lb/A	%					ppm				lb/A			
0	1.65	.24	2.27	1.40	1.27	26	22	10	45	6317	104.5	15.4	144.3
40	1.57	.25	2.22	1.18	1.20	26	21	10	39	5675	89.0	14.0	125.8
80	1.51	.27	2.04	1.24	1.15	25	22	10	42	6011	90.7	16.2	123.5
120	1.41	.28	1.86	1.28	1.27	25	20	9	44	5881	83.4	16.4	110.8
160	1.38	.33	2.07	1.25	1.14	24	24	10	41	6705	94.2	22.1	140.9
200	1.46	.28	2.39	1.41	1.23	29	18	9	45	5760	83.8	16.3	138.1
Significance	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	+	N.S.	N.S.	N.S.	N.S.	*	N.S.
B.L.S.D. (.05)												5.3	
C.V. (%)	12.6	15.3	23.9	16.9	9.3	23.3	8.8	14.0	7.2	9.1	19.2	15.6	30.7

Table 8. The effect of phosphorus on the elemental analyses of leaf samples of oilseed sunflower in experiment 2.

P_2O_5 Rate	Elemental Analyses								
	N	P	K	Ca	Mg	Mn	Zn	Cu	B
lb/A	%					ppm			
0	3.25	.39	3.21	2.73	1.82	42	37	20	98
40	3.58	.40	2.97	2.86	1.68	51	34	23	99
80	3.60	.38	2.64	2.78	1.89	51	30	18	100
120	3.39	.39	2.67	2.90	1.88	47	32	17	102
160	3.31	.40	2.58	2.93	1.88	47	33	17	98
200	3.63	.41	3.00	2.74	1.74	44	32	18	104
Significance	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
C.V. (%)	9.3	9.5	17.5	9.3	8.3	15.7	12.8	26.0	11.1

Table 9. The effect of phosphorus on seed yield, oil content, elemental analyses of the seed, and nutrient removal by the seed of oilseed sunflower in experiment 2.

P_2O_5 Rate	Seed Yield	Oil	Elemental Analyses P	K	Ca	Mg	Fe	Mn	Zn	Cu	B	Nutrient Removal P	K
lb/A	lb/A	%	%				ppm					lb/A	
0	1770	48.5	0.58	0.91	0.18	0.37	39	20	49	19	13	10.3	16.1
40	1850	50.0	0.56	0.94	0.18	0.36	38	20	48	22	12	10.4	17.3
80	1830	48.3	0.60	0.93	0.20	0.38	57	22	47	17	13	10.8	17.0
120	1850	48.7	0.59	0.98	0.18	0.37	37	19	45	17	13	11.0	18.1
160	1960	48.7	0.62	0.96	0.18	0.38	36	19	48	18	13	12.1	18.8
200	1970	49.1	0.61	0.91	0.17	0.38	39	21	45	18	13	12.1	17.9
Significance	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
C.V. (%)	7.1	2.3	9.4	4.4	5.5	5.9	28.3	9.6	6.7	21.4	7.0	13.0	9.4

Table 10. The effect of potassium on the elemental analyses, dry matter yield, and nutrient uptake of oilseed sunflower in experiment 3 (approximate height-10 inches).

K_2O Rate	Elemental Analyses N	P	K	Ca	Mg	Mn	Zn	Cu	B	T.D.M. Yield	Uptake N	P	K
lb/A	%					ppm					lb/A		
0	3.77	.49	4.85	2.66	1.51	71	26	8	52	541	20	2.7	26.3
50	3.98	.46	4.03	2.46	1.83	81	31	10	52	400	16	1.8	15.8
100	3.68	.44	4.86	2.42	1.77	82	31	9	51	526	19	2.3	25.7
150	3.82	.44	5.21	2.32	1.44	74	31	11	50	439	16	1.9	23.7
200	3.96	.46	4.69	2.46	1.71	78	30	8	52	533	21	2.5	25.0
250	3.98	.53	5.01	2.66	1.58	65	29	8	55	672	27	3.6	32.5
Significance	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
C.V. (%)	7.0	9.3	12.5	9.4	13.3	14.6	9.4	17.5	7.3	33.1	35.8	38.0	38.0

Table 11. The effect of potassium on the elemental analyses, dry matter yield, and nutrient uptake of oilseed sunflower in experiment 3 (90% pollinated).

K_2O Rate	Elemental Analyses N	P	K	Ca	Mg	Mn	Zn	Cu	B	T.D.M. Yield	Uptake N	P	K
lb/A	%					ppm					lb/A		
0	1.74	.31	2.43	1.64	1.11	28	19	8	53	6217	108.1	19.1	150.3
50	1.65	.25	2.15	1.62	1.19	30	19	8	52	6540	107.9	16.0	142.1
100	1.82	.27	2.53	1.73	1.22	38	22	8	56	6468	117.3	17.0	162.7
150	1.66	.24	2.61	1.74	1.15	33	20	9	55	6296	105.4	15.4	161.8
200	1.82	.29	2.54	1.72	1.26	34	21	8	57	6596	120.0	19.2	166.8
250	1.72	.32	2.55	1.71	1.09	26	19	7	57	7145	122.9	22.9	180.0
Significance	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
C.V. (%)	7.5	16.6	17.3	7.0	11.4	15.6	11.2	20.8	8.5	11.9	16.1	24.5	17.0

Table 12. The effect of potassium on the elemental analyses of leaf samples of oilseed sunflower in experiment 3.

K_2O Rate	Elemental Analyses								
	N	P	K	Ca	Mg	Mn	Zn	Cu	B
lb/A	%					ppm			
0	3.61	.40	2.62	3.25	1.63	43	32	21	97
50	3.29	.37	2.54	3.21	1.79	48	36	23	102
100	3.45	.38	2.67	3.25	1.65	55	32	20	94
150	3.42	.35	2.95	3.16	1.52	53	35	24	96
200	3.31	.40	2.64	2.91	1.83	42	35	17	88
250	3.37	.45	2.54	3.32	1.54	42	32	18	105
Significance	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
C.V. (%)	7.6	14.8	11.0	7.5	10.1	17.1	10.5	24.3	11.4

Table 13. The effect of potassium on seed yield, oil content, elemental analyses of the seed, and nutrient removal by the seed of oilseed sunflower in experiment 3.

K_2O Rate	Seed Yield	Oil	Elemental Analyses									Nutrient Removal	
			P	K	Ca	Mg	Fe	Mn	Zn	Cu	B	P	K
lb/A	lb/A	%	%				ppm					lb/A	
0	1870	48.3	0.60	0.95	0.20	0.37	41	19	48	24	19	11.1	17.7
50	1840	48.8	0.55	0.91	0.20	0.36	46	19	49	24	18	10.1	16.7
100	2020	49.4	0.57	0.87	0.19	0.37	40	21	48	23	15	11.4	17.7
150	1830	50.5	0.55	0.87	0.19	0.36	37	19	49	24	15	10.1	15.8
200	1710	48.9	0.57	0.91	0.19	0.37	41	20	48	23	15	9.8	15.6
250	1730	49.2	0.61	0.94	0.19	0.37	45	20	47	22	16	10.5	16.2
Significance	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
C.V. (%)	9.2	2.9	10.6	4.5	6.8	6.8	30.1	9.3	8.5	9.1	18.5	12.6	9.7

Table 14. The effect of phosphorus on the elemental analyses of leaf samples of oilseed sunflower in experiment 4.

P_2O_5 Rate	Elemental Analyses								
	N	P	K	Ca	Mg	Mn	Zn	Cu	B
lb/A	%					ppm			
0	3.21	.36	2.97	3.26	1.65	73	36	19	105
40	3.36	.40	2.61	3.09	1.79	63	32	18	89
80	3.41	.37	2.60	3.24	1.81	64	38	20	88
120	3.13	.40	2.78	3.22	1.53	69	29	13	86
160	3.31	.37	2.65	3.41	1.81	69	31	20	99
200	3.46	.38	2.28	3.40	1.92	65	34	16	90
Significance	N.S.	N.S.	*	N.S.	N.S.	N.S.	N.S.	*	N.S.
B.L.S.D. (.05)			.44					6	
C.V. (%)	6.6	11.8	9.7	5.6	13.4	16.3	17.8	18.9	14.7

Table 15. The effect of phosphorus on seed yield, oil content, elemental analyses of the seed, and nutrient removal by the seed of oilseed sunflower in experiment 4.

P_2O_5 Rate	Seed Yield	Oil	Elemental Analyses P	K	Ca	Mg	Fe	Mn	Zn	Cu	B	Nutrient Removal P	K
lb/A	lb/A	%	%				ppm					lb/A	
0	1870	48.4	0.60	0.90	0.19	0.36	38	23	51	14	14	11.2	16.9
40	1950	47.5	0.62	0.89	0.19	0.38	45	22	49	14	13	12.2	17.5
80	1890	47.3	0.62	0.86	0.19	0.37	42	23	55	15	14	11.7	16.2
120	2000	47.4	0.66	0.93	0.19	0.39	42	24	45	13	13	13.3	18.6
160	2080	47.8	0.61	0.88	0.19	0.37	41	22	44	14	13	12.6	18.2
200	2020	46.8	0.68	0.89	0.19	0.39	43	23	49	12	14	13.7	18.0
Significance	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
C.V. (%)	8.2	2.1	10.1	8.1	3.9	7.0	14.9	7.4	16.0	10.4	5.5	13.2	12.4

Table 16. The effect of potassium on the elemental analyses of leaf samples of oilseed sunflower in experiment 5.

K_2O Rate	Elemental Analyses N	P	K	Ca	Mg	Mn	Zn	Cu	B
lb/A	%					ppm			
0	3.45	.36	2.15	2.78	2.06	60	40	18	85
50	3.59	.33	2.20	3.14	2.06	66	41	18	89
100	3.42	.36	2.29	3.65	1.87	67	32	17	91
150	3.39	.35	2.13	3.22	2.02	67	36	16	89
200	3.48	.35	2.78	3.16	1.66	61	32	16	95
250	3.50	.35	2.79	3.40	1.68	61	29	17	90
Significance	N.S.	N.S.	**	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
B.L.S.D. (.05)			.38						
C.V. (%)	7.0	10.7	10.3	11.6	12.4	15.6	19.4	22.9	9.3

Table 17. The effect of potassium on seed yield, oil content, elemental analyses of the seed, and nutrient removal by the seed of oilseed sunflower in experiment 5.

K_2O Rate	Seed Yield	Oil	Elemental Analyses P	K	Ca	Mg	Fe	Mn	Zn	Cu	B	Nutrient Removal P	K
lb/A	lb/A	%	%				ppm					lb/A	
0	1650	46.5	0.59	0.89	0.19	0.38	43	23	55	16	15	9.6	14.6
50	1870	46.6	0.59	0.87	0.19	0.37	46	23	52	14	14	11.0	16.3
100	1880	46.8	0.59	0.91	0.18	0.38	48	23	58	16	15	11.1	17.1
150	1970	47.5	0.58	0.90	0.18	0.37	53	23	49	15	14	11.5	17.8
200	2040	47.7	0.59	0.88	0.19	0.38	51	23	47	15	14	12.0	17.9
250	1940	47.0	0.56	0.87	0.19	0.37	55	23	52	15	14	10.9	16.7
Significance	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
C.V. (%)	10.0	2.1	7.8	4.6	5.8	4.7	18.3	8.6	12.3	8.2	4.4	12.2	10.8

Table 18. Above ground dry matter yields, nutrient analyses of the plant, and nutrient uptake of oilseed sunflower at various sampling dates.

Experiment	Date	T.D.M.	Analyses N	Analyses P	Analyses K	Uptake N	Uptake P	Uptake K
	1981	lb/A	- - - - - % - - - -			- - - lb/A - - - -		
1	6-25	503	4.15	0.51	5.31	20.8	2.6	26.8
	8-13	7049	2.17	0.33	2.70	153.0	23.3	188.5
2	6-25	554	3.76	0.46	4.64	20.8	2.6	25.7
	8-13	6616	1.76	0.26	2.28	116.7	17.3	151.3
	9-16	6058	1.50	0.28	2.14	91.0	16.7	130.6
3	6-25	518	3.87	0.47	4.77	20.1	2.5	24.8
	8-13	6544	1.73	0.28	2.47	113.7	18.3	160.6

Table 19. Seed yields, nutrient analyses of the seed, and nutrient removal by the seed of oilseed sunflower at maturity.

Experiment	Yield	Analyses N	Analyses P	Analyses K	Removal N	Removal P	Removal K
	lb/A	- - - - - % - - - - - -			- - - - - lb/A - - - - -		
1	2253	2.55	0.60	0.90	57.4	13.5	20.2
2	1872		0.59	0.94		11.1	17.5
3	1834		0.57	0.91		10.5	16.6
4	1972		0.63	0.89		12.4	17.6
5	1893		0.58	0.89		11.0	16.7

PHOSPHORUS AND POTASSIUM FERTILITY STUDIES ON NONOILSEED SUNFLOWER

G. E. Varvel and R. K. Severson

Phosphorus and potassium response data for nonoilseed sunflower in Minnesota is limited. Additional information needs to be generated to determine the optimum levels of P and K fertilization for maximum production. These studies were initiated with those objectives in mind.

Experimental Procedure:
Two locations were used with a P and K experiment at both. A randomized, complete block design with 6 treatments was used for all experiments. At both locations, the P studies had 100 lb K_2O/A broadcast over the entire experiment while the K studies had 80 lb P_2O_5/A broadcast over the entire experiment. All treatments were applied and incorporated on April 16, 1981. Nonoilseed sunflower, Dahlgren 716, was seeded on May 6, 1981 in 30 inch rows.

Whole plant samples were taken from all of the experiments at various times to measure total above ground plant growth, nutrient content, and nutrient uptake as affected by P or K fertilizer. Seed yields were also taken.

Soil test results from samples taken on April 16, 1981 were: Experiments 1 and 2 (pH-7.6, NO_3-N (lb/A-2')-130, $NaHCO_3$ P (lb/A)-11, and exchangeable K (lb/A) - 180). Experiments 3 and 4 (pH-7.6, NO_3-N (lb/A-2')-113, $NaHCO_3$ P (lb/A)-14, and exchangeable K (lb/A)-266).

Results:
Experiment 1. Above ground dry matter yields, elemental analyses, and nutrient uptake are shown in Tables 1-3 for the June 24, Aug. 11, and Sept. 10 sampling dates respectively. The phosphorus treatments significantly increased P and Ca and decreased Zn levels in the plant at the June 24 sampling date (Table 1), significantly increased P levels in the plant and P uptake at the Aug. 11 sampling date (Table 2), and caused no differences at the Sept. 10 sampling date (Table 3).

Elemental analyses of leaf samples taken Aug. 7 are shown in Table 4. The phosphorus treatments significantly increased P and decreased Zn levels in the leaf. Significant differences in Mg levels in the leaf were also obtained but they appear unrelated to the treatments.

Seed yields were taken Sept. 14 but will not be reported here due to the amount of insect damage which caused tremendous variability in plot yields nearest the edge of the field.

Experiment 2. Above ground dry matter yields, elemental analyses, and nutrient uptake are shown in Tables 5-7 for the June 24, Aug. 11, and Sept. 10 sampling dates respectively. The potassium treatments significantly affected Mn levels in the plant at the June 24 sampling date (Table 5) and K levels in the plant at the Aug. 11 sampling date (Table 6), but they appear unrelated to the treatments. No other differences were obtained.

Elemental analyses of leaf samples taken Aug. 7 are shown in Table 8. The potassium treatments significantly affected K, Ca, and Mn levels in the leaf, but the Ca and Mn levels do not appear related to the treatments.

Seed yields taken on Sept. 14 will not be reported here due to the amount of insect damage which caused tremendous variability in plot yields nearest the edge of the field.

Experiment 3. Above ground dry matter yields, elemental analyses, and nutrient uptake are shown in Tables 9 and 10 for the June 24 and Aug. 12 sampling dates. The potassium treatments significantly increased K levels in the plant, dry matter yields, and K uptake and decreased Mg levels in the plant at the Aug. 12 sampling date (Table 10). No differences were obtained at the June 24 sampling date (Table 9).

Elemental analyses of leaf samples taken on Aug. 7 are shown in Table 11. The potassium treatments significantly increased K levels and decreased Mg levels in the leaf.

Harvest populations, seed yield, elemental analyses of the seed, and nutrient removal are shown in Table 12. No differences were obtained.

Experiment 4. Above ground dry matter yields, elemental analyses, and nutrient uptake are shown in Table 13 for the June 24 sampling date. The phosphorus treatments significantly increased P levels in the plant and P uptake and reduced Zn levels in the plant. No other sampling dates were used because of water damage to parts of the experiment.

Elemental analyses of leaf samples taken Aug. 7 are shown in Table 14. The phosphorus treatments significantly increased P levels in the leaf but had no effect on the other variables.

Seed yield, harvest populations, elemental analyses of the seed, and nutrient removal are shown in Table 15. The phosphorus treatments significantly increased P and K levels in the seed. Seed yield and Mn, Zn and Cu levels in the seed were also significantly affected, but the differences do not appear related to the treatments. Some of the variability was due to insect damage to the seed which was greater in the plots closest to the edge of the field.

Conclusions:
The results from these experiments were highly variable, but some information has been gained. Soil, plant and leaf analyses data indicate that a P response in experiments 1 and 4 and a K response in experiment 2 would have been obtained if water and insect damage had not bee incurred on the studies. Precipitation at these locations exceeded 40 inches during the growing season and due to the topography of the locations, rapid drainoff did not occur.

In spite of these problems, a summary of results from all the experiments established some basic levels in dry matter production, nutrient content, and nutrient uptake for nonoilseed sunflower (Table 16). Nutrient analyses and removal data for the seed are shown in Table 17.

Table 1. The effect of phosphorus on the elemental analyses, dry matter yield, and nutrient uptake of sunflower whole plants in experiment 1 (approximate height-10 inches).

P_2O_5	Elemental Analyses									T.D.M.	Uptake		
Rate	N	P	K	Ca	Mg	Mn	Zn	Cu	B	Yield	N	P	K
lb/A	%					ppm					lb/A		
0	3.79	.37	5.84	1.90	.97	85	26	9	45	242	9.1	.9	14.3
40	3.71	.50	6.42	2.35	.92	86	29	9	50	398	14.7	2.1	26.4
80	3.72	.47	6.31	2.37	.88	83	25	7	50	379	14.0	1.8	24.0
120	3.72	.53	5.92	2.39	.96	94	24	10	52	399	14.9	2.2	23.9
160	3.70	.47	5.97	2.43	.91	89	20	8	48	356	13.2	1.7	21.2
200	3.63	.68	6.41	2.30	.93	77	22	8	49	455	16.6	3.3	29.5
Significance	N.S.	+	N.S.	+	N.S.	N.S.	+	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
C.V. (%)	3.5	26.2	7.8	10.4	9.9	21.4	17.1	44.2	6.4	30.8	31.5	59.7	36.6

Table 2. The effect of phosphorus on the elemental analyses, dry matter yield, and nutrient uptake of sunflower whole plants in experiment 1 (90% pollinated).

P_2O_5	Elemental Analyses									T.D.M.	Uptake		
Rate	N	P	K	Ca	Mg	Mn	Zn	Cu	B	Yield	N	P	K
lb/A	%					ppm					lb/A		
0	1.95	.20	2.69	1.55	1.14	50	23	9	51	3804	74.6	7.7	102.4
40	1.98	.24	3.17	1.61	1.05	41	23	9	55	4794	94.1	11.2	149.4
80	1.93	.24	3.34	1.58	1.02	35	18	7	52	4884	95.8	11.9	164.3
120	1.97	.25	2.54	1.62	1.26	45	21	9	52	5123	102.9	12.9	128.1
160	1.92	.27	3.03	1.81	1.09	51	19	8	53	5172	100.1	14.1	157.8
200	2.04	.29	2.96	1.76	1.15	46	19	9	55	5231	104.5	15.3	154.6
Significance	N.S.	*	N.S.	N.S.	N.S.	N.S.	*	N.S.	N.S.	N.S.	N.S.	*	N.S.
B.L.S.D. (.05)		.06					5					4.7	
C.V. (%)	8.6	13.9	16.7	8.6	13.1	17.5	13.3	39.8	7.2	15.4	22.7	23.0	22.3

Table 3. The effect of phosphorus on the elemental analyses, dry matter yield, and nutrient uptake of sunflower whole plants in experiment 1 at maturity.

P_2O_5 Rate	Elemental Analyses									T.D.M. Yield	Uptake		
	N	P	K	Ca	Mg	Mn	Zn	Cu	B		N	P	K
lb/A	%					ppm				lb/A			
0	1.51	.21	2.24	1.38	.84	38	26	11	48	5591	83.8	11.7	124.6
40	1.57	.24	2.54	1.40	.82	30	25	10	47	6244	97.9	14.8	160.0
80	1.55	.24	2.64	1.33	.78	28	19	9	46	6660	102.8	15.8	175.1
120	1.49	.25	2.18	1.28	.90	33	20	9	44	6505	97.0	15.9	143.0
160	1.55	.32	2.50	1.45	.83	34	21	11	49	5532	83.4	17.1	134.9
200	1.41	.26	2.34	1.40	.93	30	20	13	48	6325	88.6	16.6	148.4
Significance	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
C.V. (%)	14.2	20.9	16.3	11.4	17.2	26.3	18.5	43.4	9.6	13.9	14.7	17.0	21.1

Table 4. The effect of phosphorus on the elemental analyses of leaf samples of nonoilseed sunflower in experiment 1.

P_2O_5 Rate	Elemental Analyses								
	N	P	K	Ca	Mg	Mn	Zn	Cu	B
lb/A	%					ppm			
0	3.47	.27	2.81	2.52	1.35	69	28	15	80
40	3.50	.27	3.14	2.62	1.21	50	23	15	82
80	3.48	.29	2.96	2.65	1.29	56	20	11	84
120	3.52	.31	2.59	2.77	1.54	66	24	15	83
160	3.14	.32	3.00	2.69	1.29	65	21	12	76
200	3.18	.35	2.89	2.98	1.40	59	19	14	92
Significance	N.S.	**	N.S.	N.S.	*	N.S.	*	N.S.	N.S.
B.L.S.D. (.05)		.05			.23		7		
C.V. (%)	7.1	10.1	13.8	9.7	10.0	22.3	17.0	51.7	11.3

Table 5. The effect of potassium on the elemental analyses, dry matter yield, and nutrient uptake of sunflower whole plants in experiment 2 (approximate height-10 inches).

K_2O Rate	Elemental Analyses									T.D.M. Yield	Uptake		
	N	P	K	Ca	Mg	Mn	Zn	Cu	B		N	P	K
	%					ppm				lb/A			
0	3.56	.56	6.19	2.22	1.03	70	28	10	52	496	17.3	3.0	31.4
50	3.66	.60	6.39	2.16	1.00	83	23	8	53	534	19.6	3.2	34.3
100	3.50	.60	6.33	2.26	.90	80	24	7	49	471	16.5	3.0	29.9
150	3.61	.52	6.00	2.38	1.09	104	25	9	54	437	15.8	2.3	26.2
200	3.60	.54	6.61	2.10	.99	81	24	8	49	469	16.9	2.5	31.0
250	3.39	.55	6.76	1.88	1.00	59	24	9	46	427	14.6	2.5	29.4
Significance	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
B.L.S.D. (.05)													
C.V. (%)	4.6	27.2	7.9	11.7	11.3	20.1	14.4	38.0	8.3	33.0	33.2	48.7	36.9

Table 6. The effect of potassium on the elemental analyses, dry matter yield, and nutrient uptake of sunflower whole plants in experiment 2 (90% pollinated).

K_2O Rate	Elemental Analyses N	P	K	Ca	Mg	Mn	Zn	Cu	B	T.D.M. Yield	Uptake N	P	K
lb/A	%					ppm				lb/A			
0	1.95	.27	3.28	1.49	1.01	30	23	11	53	4689	89.5	12.3	153.3
50	2.00	.28	3.25	1.73	1.19	45	21	8	64	5949	119.0	16.7	193.4
100	1.87	.23	2.84	1.78	1.21	48	18	9	56	5257	97.6	11.8	149.3
150	1.69	.24	2.93	1.47	1.27	46	19	10	50	5272	88.7	12.4	154.5
200	1.81	.24	3.44	1.53	1.01	37	17	8	45	4690	83.3	11.0	162.3
250	1.83	.25	3.42	1.49	1.05	29	24	13	54	5307	102.7	13.3	182.0
Significance	N.S.	N.S.	*	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
B.L.S.D. (.05)			0.45										
C.V. (%)	7.1	9.0	5.0	7.4	7.2	16.9	21.6	42.1	10.1	10.4	8.2	10.9	13.1

Table 7. The effect of potassium on the elemental analyses, dry matter yield, and nutrient uptake of sunflower whole plants in experiment 2 at maturity.

K_2O Rate	Elemental Analyses N	P	K	Ca	Mg	Mn	Zn	Cu	B	T.D.M. Yield	Uptake N	P	K
	%					ppm				lb/A			
0	1.82	.23	2.12	1.22	.88	21	22	12	38	6396	117.3	14.7	134.1
50	1.59	.26	2.41	1.05	.83	28	20	8	36	7145	113.5	18.6	172.4
100	1.44	.20	2.74	1.06	.77	24	18	9	32	6921	99.2	13.5	189.8
150	1.42	.22	2.44	.99	.99	24	22	12	34	5988	84.8	12.9	145.8
200	1.55	.27	2.68	1.18	.71	24	21	11	34	6952	107.5	18.4	183.0
250	1.61	.21	2.36	1.02	.87	21	28	16	37	6256	100.7	13.1	147.6
Significance	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
C.V. (%)	8.6	13.4	14.4	8.4	11.0	8.8	30.2	43.5	11.3	9.8	15.4	12.5	11.1

Table 8. The effect of potassium on the elemental analyses of leaf samples of nonoilseed sunflower in experiment 2.

K_2O Rate	Elemental Analyses N	P	K	Ca	Mg	Mn	Zn	Cu	B
lb/A	%					ppm			
0	3.17	.33	3.28	2.75	1.36	53	27	18	85
50	3.23	.34	2.99	2.67	1.48	71	21	11	89
100	3.25	.33	3.04	3.12	1.28	74	22	13	96
150	3.30	.31	3.44	2.47	1.41	59	24	21	79
200	3.28	.32	3.26	3.02	1.30	69	24	16	83
250	3.32	.34	3.61	2.52	1.26	52	25	22	83
Significance	N.S.	N.S.	*	*	N.S.	**	N.S.	N.S.	N.S.
B.L.S.D. (.05)			0.42	0.52		16			
C.V. (%)	5.5	9.7	7.9	11.3	15.2	14.9	20.9	48.1	12.0

Table 9. The effect of potassium on the elemental analyses, dry matter yield, and nutrient uptake of sunflower whole plants in experiment 3 (approximate height-10 inches).

K_2O Rate	Elemental Analyses N	P	K	Ca	Mg	Mn	Zn	Cu	B	T.D.M. Yield	Uptake N	P	K
lb/A	%					ppm				lb/A			
0	3.30	.47	5.76	2.45	.91	83	21	9	50	313	10	1.5	18
50	3.19	.44	5.72	2.31	.98	84	22	11	49	360	12	1.6	21
100	3.50	.46	5.69	2.36	.95	81	22	11	49	338	12	1.6	19
150	3.42	.45	5.68	2.74	.96	95	22	12	50	346	12	1.4	20
200	3.30	.43	5.84	2.40	.88	87	22	11	48	358	12	1.3	21
250	3.21	.47	6.20	2.38	.87	78	23	11	49	319	10	1.5	20
Significance	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
C.V. (%)	5.2	16.8	5.4	11.8	9.9	14.1	13.9	25.8	5.9	17.0	15.5	24.3	20.3

Table 10. The effect of potassium on the elemental analyses, dry matter yield, and nutrient uptake of sunflower whole plants in experiment 3 (90% pollinated).

K_2O Rate	Elemental Analyses N	P	K	Ca	Mg	Mn	Zn	Cu	B	T.D.M. Yield	Uptake N	P	K
lb/A	%					ppm				lb/A			
0	1.88	.24	2.20	1.74	1.31	44	19	9	46	5398	85.6	12.6	118.8
50	1.88	.24	2.58	1.54	1.29	43	21	10	45	5019	94.6	12.2	128.2
100	1.80	.23	2.60	1.70	1.26	42	18	9	45	5140	92.1	11.7	133.5
150	1.87	.24	2.73	1.72	1.21	42	19	10	44	5255	98.1	12.6	143.6
200	1.74	.22	3.08	1.55	1.10	39	18	10	42	5433	94.6	11.6	168.0
250	1.75	.22	3.20	1.54	1.03	36	20	9	44	6076	106.0	13.2	194.7
Significance	N.S.	N.S.	**	N.S.	**	N.S.	N.S.	N.S.	N.S.	*	N.S.	N.S.	**
B.L.S.D. (.05)			.48		.16					685			28.8
C.V. (%)	5.3	8.2	11.3	10.9	8.5	12.2	23.2	25.5	8.9	7.5	15.4	12.9	13.1

Table 11. The effect of potassium on the elemental analyses of leaf samples of nonoilseed sunflower in experiment 3.

K_2O Rate	Elemental Analyses N	P	K	Ca	Mg	Mn	Zn	Cu	B
lb/A	%					ppm			
0	3.05	.31	2.44	2.99	1.72	66	21	16	69
50	2.97	.31	2.59	2.86	1.76	69	23	17	69
100	3.07	.33	2.68	3.20	1.65	73	20	16	73
150	3.33	.32	2.85	2.92	1.56	65	21	15	59
200	3.06	.31	3.00	3.07	1.45	71	22	20	67
250	3.12	.30	3.22	2.93	1.41	64	22	17	68
Significance	N.S.	N.S.	**	N.S.	**	N.S.	N.S.	N.S.	N.S.
B.L.S.D. (.05)			.31		.17				
C.V. (%)	5.6	8.7	7.4	10.2	6.8	9.5	22.8	31.9	12.1

Table 12. The effect of potassium on seed yield, harvest population, elemental analyses of the seed, and nutrient removal at maturity of nonoilseed sunflower in experiment 3.

K_2O Rate	Seed Yield	Harvest Population	Elemental Analyses N	P	K	Ca	Mg	Fe	Mn	Zn	Cu	B	Nutrient Removal N	P	K
lb/A	lb/A	Plants/A	%					ppm					lb/A		
0	1633	18,590	3.22	0.55	0.85	0.24	0.38	43	25	40	15	19	51.9	8.8	13.8
50	1629	18,590	2.89	0.50	0.82	0.21	0.35	39	23	37	16	17	47.6	8.2	13.4
100	1637	19,310	3.23	0.56	0.87	0.24	0.38	44	26	36	14	19	52.8	9.1	14.1
150	1751	18,440	3.11	0.54	0.86	0.23	0.37	47	25	37	14	18	54.6	9.5	15.0
200	1801	17,280	3.35	0.54	0.85	0.23	0.36	46	25	38	15	18	60.3	9.7	15.4
250	1679	16,990	3.34	0.57	0.89	0.23	0.38	49	26	40	15	19	56.1	9.6	15.0
Significance	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
C.V. (%)	13.4	7.1	7.1	8.9	4.4	7.4	7.8	10.3	9.2	18.6	12.9	6.3	14.8	18.0	13.6

Table 13. The effect of phosphorus on the elemental analyses, dry matter yield, and nutrient uptake of sunflower whole plants in experiment 4 (approximate height-10 inches).

P_2O_5 Rate	Elemental Analyses N	P	K	Ca	Mg	Mn	Zn	Cu	B	T.D.M. Yield	Uptake N	P	K
lb/A	%					ppm					lb/A		
0	3.37	.36	5.89	1.94	1.00	63	21	8	43	354	12.3	1.3	21.2
40	3.47	.41	5.87	2.07	.99	59	21	9	44	380	13.1	1.5	22.4
80	3.46	.53	5.52	2.21	1.03	63	19	8	47	397	13.6	2.1	22.4
120	3.06	.66	5.69	2.11	.96	50	18	7	42	375	11.6	2.5	21.5
160	3.11	.69	5.76	2.17	1.02	53	18	7	45	427	13.4	2.9	24.6
200	3.29	.76	5.88	2.08	1.03	52	18	8	44	397	13.1	3.0	23.8
Significance	N.S.	**	N.S.	N.S.	N.S.	N.S.	*	N.S.	N.S.	N.S.	N.S.	*	N.S.
B.L.S.D. (.05)		.19					3					1.2	
C.V. (%)	7.5	22.1	7.7	11.4	11.9	20.6	10.4	14.9	5.8	17.6	22.2	32.9	21.1

Table 14. The effect of phosphorus on the elemental analyses of leaf samples of nonoilseed sunflower in experiment 4.

P_2O_5 Rate	Elemental Analyses N	P	K	Ca	Mg	Mn	Zn	Cu	B
lb/A	%					ppm			
0	3.34	.32	3.43	2.54	1.31	50	27	24	81
40	3.07	.31	3.24	2.74	1.34	46	24	19	67
80	3.15	.37	3.14	2.81	1.37	49	19	15	74
120	3.08	.38	3.44	2.89	1.32	50	20	14	74
160	3.10	.40	3.18	2.92	1.34	49	19	16	79
200	3.23	.37	3.45	2.65	1.41	52	20	18	75
Significance	N.S.	*	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
B.L.S.D. (.05)		0.08							
C.V. (%)	8.3	12.3	5.2	8.7	10.7	14.6	18.1	29.3	9.8

Table 15. The effect of potassium on seed yield, harvest population, elemental analyses of the seed, and nutrient removal at maturity of nonoilseed sunflower in experiment 4.

P_2O_5 Rate	Seed Yield	Harvest Population	Elemental Analyses N	P	K	Ca	Mg	Fe	Mn	Zn	Cu	B	Nutrient Removal N	P	K
lb/A	lb/A	Plants/A	%					ppm					lb/A		
0	1329	16,840	3.30	0.61	0.94	0.24	0.41	53	28	55	19	20	43.8	8.1	12.5
40	1620	16,840	3.20	0.55	0.93	0.23	0.39	49	24	51	18	20	51.9	8.8	15.0
80	1671	17,420	3.14	0.63	0.95	0.23	0.42	50	25	41	15	19	52.7	10.5	15.8
120	1476	17,230	3.34	0.67	1.01	0.25	0.43	50	26	44	16	21	49.2	9.9	14.9
160	1614	17,230	3.47	0.67	0.98	0.24	0.43	58	27	45	16	21	49.2	10.8	15.7
200	1258	17,420	3.56	0.68	1.02	0.24	0.45	56	29	53	19	22	55.9	8.6	12.9
Significance	+	N.S.	N.S.	**	**	N.S.	N.S.	N.S.	*	*	*	N.S.	N.S.	N.S.	N.S.
B.L.S.D. (.05)				0.06	0.06				3	10	3				
C.V. (%)	11.9	4.9	6.0	6.0	3.6	9.7	6.7	9.1	7.4	12.8	11.2	6.3	13.4	15.5	13.6

Table 16. Dry matter yields, nutrient content, and nutrient uptake of nonoilseed sunflower at various sampling dates.

Experiment	Sampling Date	T.D.M.	Nutrient Content N	P	K	Uptake N	P	K
	1981	lb/A	%			lb/A		
1	6-24	372	3.71	0.50	6.14	13.7	2.0	23.2
1	8-11	4801	1.96	0.25	2.99	95.0	12.2	143.8
1	9-10	6135	1.52	0.25	2.41	92.4	15.3	147.6
2	6-24	470	3.54	0.56	6.40	16.7	2.7	30.3
2	8-11	5211	1.86	0.25	3.19	96.2	12.9	166.1
2	9-10	6642	1.56	0.23	2.47	104.1	15.4	163.4
3	6-24	327	3.32	0.45	5.81	10.8	1.5	19.1
3	8-11	5387	1.82	0.23	2.73	95.2	12.3	147.8
4	6-24	388	3.29	0.57	5.77	12.8	2.2	22.6

Table 17. Nutrient analyses and removal data for the seed of nonoilseed sunflower.

Experiment	Seed Yield	Nutrient Content N	P	K	Removal N	P	K
	lb/A	%			lb/A		
3	1688	3.19	0.54	0.86	53.9	9.2	14.4
4	1528	3.33	0.63	0.97	50.1	9.6	14.6

EFFECTS OF NITROGEN RATE AND PLACEMENT ON TWO MALTING BARLEY VARIETIES

G. E. Varvel and R. K. Severson

The importance of malting barley in Northwest Minnesota has generated the need for additional information on nitrogen fertilization with the release of higher yielding varieties. These varieties have higher yield potentials, greater straw strength and better disease resistance than previously released varieties, but their performance under varying nitrogen management programs has had very little testing. This study was established to evaluate the effects of nitrogen and its placement on two of the recently released varieties, Morex and Glenn.

Experimental Procedure:

The treatments consisted of nitrogen fertilizer (28-0-0) at rates of 0, 50, 100 and 150 lb N/A, surface applied (broadcast) and injected (6 inches deep, 14 inches apart), on two malting barley varieties in a complete factorial arrangement. Four replications were used. The fertilizer was applied and the varieties planted on May 1, 1981.

Whole plant samples were taken at late tillering (6-16-81) and N content was determined. Forage samples were taken at soft dough (7-20-81) to measure total N uptake. Grain was harvested (7-28-81) to determine yield and quality. Lodging scores were taken (7-13-81).

Initial soil test results indicated 70 lb NO_3-N/A available in the top 2 feet.

Results:

The effects of the treatments are shown in Table 1. A significant variety by nitrogen rate interaction was obtained with respect to grain yield and test weight. Morex increased in yield with the addition of the first 50 lb/A N applied and then decreased as additional N was added while Glenn also increased in yield with the first 50 lb/A N applied and then its yield remained the same as additional N was added. The test weight of Morex decreased with each increment of additional N while Glenn's test weight did not start to decrease until 100 lb/A N was added.

Significant differences in early plant N content, forage yield, protein, and plump kernels were obtained between the varieties (Table 1). Morex was significantly higher in early plant N content and protein and significantly lower in forage yield and plump kernels than Glenn. No significant differences in forage N, N uptake, or lodging were obtained between the varieties.

Increasing nitrogen significantly increased early plant N content, forage yield, forage N content, N uptake, protein, and lodging and significantly reduced plump kernels (Table 1).

Nitrogen placement caused significant differences in early plant N content, forage N content, N uptake and test weight (Table 1). Injection of the N caused significantly higher early plant N content, forage N content, and N uptake and significantly reduced test weight when compared to the surface N application.

Table 1. Influence of N rate, placement and variety on early plant N, forage yield, N content and N uptake, grain yield, bushel weight, protein, plump kernels, and lodging.

			Forage			Grain				
Variety	N-Rate	N[1/]	D.M. Yield	N[2/]	N Uptake	Yield	Test Weight	Protein	Plump Kernels	Lodging[3/]
	lb/A	%	lb/A	%	lb/A	Bu/A	lb/Bu	%	%	
Morex	0	2.36	5885	0.89	52.7	64.6	45.1	9.5	64.2	1.00
Morex	50	2.78	7539	1.11	83.3	82.3	43.7	11.0	58.9	1.13
Morex	100	3.36	7976	1.19	95.0	78.9	42.3	12.0	57.2	1.88
Morex	150	3.47	8104	1.37	110.8	74.0	41.2	12.8	52.0	3.13
Glenn	0	2.02	6284	0.86	54.1	66.0	45.3	9.2	74.7	1.00
Glenn	50	2.56	7939	1.05	82.9	87.8	45.1	10.5	72.0	1.00
Glenn	100	2.86	8550	1.25	107.1	89.5	43.8	11.7	63.6	1.75
Glenn	150	3.24	8293	1.27	104.9	88.7	42.7	12.4	60.2	2.63
Significance		N.S.	N.S.	N.S.	N.S.	*	*	N.S.	N.S.	N.S.
C.V. (%)		8.6	8.0	9.8	12.3	7.7	1.7	5.1	16.0	33.5
Main Effects										
Variety										
Morex		2.99	7376	1.14	85.4	74.9	43.1	11.3	58.1	1.78
Glenn		2.67	7767	1.11	87.2	83.0	44.2	11.0	67.6	1.59
Significance		**	**	N.S.	N.S.			*	**	N.S.
B.L.S.D. (.05)		0.12	308					0.3	5.1	
N Rate lb/A										
0		2.19	6085	0.88	53.4	65.3	45.2	9.4	69.4	1.00
50		2.67	7739	1.08	83.1	85.1	44.4	10.7	65.4	1.06
100		3.11	8263	1.22	101.0	84.2	43.1	11.8	60.4	1.81
150		3.36	8198	1.32	107.8	81.4	41.9	12.6	56.1	2.88
Significance		**	**	**	**			**	**	**
B.L.S.D. (.05)		0.15	389	0.07	6.7			0.3	7.2	0.36
N Placement										
Surface		2.77	7625	1.07	82.9	79.2	43.8	11.0	63.6	1.59
Injected		2.89	7518	1.18	89.7	78.7	43.4	11.3	62.1	1.78
Significance		*	N.S.	**	**	N.S.	*	N.S.	N.S.	N.S.
B.L.S.D. (.05)		0.12		0.06	5.4		0.4			

[1/] Kjeldahl N (whole plant - late tillering).

[2/] Kjeldahl N.

[3/] Lodging scores (1=erect, 5=flat).

THE EFFECTS OF ANHYDROUS AMMONIA AT PLANTING TIME ON SPRING WHEAT AND BARLEY

G.E. Varvel and R.K. Severson

Anhydrous ammonia has become the main N source used in the Northern Great Plains on small grains, but most of it is applied in the fall preceding the crop year. This practice works satisfactorily in most years, but cases do arise where spring application of the N fertilizer becomes necessary. In these cases, some questions have arisen concerning the timing of anhydrous application with respect to seeding time. The main concern has been possible germination damage if seeding was done too soon after the anhydrous application. This study was designed to determine the effect of anhydrous ammonia at planting time on spring wheat and barley.

Experimental Procedure:

Three years of field experiments were conducted on a Wheatville loam soil. Results reported here are from the final year (1981) of the study. The experiment was conducted using a split-plot design with time of seeding as the main plot with combinations of 4 reates of N (0, 40, 80 and 120 lb/A) at 3 application depths (3, 6 and 9 inches) in a factorial arrangement as subplots within each main plot. Four replications were used. Times of seeding were 0, 24 and 48 hours after the anhydrous treatments were applied on May 5, 1981.

Stand counts were taken on May 30, 1981. Yield samples were taken on July 28 and August 11, 1981 for the barley and wheat respectively with subsamples taken for protein analyses.

Initial soil test levels for the study were: pH-7.9, NO_3-N (0-2')-50 lb/A, $NaHCO_3$ P-30 lb/A, and exchangeable K-330 lb/A.

Results:

Grain yield, protein, and stand count were not affected by time of seeding of wheat or barley (Table 1). Nitrogen significantly increased yield and protein of wheat and barley and reduced barley stand count. It had no affect on wheat stand count (Table 1). Depth of application significantly reduced stand count of both wheat and barley, wheat yield, and increased protein of barley. No significant interactions were obtained.

Table 1. Effects of time of seeding after anhydrous application, N rate, and depth of application on yield, protein, and stand count of spring wheat and barley.

Seeding Time 1/	Wheat			Barley		
	Yield	Protein	Stand	Yield	Protein	Stand
	Bu/A	%	Plants/m^2	Bu/A	%	Plants/m^2
0	38.4	12.4	183	55.2	12.0	174
24	39.6	12.6	201	54.7	11.8	185
48	37.7	12.5	197	52.7	11.7	184
Significance	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
C.V. (%)	11.7	4.7	10.7	13.1	5.5	9.9
N Rate lb/A						
0	33.4	11.3	193	43.5	10.5	181
40	39.8	12.1	194	54.6	11.2	186
80	41.1	13.2	193	61.0	12.4	180
120	40.1	13.5	193	57.8	13.2	177
Significance	**	**	N.S.	N.S.	**	N.S.
B.L.S.D. (.05)	1.9	0.1		3.0	0.3	
Application Depth inches						
3	39.2	12.4	199	54.1	11.6	185
6	39.6	12.5	200	56.1	11.9	188
9	36.9	12.6	182	52.5	12.0	170
Significance	**	N.S.	**	*	*	**
B.L.S.D. (.05)	1.8		8	3.1	0.3	7

1/ - Seeding times in hours after anhydrous application.

EFFECTS OF DIFFERENT FERTILIZER PROGRAMS ON SOIL TEST LEVELS IN A CONTINUOUS WHEAT CROPPING SYSTEM

G.E. Varvel and R. K. Severson

The objective of this study was to measure the effect of different fertilizer programs over a 10-year period on soil test levels in a continuous wheat cropping system on a Wheatville loam soil. Measurements on a yearly basis will provide information for evaluation and determination of the most effective fertilizer program.

Experimental Procedure:
Five treatments in a randomized, complete block design with 4 replications were used. Each treatment was based upon soil test data from the plots on which that treatment had been applied in the previous year. All treatments were applied in the fall of 1980 and plowed down. Era wheat was planted April 8, 1981 and harvested Aug. 8, 1981. Whole plant samples taken July 16, 1981 at soft dough were used to determine forage yields and analyzed for nutrient content so that N, P and K uptake could be calculated. Soil samples taken August 18, 1981 were analyzed for N, P and K to determine the effects of the 1981 treatments and to establish the 1982 treatments.

Results:
The treatments caused no significant differences in grain yield (Table 1). All treatments which had fertilizer applied caused significantly higher protein, N removal, forage yield, and N, P, and K uptake values than were obtained with the check treatment (Table 1). Test weight of the grain was significantly reduced where fertilizer had been applied.

Table 1. The effect of various fertilizer programs on grain yield, test weight, protein, N removal, forage yield, and N, P, and K uptake of Era wheat.

Treatment			Grain				Forage			
				Test		N	T.D.M.	Uptake		
N	P_2O_5	K_2O	Yield	Weight	Protein	Removal	Yield	N	P	K
- - - lb/A - - -			Bu/A	lb/Bu	%	lb/A	- - - - - - - lb/A - - - - - -			
0	0	0	50.3	59.0	12.0	63.7	5720	76.9	11.4	67.8
50	0	20	54.7	56.1	13.5	77.9	7373	107.6	15.7	87.7
50	0	50	53.2	56.6	13.5	75.7	7273	103.2	14.3	94.1
60	0	20	54.0	55.9	14.0	79.5	7330	116.6	14.5	96.5
50	30	20	56.5	57.2	13.5	80.1	7334	107.7	17.0	98.2
Significance			N.S.	*	**	*	**	**	**	**
B.L.S.D. (.05)				2.4	0.4	13.2	973	15.4	3.1	17.3
C.V. (%)			9.9	2.5	2.2	10.2	8.7	9.9	13.0	12.2

Soil test results from the fall of 1981 sampling are shown in Tables 2 and 3. Table 2 contains NO_3-N levels at the various depths and total NO_3-N levels for the 0-2' and 0-5' depths. Significant differences in NO_3-N for the 0-1' and 1-2' depths and total NO_3-N for the 0-2' depth were obtained between the check and all the other treatments (Table 2).

Table 2. The effect of various fertilizer programs on NO_3-N soil test levels.

Treatment			NO_3-N					Total NO_3-N	
N	P_2O_5	K_2O	0-1'	1-2'	2-3'	3-4'	4-5'	0-2'	0-5'
- - - - lb/A - - - -			- - - - - - - lb/depth - - - - - - -					- - lb/A - -	
0	0	0	14	5	5	10	11	18	43
50	0	20	22	21	37	28	10	42	116
50	0	50	22	12	35	29	13	34	110
60	0	20	23	18	44	38	18	41	141
50	30	20	19	14	40	64	19	33	155
Significance			+	+	N.S.	N.S.	N.S.	*	N.S.
B.L.S.D. (.05)			8	14				15	
C.V. (%)			23.8	58.4	96.4	114.1	81.9	26.8	61.9

+,* - Indicates significance at the 10% and 5% levels respectively.

Table 3 contains pH, P and K soil test measurements for the 0-6" and 6-12" depths from the North Dakota State University soil testing laboratory and for the 0-6" depth from the University of Minnesota soil testing laboratory. Significant differences in $NaHCO_3$ P levels and Bray P-1 (50:1) levels were obtained between the fertilizer programs and the check. [3]No other differences were obtained.

Table 3. The effect of various fertilizer programs on pH, P and K soil test measurements.

Treatment			N.D.S.U.						U of M			
			pH		$NaHCO_3$ P		Exchangeable K		pH	Bray P-1		Exchangeable K
N	P_2O_5	K_2O	0-6"	6-12"	0-6"	6-12"	0-6"	6-12"	0-6"	10:1 0-6"	50:1 0-6"	0-6"
- - - - lb/A - - -					- - lb/A - - - - - - - - - -					- - - lb/A - - - - - - -		
0	0	0	8.3	8.4	6	4	226	188	7.9	3	18	247
50	0	20	8.2	8.3	11	8	245	199	8.0	5	26	253
50	0	50	8.2	8.4	10	7	243	199	8.0	5	27	253
60	0	20	8.2	8.3	11	5	233	183	7.9	7	27	244
50	30	20	8.2	8.3	14	9	228	189	7.9	11	31	242
Significance			N.S.	N.S.	**	**	N.S.	N.S.	N.S.	N.S.	**	N.S.
B.L.S.D. (.05)					4	3					5	
C.V. (%)			0.9	0.9	26.0	30.5	7.2	4.8	0.7	95.0	12.8	6.7

Nitrogen Fertilization and Nitrogen Utilization by Fourteen Small Grain Varieties -- Crookston, MN. - 1981*

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 1979 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 responsivesness 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 10th, utilizing a cone seeder.

Dry matter production was determined at approximately the "soft dough" stage of growth (July 17th) and samples collected for nitrogen content and calculation of nitrogen uptake. Yield grain was harvested August 4th 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 weighted, 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 1981 were excellent when considering the exceptionally dry conditions that were experienced early in the growing season. Grain yields ranged from 34-62 bu/A with the top yielding varieties including MN7125,MN7222, Butte, Olaf, and MN70170 R. Grain yields were substancially increased with the addition of 60#/A of fertilizer nitrogen, but were significantly reduced when the rate of nitrogen application was increased to 120 #N/A. Varieties reflecting the largest decrease included Kitt, Marquis, MN7125 and Waldron. Protein content of the grain was significantly increased by nitrogen fertilizer up through the highest rate of application (120#N/A). Waldron, Coteau, Olaf, WS1809 and Chris were among the varieties with the highest protein content while Era, MN7125, MN7222 and MN70170R were among the lower protein varieites. Total nitrogen removal by the crop was increased with nitrogen application but varied significantly between varieties with a significant N x Variety interaction. Olaf, Butte, MN7125, Waldron, and Kitt removed the highest total amount of nitrogen. These varieties were not necessarily the varieties with the highest nitrogen removal with the grain.

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

Table 1. Influence of nitrogen fertilzer and variety on yield, N content and test weight of 14 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	-	41.6	2.24	58.5	3.18	0.81
60		49.9	2.46	58.4	3.75	1.06
120		48.5	2.63	57.7	3.76	1.31
Significance		**	**	NS	**	**
BLSD (.05)		1.3	0.09	0.5	0.21	0.08
-	Coteau	44.9	2.74	59.9	3.63	0.97
-	WS 1809	45.2	2.63	56.5	3.16	1.20
-	Era	50.4	2.05	59.4	3.36	1.08
-	Mn 70170R	51.1	2.29	59.3	3.58	1.11
-	Chris	40.2	2.60	58.6	3.48	1.05
-	James	46.7	2.45	57.1	3.60	1.03
-	Waldron	43.9	2.76	57.4	3.83	0.94
-	Mn 7125	56.6	2.12	58.1	3.84	1.05
-	Butte	53.7	2.38	61.2	4.04	0.97
-	Olaf	51.1	2.69	58.9	3.74	1.12
-	Mn 7222	55.0	2.17	56.5	3.76	1.03
-	Thatcher	33.5	2.47	56.1	3.28	0.99
-	Marquis	32.3	2.42	58.4	3.26	1.10
-	Kitt	48.4	2.45	57.5	3.36	1.15
Significance		**	**	**	**	**
BLSD (.05)		3.9	0.11	1.0	0.25	0.14
0	Coteau	36.3	2.57	59.3	3.29	0.70
0	WS1809	39.4	2.40	56.7	2.79	0.92
0	Era	37.8	1.80	58.7	2.45	0.76
0	Mn70170R	45.5	2.00	59.9	3.15	0.78
0	Chris	34.7	2.44	58.4	3.02	0.84
0	James	41.4	2.21	57.6	3.08	0.80
0	Waldron	39.0	2.65	57.3	3.47	0.83
0	Mn7125	48.6	1.90	57.4	3.42	0.79
0	Butte	44.7	1.95	61.4	3.73	0.62
0	Olaf	46.8	2.62	59.7	3.46	0.91
0	Mn7222	52.3	1.94	59.1	3.29	0.76
0	Thatcher	38.1	2.44	56.7	3.15	0.83
0	Marquis	34.9	2.18	59.2	3.24	0.87
0	Kitt	43.6	2.23	58.1	3.05	0.93
60	Coteau	48.5	2.75	60.7	3.82	0.98
60	WS1809	47.1	2.67	56.4	3.52	1.21
60	Ear	57.0	2.02	59.7	3.82	1.16
60	Mn 70170R	54.2	2.29	59.9	3.76	1.15
60	Chris	42.5	2.48	59.0	3.70	1.06
60	James	49.1	2.50	57.7	3.88	1.05
60	Waldron	48.2	2.73	57.5	3.91	0.88
60	Mn 7125	62.8	2.13	59.0	4.01	1.04
60	Butte	59.2	2.52	61.0	4.07	1.07
60	Olaf	52.5	2.70	59.2	3.82	1.14
60	Mn 7222	57.0	2.26	55.5	3.95	0.97
60	Thatcher	32.6	2.48	56.2	3.43	0.97
60	Marquis	33.2	2.56	58.0	3.34	1.01
60	Kitt	54.3	2.45	57.9	3.51	1.12

"Table 1 continued on page after next"

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 Dry Matter	Harvest Straw N Content	Nitrogen Removal Forage	Nitrogen Removal Straw	Nitrogen Removal Grain	Grain a Straw
#/A		T/A	%	#/A			
0		1.90	0.30	51.9	11.6	48.0	59.7
60		2.33	0.46	73.3	21.4	63.3	84.8
120		2.29	0.61	98.1	27.7	66.0	93.7
Significance		*	**	**	**	**	**
BLSD (.05)		0.26	0.05	6.4	1.6	2.7	2.8
-	Coteau	2.30	0.39	71.6	18.5	64.4	82.9
-	WS 1809	1.83	0.46	76.8	17.1	62.0	79.1
-	Era	1.95	0.49	76.0	20.1	54.4	74.5
-	Mn 70170R	2.07	0.47	81.8	20.2	61.2	81.4
-	Chris	2.31	0.47	74.7	22.2	54.5	76.7
-	James	2.32	0.45	75.4	21.3	59.6	80.9
-	Waldron	2.36	0.44	73.5	20.9	63.1	84.0
-	Mn 7125	2.22	0.47	82.1	21.4	62.7	84.1
-	Butte	2.32	0.44	79.1	20.7	67.2	87.9
-	Olaf	2.42	0.44	84.6	21.6	71.4	93.0
-	Mn 7222	2.08	0.46	79.2	19.3	62.1	81.4
-	Thatcher	2.15	0.44	65.5	18.8	42.9	61.6
-	Marquis	2.09	0.49	71.3	20.1	40.5	60.6
-	Kitt	2.02	0.51	78.7	21.4	61.9	83.3
Significance		**	**	NS	*	**	**
BLSD (.05)		0.16	0.06	-	3.9	6.1	7.0
0	Coteau	1.90	0.29	46.3	11.0	48.2	59.1
0	WS 1809	1.54	0.31	52.2	9.5	48.9	58.5
0	Era	1.48	0.28	37.4	8.5	34.8	43.3
0	Mn 70170R	1.67	0.33	49.8	11.3	47.6	58.9
0	Chris	2.07	0.28	51.6	11.9	44.0	56.0
0	James	2.06	0.29	50.7	11.7	47.3	59.0
0	Waldron	2.12	0.32	58.8	13.5	53.7	67.2
0	Mn 7125	1.90	0.28	53.5	10.6	47.7	58.3
0	Butte	2.05	0.26	45.3	10.8	45.1	56.0
0	Olaf	2.12	0.35	63.4	14.8	64.0	78.8
0	Mn 7222	1.86	0.34	50.5	12.4	52.6	65.1
0	Thatcher	2.14	0.30	52.5	12.9	48.1	61.0
0	Marquis	2.09	0.30	56.3	12.7	39.5	52.3
0	Kitt	1.66	0.34	58.1	11.5	50.9	62.3
60	Coteau	2.49	0.37	75.6	18.4	69.1	87.5
60	WS 1809	1.97	0.45	84.8	17.5	65.0	82.5
60	Era	2.26	0.53	88.7	23.8	59.5	83.2
60	Mn 70170R	2.26	0.49	86.8	22.2	64.3	86.5
60	Chris	2.59	0.45	78.3	23.4	54.6	78.0
60	James	2.43	0.45	81.0	22.3	63.7	86.0
60	Waldron	2.42	0.45	68.8	21.5	68.9	90.4
60	Mn 7125	2.47	0.50	84.7	24.6	69.3	93.9
60	Butte	2.49	0.47	86.7	23.1	77.2	100.3
60	Olaf	2.49	0.39	87.1	19.1	73.5	92.6
60	Mn 7222	2.13	0.49	76.1	20.8	66.6	87.4
60	Thatcher	2.25	0.45	66.5	20.2	41.8	61.9
60	Marquis	2.14	0.48	66.5	20.6	44.0	64.7
60	Kitt	2.19	0.52	78.4	22.5	69.0	91.5

"Table 2 continued on next page"

Table 1. Influence of nitrogen fertilizer and variety on yield, N content and test weight of 14 red spring wheat varieties (con't)

Nitrogen Rate	Variety	Grain Yield	Grain N Content	Grain Test wt.	Forage Total Dry Matter	Forage N Content
#/A		bu/A	%	#/bu	T/A	%
120	Coteau	50.1	2.92	59.6	3.78	1.23
120	WS1809	49.3	2.83	56.4	3.19	1.46
120	Era	56.3	2.35	59.9	3.82	1.33
120	Mn 70170R	53.7	2.57	58.2	3.82	1.43
120	Chris	43.6	2.88	58.3	3.73	1.26
120	James	49.7	2.63	56.2	3.83	1.23
120	Waldron	44.4	2.90	57.4	4.11	1.13
120	Mn 7125	58.5	2.34	57.9	4.09	1.32
120	Butte	57.1	2.67	61.2	4.32	1.22
120	Olaf	53.9	2.74	57.9	3.95	1.31
120	Mn 7222	55.7	2.32	54.9	4.04	1.36
120	Thatcher	30.0	2.49	55.4	3.29	1.18
120	Marquis	28.8	2.53	57.9	3.20	1.42
120	Kitt	47.3	2.69	56.6	3.52	1.41
Significance		**	**	+	NS	NS
BLSD (.05)		9.1	0.28	2.4	-	-

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 varieites (con't)

Nitrogen Rate	Variety	Harvest Straw Dry Matter	Harvest Straw N Content	Nitrogen Removal Forage	Nitrogen Removal Straw	Nitrogen Removal Grain	Grain a Straw
#/A		T/A	%	#/A			
120	Coteau	2.51	0.52	92.9	26.0	76.0	102.0
120	WS 1809	1.99	0.61	93.3	24.3	71.9	96.2
120	Era	2.10	0.67	101.9	28.0	68.8	96.8
120	Mn 70170R	2.27	0.60	108.7	27.2	71.8	98.9
120	Chris	2.27	0.69	94.3	31.3	64.7	96.1
120	James	2.48	0.60	94.6	29.8	67.7	97.5
120	Waldron	2.54	0.55	92.8	27.9	66.7	94.6
120	Mn7125	2.29	0.64	108.1	29.2	71.0	100.2
120	Butte	2.41	0.59	105.2	28.3	79.2	107.5
120	Olaf	2.64	0.59	103.3	30.9	76.6	107.5
120	Mn 7222	2.26	0.55	110.3	24.8	67.1	91.8
120	Thatcher	2.06	0.57	77.4	23.2	38.7	61.9
120	Marquis	2.05	0.67	91.2	27.0	37.8	64.8
120	Kitt	2.22	0.68	99.7	30.2	65.9	96.1
Significance		*	NS	NS	NS	**	**
BLSD (.05)		0.43	-	-	-	13.3	14.9

TWENTY-TWO YEARS OF FIELD EXPERIMENTATION WITH NITROGEN SOURCE, PLACEMENT, AND TIME OF APPLICATION TO A WEBSTER LOAM NEAR LAMBERTON, MN

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

(Annual reports of this experiment have been reported in Soil Series 74 through 109 and some of this information will not be include here).

The fertilizer treatments have now been annually applied to the same plot area for 22 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 replication are arranged in a randomized block. Spring N treatments are broadcast before seedbed preparation late in April or early May. The corn is planted in 30 inch rows at a plant population of 20,000 plant/A, using a band starter fertilizer of 8-24-12 at a rate of 180 lbs/A over the entire experimental area, thus supplying an additional 14 #N/A to all the plots. Nitrogen sidedressing treatments were boradcast on June 20th. Nitrogen concentrations for the yield grain were determined and are reported along with plot yields in table 1. The yields obtained in 1981 were below average when considering the long term previous average for this experiment. Treatment averages in 1981 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 early in the growing season appeared to have a considerable influence on the results obtained.

Twenty-one 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 1981 experiment. The major yield differences that were obtained in 1981 were due to the rate of nitrogen fertilization. The twenty-one year average would suggest that when only 40 # of N/A was fall applied, urea was slightly better than ammonium nitrate with very little difference due to incorporation.

Plowing down 80 # 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 yields as with spring applications although ammonium nitrate applied in the fall was inferior to spring applications at the 40 # N/A rate of application.

Table 1. Average N in yield grain, grain yield at 15.5% moisture, and 21 year corn average from Webster loam fertilized annually with NH_4NO_3 or urea.

N applied annually lbs/A	Yield Grain % N	Yield Grain bu/A Rep I	Rep II	Rep III	Rep IV	Ave
Check	1.12	74.7	61.2	51.9	60.2	62.0
40-NH_4NO_3-fpd[2]	1.20	77.7	90.4	74.3	67.2	77.4
40-urea-fpd	1.22	65.5	97.1	73.2	112.1	87.0
40-NH_4NO_3 - fps[3]	1.22	101.8	87.9	70.6	97.4	89.4
40-urea - fps	1.20	83.2	73.4	77.2	88.1	80.5
80-NH_4NO_3 - fpd	1.38	85.0	77.0	95.9	100.6	89.6
80 - urea - fpd	1.38	93.7	101.8	100.9	111.0	101.8
160 - NH_4NO_3 - fpd	1.45	67.1	104.6	96.8	96.8	91.3
160 - urea - fpd	1.40	116.9	77.2	85.1	111.1	97.6
40 - NH_4NO_3-std[4]	1.15	102.8	87.5	74.5	95.1	90.0
40 - urea - std	1.12	97.5	94.4	68.3	86.0	86.6
80 - NH_4NO_3-std	1.28	101.6	104.3	102.9	96.9	101.4
80 - urea - std	1.30	91.1	97.7	96.8	125.8	102.8
40 - NH_4NO_3-sd[5]	1.22	72.2	77.1	87.5	97.6	83.6
40 - urea - sd	1.25	102.3	76.8	87.3	83.4	87.4
80 - NH_4NO_3-sd	1.38	65.5	95.3	68.6	87.7	79.3
80 - urea - sd	1.32	103.8	96.4	64.6	84.6	87.4
160 -NH_4NO_3-sd	1.45	105.5	75.9	93.6	111.9	96.7
Significance	**					*
BLSD (.05)	0.07					21.9

[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 21 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	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	*1/ 1977	1978	1979	1980	1981	21 yr Ave.
Check	85.7	40.8	75.6	69.2	53.4	58.3	141.2	64.6	37.6	46.5	65.8	63.1
40 NH_4NO_3-fpd[2]	96.3	88.7	113.6	92.0	80.5	88.6	145.1	98.1	63.1	67.6	77.4	81.0
40 Urea-fpd	120.4	100.7	113.9	101.5	96.9	96.6	165.2	110.2	76.7	65.2	87.0	87.6
40 NH_4NO_3-fps	122.5	81.5	109.9	93.0	88.3	78.2	149.4	101.3	64.6	69.7	89.4	83.8
40 Urea-fpd	121.2	82.4	106.7	97.8	85.0	78.9	156.8	101.4	80.2	63.8	80.5	86.5
80 NH_4NO_3-fpd	134.7	108.0	143.1	121.7	103.6	89.2	156.9	128.4	94.8	90.3	89.6	101.1
80 Urea -fpd	141.4	107.8	140.1	117.9	107.2	96.9	146.0	123.6	86.2	84.7	101.8	98.8
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	91.3	104.4
160 Urea-fpd	140.4	110.6	151.7	114.9	105.1	82.4	163.0	124.4	127.3	103.7	97.6	106.6
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	90.0	91.1
40 Urea-std	118.9	94.6	116.5	97.1	94.5	89.0	165.2	103.9	74.5	64.3	86.6	89.8
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	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	102.8	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	83.6	92.3
40 Urea-sd	117.1	100.5	133.9	103.9	80.4	92.6	165.4	104.8	94.2	80.4	87.4	91.9
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	79.3	95.4
80 Urea-sd	140.5	124.4	149.8	124.0	95.6	90.1	162.8	126.7	118.1	89.6	87.4	104.8
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	96.7	106.6
Ave. annual corn yield in bu/A	127.0	99.4	128.6	106.6	92.4	88.3	157.2	111.2	919	79.4	88.6	93.8
Significance											**	**
C.V. (%)											14.2	10.1
BLSD (.05)											21.9	5.2

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

*1/ 1976 No Yields Taken

NITRATE CORRELATION STUDY WITH CORN FOLLOWING CORN, SOYBEANS AND WHEAT - Lamberton, MN - 1981

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 in 1980 and again in 1981 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 were replicated four times in each experiment. The fertilizer was applied on April 28th and incorporated by field cultivator, corn (Pioneer 3732) was planted on April 29th at 24,000 seeds/A. A tank mix of Lasso (2 1/2 # ai/A) and Bladex (1 1/2 # ai/A) was used for weed control.

Yields were taken by combine and justed to 15.5% moisture, and a subsample taken for Kjeldahl nitrogen.

General Results

The climate experienced at Lamberton in 1981 was characterized by being extremely dry during the first part of the growing season with more than adequate precipitation later in the season. Considering these extremes corn grain yields were quite respectable. Added fertilizer nitrogen increased corn grain yields on corn following corn up through the 160 # N/A application. There was no yield response to the addition of nitrogen with corn following soybeans or corn following wheat. The grain yields on the corn following soybeans were comparable to the higher rates of nitrogen on the corn following corn. Yield levels on the corn following wheat area were considerably reduced suggesting that some other factor other than nitrogen limited full expression of the yield potential in 1981. Responses reflected the quantity of residual nitrate nitrogen as well as previous cropping history.

A new soil testing technique has been developed and implemented for use in Western Minnesota in making nitrogen fertilizer recommendations to corn. The recommendation is based on three major factors: 1) Residual nitrate nitrogen - samples are requested from a 0-2' depth or a 0-2' and 2-4' depths - corrections are made for positional availability of nitrate nitrogen (water utilization characteristics) 2) A credit for organic matter mineralization and 3) An adjustment for previous cropping history. This information is used to calculate a base yield, and the fertilizer N requirement is based on the difference between this value and the producers yield goal. This technique provided very good fertilizer nitrogen recommendations when used with the 1981 research information. Further details concerning this procedure will be forthcoming.

Table 1. Influence of nitrogen rates on yield grain content and grain yield on corn following corn, soybeans and wheat at Lamberton, MN - 1981

	Corn/Corn		Corn/Soybeans		Corn/Wheat	
Treatments	Grain N	Yield	Grain N	Yield	Grain N	Yield
#N/A	%	bu/A	%	bu/A	%	bu/A
Check	1.25	91.4	1.21	128.4	1.21	104.1
40	1.18	111.2	1.27	137.6	1.28	106.6
80	1.20	121.7	1.31	144.6	1.34	100.2
120	1.36	114.4	1.37	143.6	1.32	113.7
160	1.34	132.6	1.42	133.8	1.49	109.9
240	1.40	136.4	1.36	131.6	1.39	110.4
Significance	NS	**	*	NS	*	NS
BLSD (.05)	-	18.1	0.14	-	0.15	-

Table 2. 1980 Fall nitrates for corn, soybeans, and wheat plots

depth	corn	soybeans	wheat
ft	----------ppm----------		
0-1	2.5	4.8	11.4
1-2	0.9	1.9	4.0
2-3	0.9	2.0	5.5
3-4	1.9	3.8	9.7
4-5	2.5	4.7	11.1

WEST CENTRAL EXPERIMENT STATION - MORRIS

WEATHER SUMMARY - 1981

Month	Period	Precipitation 1981	Precipitation 94-yr. av.	Precipitation Dev. from av.	Air Temperature 1981	Air Temperature 94-yr. av.	Air Temperature Dev. from av.	Soil (10 cm) Temperature 1981	Soil (10 cm) Temperature 10-yr.av.
January	1-31	.23	.68	- .45	12.9	8.0	+4.9	18.1	20.7
February	1-28	1.43	.67	+ .76	19.9	12.6	+7.3	21.2	23.9
March	1-31	.67	1.09	- .42	35.0	26.7	+8.4	36.9	29.2
April	1-10	.57	.58	- .01	45.3	37.9	+7.4	43.5	
	11-20	.10	.65	- .55	47.1	44.4	+2.7	48.6	
	21-31	1.11	1.08	+ .03	49.7	48.2	+1.5	51.1	
Total or av.		1.78	2.31	- .53	47.4	43.5	+3.9	46.1	41.4
May	1-10	.25	.78	- .53	51.4	51.9	-0.5	55.7	
	11-20	T	.95	- .95	53.6	55.8	-2.2	60.8	
	21-31	1.69	1.25	+ .44	59.3	60.1	-0.8	61.9	
Total or av.		1.94	2.98	-1.04	55.0	56.1	-1.1	59.5	57.1
June	1-10	1.91	1.26	+ .65	64.4	63.1	+1.3	67.1	
	11-20	3.76	1.27	+2.49	61.7	66.5	-4.8	66.6	
	21-30	1.01	1.38	- .37	64.0	68.2	-4.2	67.9	
Total or av.		6.68	3.91	+2.77	63.4	66.0	-2.5	67.2	69.3
July	1-10	T	1.48	-1.48	72.4	70.0	+2.4	81.0	
	11-20	3.64	1.03	+2.61	72.1	71.3	+0.8	77.1	
	21-31	.12	1.03	- .91	66.0	71.5	-5.5	74.2	
Total or av.		3.76	3.54	+ .23	70.1	71.0	-0.9	77.3	76.7
August	1-10	1.30	1.05	+ .25	71.2	70.3	+0.9	77.5	
	11-20	.15	.90	- .75	66.4	69.2	-2.8	76.3	
	21-31	1.22	.98	+ .24	66.1	66.9	-0.8	70.1	
Total or av.		2.67	2.93	- .26	67.8	68.7	-0.9	74.5	73.9
September	1-30	.54	2.19	-1.65	58.5	59.1	-0.6	63.2	61.5
October	1-31	3.28	1.62	+1.66	44.2	47.3	-3.1	44.2	47.8
November	1-30	.64	.96	- .32	36.0	29.7	+6.3	37.1	33.6
December	1-31	.56	.68	- .12	12.1	15.5	-3.4	29.0	23.4
April-August Growing Season		16.83	15.67	+1.16	60.7	61.1	-0.4	64.9	63.8
January-December Annual		24.18	23.56	+ .62	43.8	42.0	+1.8	48.1	46.7

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, 107 and 109. The last manure applications were 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 28, 1981. 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 and zinc as $ZnSO_4$ were applied to the fertilized plots to provide 125 lbs/acre of N and 12 lbs/acre of Zinc, respectively, on October 30, 1980. Lasso (2.5 lbs/acre) and Bladex (2.2 lbs/acre) were broadcast on April 29, 1981. Atrazine (1.5 lbs/acre) and booster concentrate (1 qt/acre) were applied June 5, 1981.

II. Soil Sampling and Analysis

A. 1980 Measurements

NO_3-N was the only variable measured in the fall of 1980. The values shown in Table 1 indicate very little change from those values one year earlier.

B. 1981 Measurements

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

III. Plant Tissue Analysis (Table 2)

There were significant effects on all elements except copper. There were some significant effects of solid beef manure on increasing leaf levels of P, K and Fe and decreasing leaf levels of Ca, Mg and Zn as compared to the fertilized check. The effects of liquid beef manure were similar with most elements.

IV. Growth and Yield Measurements (Table 3)

A. Early plant height and dry matter - Plants on the manure treated plots were taller (except for LB1) and weighed more than on the fertilized check.

B. Grain - In no cases were there significant differences in yield or grain N content between manure treated and fertilized plots. There were significant differences in grain moisture, but there were no clear trends.

C. Silage - Some manure treated plots were significantly wetter than the fertilized check. There were no significant differences in yield between the manure treated and fertilized plots. The ear:stalk ratios were not significantly affected by treatment.

V. Summary

The 1981 cropping season was the third 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. Effect of two types of beef cattle manure and commercial fertilizer on the NO_3-N level of a Tara soil profile - Fall 1980.

Depth - ft -	Treatment CK	FE	SB1	SB2	SB3	LB1	LB2	LB3
	- NO_3-N, ppm -							
0-1	8.3	13.9	28.5	33.7	98.0	11.2	14.4	63.6
1-2	1.4	77.8	23.6	127.3	158.7	33.9	52.0	136.4
2-3	2.4	70.0	78.7	148.9	178.7	52.4	47.9	130.0
3-4	5.9	48.1	53.3	127.0	149.3	35.4	51.9	129.0

Table 2. Summary of analysis of corn leaves at silking - 1981.

Treatment	N	P	K	Ca	Mg	Fe	Zn	Cu	Mn	B
	%					ppm				
CK	2.44	.26	1.17	.42	.50	80	17.1	2.2	74	4.6
FE	2.71	.25	1.41	.47	.46	82	21.8	2.2	100	4.1
SB1	2.82	.37	2.04	.46	.30	92	13.9	2.7	100	4.2
SB2	2.96	.54	2.45	.39	.22	99	16.9	2.0	74	3.6
SB3	2.78	.55	2.62	.35	.21	93	19.0	1.9	62	3.5
LB1	2.67	.30	1.57	.46	.41	81	15.4	2.7	90	4.1
LB2	2.79	.34	1.92	.43	.36	88	15.1	3.1	91	4.0
LB3	2.86	.48	2.08	.46	.31	104	12.4	2.1	87	4.0
Significance	**	**	**	**	**	**	**	NS	*	**
BLSD(.05)	0.24	.07	.23	.05	.03	8	2.8	--	8	0.7
CV(%)	4.6	10.9	7.6	6.5	6.3	5.5	10.1	23.6	4.9	10.6

Table 3. Summary of plant measurements - 1981.

Treatment	Early plant height inches	Early plants (10) dry weight grams	Grain: Moisture at harvest %	Grain: Yield @ 15.5% M Bu/A	Grain: Nitrogen %	Silage: Dry matter at harvest %	Silage: Silage yield (D.M.) lbs/A	Silage: Ear wt. ÷ Silage wt. %
CK	23.0	47.0	23.1	94.8	1.10	48.2	9033	58.7
FE	23.8	57.7	22.4	133.1	1.41	46.0	12300	59.0
SB1	30.5	123.7	19.9	135.6	1.32	51.7	14297	59.4
SB2	31.5	130.7	18.9	125.7	1.51	50.8	13020	59.8
SB3	31.7	129.5	20.0	142.3	1.48	45.0	14242	59.4
LB1	24.4	71.3	21.1	131.6	1.38	52.6	13783	59.8
LB2	28.6	98.4	19.4	132.1	1.42	52.6	13777	59.1
LB3	30.8	117.9	19.7	136.7	1.47	50.2	14434	58.7
Significance	**	**	**	**	*	**	**	NS
BLSD(.05)	1.8	15.9	0.8	19.3	0.24	4.3	2744	--
CV(%)	4.0	10.1	2.8	8.3	8.8	4.7	11.2	2.3

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 from previous years are given in Soil Series 88, 89, 91, 95, 97, 99, 103, 105, 107 and 109. 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 28, 1981. Counter at 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 and zinc as $ZnSO_4$ were applied to the fertilized plots to provide 125 lbs/acre of N and 12 lbs/acre of zinc, respectively, on October 30, 1980. Lasso (2.5 lbs/acre) and Bladex (2.2 lbs/acre) were applied broadcast on April 29, 1981. Atrazine (1.5 lbs/acre) and booster concentrate (1 qt/acre) were applied on June 5, 1981.

II. Soil Sampling and Analysis

A. 1980 Measurements

NO_3-N was the only variable measured in the fall of 1980. The values shown in Table 1 indicate that levels in most soil zones changed little in the past year. The only exception was a substantial increase in the 3- to 4-foot increment of SB.

B. 1981 Measurements

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

III. Plant Tissue Analysis

The nutrient concentrations in the ear leaves at silking in 1981 are given in Table 2. There were significant effects on most elements. The concentrations of P and K were higher in all manure treatments than in the fertilized treatment. There were significant differences between at least one manure treatment and the fertilized treatment for N, Ca, Mg, Zn, Cu and B.

IV. Growth and Yield Measurements (Table 3)

A. Early plant height and dry matter - Plants on the manure treated plots were taller than those on the fertilized treatment. Dry matter differences were not significant.

B. Grain - There were no significant differences in grain yield or grain N content between the manure treatments and the fertilized treatment.

C. Silage - There were no significant differences between the manure treatments and the fertilized treatment in silage yield, but there were minor differences in the ear:stalk ratio.

V. Summary

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

Table 1. Effect of high rates of manure and commercial fertilizer ten years (fall 1980) after application on the NO_3-N level of a Tara soil profile.

Depth - ft -	Treatment CK	FE	SB	LB	LH
	- NO_3-N, ppm -				
0-1	5.9	10.3	14.9	16.4	6.6
1-2	4.8	31.6	26.9	85.3	11.4
2-3	0.6	48.1	79.7	131.3	45.0
3-4	1.1	34.5	95.7	130.3	47.7

Table 2. Summary of analysis of corn leaves at silking - 1981.

Treatment	N	P	K	Ca	Mg	Fe	Zn	Cu	Mn	B
	%					ppm				
CK	2.01	.21	0.96	.48	.53	76	16.4	2.4	88	5.6
FE	2.70	.28	1.33	.51	.51	88	21.1	2.1	85	4.4
SB	2.68	.38	2.08	.43	.25	90	15.2	3.2	84	3.8
LB	2.69	.43	1.90	.51	.28	97	13.0	2.4	74	4.1
LH	2.35	.34	1.82	.46	.33	85	20.3	3.8	76	4.3
Significance	**	**	**	*	**	*	**	*	NS	**
BLSD(.05)	0.32	.05	0.25	.06	.05	11	3.7	0.8	--	0.4
CV(%)	5.7	9.0	8.6	6.6	6.7	7.3	13.0	17.7	16.9	5.2

Table 3. Summary of plant measurements - 1981.

Treatment	Early plant height inches	Early plants (10) dry wt. grams	Grain: Ear moisture at harvest %	Grain: Yield @ 15.5% M. Bu/A	Grain: Nitrogen %	Silage: Dry matter at harvest %	Silage: Silage yield (D.M.) lb/A	Silage: Ear wt. ÷ silage wt. %
CK	18.4	59.5	22.8	67.2	0.92	49.8	8315	53.6
FE	24.1	82.9	20.3	115.6	1.35	48.7	13032	59.2
SB	31.2	90.5	19.5	114.6	1.37	53.5	13483	59.9
LB	32.0	108.0	19.7	115.0	1.31	52.8	12958	60.1
LH	27.9	78.2	20.0	107.0	1.34	53.2	13151	61.6
Significance	**	NS	**	**	*	*	**	**
BLSD(.05)	1.6	--	1.2	36.8	0.29	2.9	814	1.9
CV(%)	3.3	44.8	3.2	6.2	9.6	2.9	3.8	1.8

NITROGEN FERTILIZATION AND NITROGEN UTILIZATION BY EIGHT SMALL GRAIN VARIETIES - MORRIS, MN - 1981

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

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. These short statured varieties not only provided improved physical characteristics, but also provide the potential for a system which might be capable of responding to higher rates of nitrogen application without lodging. The difference that exist between wheat varieties in their ability to utilize soil and fertilizer nitrogen is not well understood. A portion of the differences which exist 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 overall protein content of the grain. Trials were established in 1979 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 trails were conducted at Crookston as well as Morris, MN.

Experimental Procedure

Eight varieties of hard red spring wheat were compared at nitrogen application rates of 0, 60 and 120 # N/A at the West Central Experiment Station at Morris, MN. 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 10th, utilizing a cone seeder.

Total plant dry matter was measured at approximately the "soft dough" stage of growth (July 9th) for the earlier maturing varieties and (July 16th) for the later maturing varieties. Samples were collected for nitrogen content and calculation of nitrogen uptake. Yield grain was harvested on July 27th for the early maturing varieties and July 29th for the later maturing varieties by harvesting 16 ft^2 of the plot area. The above ground growth (straw and 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 weights were determined by difference. Samples of straw and grain were collected and analyzed for nitrogen content and determination of nitrogen removal.

General Results

Wheat grain yields were significantly influenced both by rate of nitrogen application and variety. In general response was limited to the first 60 # N/A application although some varieties such as Coteau provide modest increases upto the 120 # N/A rate of application. Varieties when averaged across nitrogen rates provided a range of 34-47 bu/A, with MN7222, Era and MN70170R among the top yielding varieties. These same varieties were among the highest yielding reguardless of nitrogen rate. The protein content of the grain was not influence by N rate, but was influenced by variety with MN70170R having the highest protein content among the highest yielding varieties. Total nitrogen removal was influenced both by rate of N fertilization and variety. In general as nitrogen rate increased so did total nitrogen uptake. The quantity of nitrogen translocated into the grain also increased but at a much slower rate than grain nitrogen removal suggesting that a large portion of the nitrogen taken up remained in the straw. When averaged over nitrogen rate there was very little difference between varieties in their ability to accumulate nitrogen in the grain. When evaluating varieties within nitrogen rates, the varieties did show some differences. At low (check) nitrogen levels MN7222 was able to acculate a larger proportion of its total N uptake

in the grain, while at the higer nitrogen rates (120 # N/A) Coteau and Waldron exhibited the greatest ability to translocate its nitrogen into the grain. Further research is needed in this area to assist in developing varieties which are both effective in nitrogen uptake and efficient in translocation into the grain.

Table 1. Influence of nitrogen fertilizeration and variety on yield, N content and test weight, of eight spring wehat 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	-	29.6	2.55	58.2	2.45	1.03
60	-	45.0	2.59	58.0	3.40	1.16
120	-	46.2	2.64	56.6	3.59	1.28
Significance		**	NS	*	**	**
BLSD(.05)		4.2	-	1.3	0.36	0.08
-	Coteau	38.8	3.00	59.2	3.28	1.18
-	WS1809	33.6	2.67	55.6	3.33	1.36
-	Era	44.8	2.29	58.8	3.30	1.08
-	Mn70170R	43.8	2.52	57.8	3.24	1.17
-	Chris	34.6	2.71	57.9	3.44	1.08
-	James	42.7	2.51	58.0	3.37	1.17
-	Waldron	37.0	2.80	57.8	3.12	1.10
-	MN7222	46.6	2.24	56.0	3.10	1.14
Significance		**	**	**	**	**
BLSD(.05)		3.7	0.09	1.1	0.22	0.09
0	Coteau	25.7	2.81	59.1	2.35	1.16
0	WS1809	24.7	2.58	57.9	1.84	1.09
0	Era	34.2	2.18	59.5	2.61	1.00
0	MN70170R	34.2	2.62	57.6	2.67	0.99
0	Chris	27.1	2.52	57.8	2.77	1.11
0	James	32.6	2.57	58.3	2.75	1.04
0	Waldron	23.0	2.86	58.2	2.37	0.89
0	MN7222	35.2	2.26	57.1	2.24	0.96
60	Coteau	42.9	3.09	58.9	3.68	1.24
60	WS1809	37.9	2.76	55.2	2.52	1.37
60	Era	51.2	2.33	60.1	3.55	1.04
60	MN70170R	48.5	2.33	58.8	3.46	1.20
60	Chris	37.6	2.86	59.2	3.58	1.04
60	James	47.7	2.39	58.8	3.51	1.16
60	Waldron	41.5	2.79	58.2	3.43	1.22
60	MN7222	52.3	2.19	55.1	3.47	1.06
120	Coteau	47.7	3.10	59.6	3.80	1.15
120	WS1809	38.3	2.68	53.7	2.62	1.61
120	Era	49.1	2.37	57.0	3.75	1.21
120	MN70170R	48.7	2.61	57.1	3.60	1.33
120	Chris	39.2	2.76	57.7	3.99	1.09
120	James	47.9	2.57	56.8	3.85	1.30
120	Waldron	46.4	2.78	57.1	3.56	1.18
120	MN7222	52.5	2.29	54.7	3.58	1.40
Significance		NS	**	+	NS	**
BLSD(.05)		-	0.18	2.4	-	0.18

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

Nitrogen Rate	Variety	Harvest Dry Matter	Straw N Content	Nitrogen Removal Forage	straw	Grain	Grain + straw
#/A		T/A	%	#/A			
0	-	1.24	0.36	50.8	8.6	38.6	47.2
60	-	2.05	0.42	78.7	17.2	59.7	76.9
120	-	2.40	0.60	91.1	28.5	63.2	91.7
Significance		**	**	**	**	**	**
BLSD(.05)		0.20	0.10	8.5	4.4	5.4	8.1
-	Coteau	2.12	0.40	78.1	17.9	60.9	78.8
-	WS1809	1.39	0.59	64.3	17.3	46.9	64.2
-	Era	1.93	0.47	72.5	19.2	53.6	72.8
-	Mn70170R	1.87	0.49	77.3	19.3	57.0	76.2
-	Chris	2.09	0.42	74.6	18.6	48.9	65.6
-	James	2.12	0.48	79.5	20.5	55.5	75.8
-	Waldron	1.93	0.40	69.9	16.1	53.8	70.0
-	MN7222	1.72	0.44	72.2	16.0	54.3	70.4
Significance		**	**	**	+	**	**
BLSD(.05)		0.13	0.06	9.1	9.1	5.9	7.5
0	Coteau	1.33	0.33	56.3	8.8	37.6	46.4
0	WS1809	0.79	0.50	40.1	8.0	33.0	41.0
0	Era	1.29	0.35	52.6	8.8	38.5	47.3
0	MN70170R	1.28	0.36	53.9	9.1	46.4	55.5
0	Chris	1.32	0.28	62.4	7.5	35.3	42.8
0	James	1.45	0.44	56.6	11.6	42.8	54.5
0	Waldron	1.27	0.34	41.5	8.4	34.4	42.8
0	MN7222	1.15	0.28	43.2	6.5	41.4	47.6
60	Coteau	2.39	0.39	91.0	18.5	68.4	86.9
60	WS1809	1.54	0.53	68.6	16.5	54.4	70.8
60	Era	2.08	0.44	74.1	18.3	62.0	80.3
60	MN70170R	1.94	0.43	82.8	16.7	58.6	75.3
60	Chris	2.25	0.40	74.7	17.9	55.3	73.2
60	James	2.28	0.41	81.5	18.4	59.5	77.9
60	Waldron	2.08	0.38	83.7	15.9	60.0	75.9
60	MN7222	1.85	0.43	72.9	15.7	59.4	75.0
120	Coteau	2.65	0.49	87.0	26.4	76.7	103.0
120	WS1809	1.84	0.74	84.2	27.4	53.3	80.7
120	Era	2.42	0.63	90.9	30.7	60.2	90.9
120	MN70170R	2.39	0.67	95.3	31.9	65.9	97.8
120	Chris	2.68	0.57	86.6	30.5	56.2	86.7
120	James	2.62	0.60	100.4	31.4	63.8	95.1
120	Waldron	2.45	0.49	84.4	24.1	67.1	91.2
120	MN7222	2.16	0.60	100.4	25.9	62.5	88.4
Significance		NS	NS	+	NS	NS	NS
BLSD(.05)		-	-	15.9	-	-	-

EFFECTS OF NITROGEN AND PHOSPHORUS APPLICATION METHODS ON SPRING WHEAT - 1981

West Central Experiment Station - Morris

S. D. Evans

The objective of this study was to compare nitrogen and phosphorus application methods on spring wheat. The study was initiated to determine if dual banding of dry forms of nitrogen and phosphorus is more effective than broadcast or drill applications on spring wheat growth and yield.

Experimental Procedures

Treatments used are given in Table 1. The experimental area had been in oats in 1980. In September the area was chisel plowed. The fall treatments were applied on November 5-6, 1980. Rates were calculated to give equal final rates of N and P. Materials used were urea (46-0-0) and triple superphosphate (0-46-0). The materials were mixed and applied with an air seeder as described in Table 1.

Era wheat was seeded April 7 and harvested August 7 with a plot combine. Whole plant samples were collected on July 17 and were used to calculate forage yield and N and P uptake.

Soil test results for the area were: pH = 7.7-8.2, NO_3-N (0-2') = 21 lb/A, Bray exchangeable P = 16 lb/A, extractable K = 219. The soil type was a complex of Tara and McIntosh silt loams.

Results and Discussion

The results from this study are shown in Table 1. The dry matter yield was increased significantly by nitrogen application, but there was no significant effect of placement or the combination of N and P. Phosphorus uptake was higher where N and P were applied together than where N only was applied. Nitrogen uptake was closely related to N rate applied. The highest % N and N uptake occurred with the drill application of 70 N + 40 P_2O_5 and this treatment was significantly different from the same N and P rates surface broadcast or deep banded.

Grain yields were also related largely to N application rate. There was a significant difference in yield between the check treatment and the 40 lb/A N rate and between the 40 lb/A N rate and the 80 lb/A N rate. In no case were there significant differences in yields between placement methods. There appeared to be a phosphorus response at the higher N rate. Grain protein was not significantly affected by treatment.

Table 1. The effect of N and P application methods on spring wheat.

	Whole Plants @ Soft Dough Stage					Lodging Score		
Treatment Description[1]	D.M. Yield	Phosphorus	Phosphorus Uptake	Nitrogen	Nitrogen Uptake	at Harvest[3]	Grain Yield	Grain Protein
	lb/A	%	lb/A	%	lb/A		Bu/A	%
Check	4324	.200	8.58	1.15	47.8	2.0	33.7	12.0
35 N + 40 P_2O_5, Surface BCST	5674	.199	11.24	1.07	62.6	3.2	44.1	12.1
70 N + 40 P_2O_5, Surface BCST	7198	.172	12.34	0.98	70.7	4.5	57.2	12.7
35 N + 40 P_2O_5, Deep Band[2] (12" Spacing)	5234	.192	10.02	1.06	56.0	2.8	47.9	11.4
70 N + 40 P_2O_5, Deep Band (12" Spacing)	6722	.162	10.76	0.95	63.6	3.8	55.1	12.0
25 N, Surface BCST + 10 N and 40 P_2O_5 with Drill	6373	.156	10.04	0.91	59.8	3.8	47.5	12.2
60 N, Surface BCST + 10 N and 40 P_2O_5 with Drill	7415	.182	13.29	1.27	93.2	5.8	60.8	13.0
35 N, Deep Band (12" Spacing)	5404	.158	8.62	1.00	54.4	2.8	44.9	11.7
70 N, Deep Band (12" Spacing)	6410	.152	9.81	1.07	69.1	3.8	47.7	11.7
40 P_2O_5, Deep Band (12" Spacing)	3886	.182	7.07	0.96	37.0	1.5	31.4	12.4
Significance:	**	NS	*	NS	*	**	**	NS
BLSD (.05):	1442	-	4.26	-	29.0	2.3	11.5	-
CV (%)	16.9	20.0	23.7	24.2	28.5	37.5	16.8	9.1

[1] All material except drill applications were made on Nov. 5-6, 1980. All plots were chisel plowed during or after fertilizer application.

[2] Deep bands applied with Wil-Rich Air Seeder with chisel points, depth 8-10".

[3] Lodging score: 1 = No lodging, 9 = Flat.

EFFECTS OF NITROGEN AND PHOSPHORUS APPLICATION METHODS ON CORN - 1981

West Central Experiment Station - Morris

S. D. Evans and G. L. Malzer

The objective of this study was to compare nitrogen and phosphorus application methods on corn. The study was initiated to determine if dual banding of dry forms of nitrogen and phosphorus is more effective than broadcast applications on corn growth and yield.

Experimental Procedures

Treatments used are given in Table 1. The experimental area had been in oats in 1980. Soil test results in August 1980 were: pH = 6.6-7.8, Bray exchangeable P = 14*-32 lb/A, extractable K = 296-416 lb/A. A fertilizer application consisting of 110 lb/A of P_2O_5 and 70 lb/A of K_2O was broadcast on September 10, 1980. The entire area was chisel plowed on September 18. The fall treatments were applied November 5-6, 1980. The deep bander was pulled thru the check and surface broadcast so that all plots had the same tillage.

The area was dug with a field cultivator keeping the tillage depth above the fall applied bands. The area was drug and planted to corn (Pioneer 3906) @ 22,000 seeds/acre on May 5. Ear leaf samples at silking were collected on July 24. Silage yields with ears and stover being separated were taken on September 16. Grain yields were taken with a plot combine on October 19.

Results and Discussion

The results of the study are shown in Table 1. The silage and grain yields were not significantly affected by treatment. There was some apparent N response in grain yield with the 35-lb N rate generally yielding more than the check and the 70-lb N rate yielding more than the 35-lb N rate.

Ear leaf N concentrations were significantly affected by treatment. However the only significant differences are between those plots receiving no nitrogen and those receiving 70 lb/A of nitrogen. Ear leaf P concentrations were not significantly different.

The only significant variable measured in the stover was percent N. The deep band treatments with N and P appeared to have lower values than the same N levels without P. There were no consistent effects of N rates.

Grain analysis showed significant effects on percent N and N uptake. The treatments with no N were significantly lower than all other treatments. At the 35-lb N rate surface broadcast was significantly higher than deep band but at the 70-lb N rate the percent N values were identical. There appeared to be little effect on the P. The N uptake figures show a significant effect of N rates but no effect of placement or P. The percent P and P uptake figures show no effect of treatment.

Table 1. Effect of N and P application methods on corn.

N[1] Rate	P_2O_5[1] Rate	Placement Method[2]	Ear Leaf Analysis at Silking N	Ear Leaf Analysis at Silking P	Stover N	Stover N Uptake	Stover P	Stover P Uptake	Grain N	Grain N Uptake	Grain P	Grain P Uptake	Silage Yield	Grain Yield
lb/A	lb/A	-	%	%	%	lb/A	%	lb/A	%	lb/A	%	lb/A	T DM/A	Bu/A
0	0	-	2.57	.29	.44	20.2	.057	2.7	1.18	89.4	.28	20.8	6.09	112.6
35	40	SB	2.79	.28	.54	27.4	.062	3.1	1.37	111.4	.27	21.8	6.56	110.8
70	40	SB	3.09	.30	.58	27.2	.058	2.7	1.49	122.8	.27	22.0	6.47	127.6
35	40	DB	2.65	.30	.49	23.1	.060	2.9	1.21	100.6	.28	22.9	6.53	124.4
70	40	DB	2.94	.30	.49	25.0	.050	2.6	1.40	118.9	.27	22.6	6.80	128.0
35	0	DB	2.85	.30	.61	28.0	.078	3.3	1.34	105.4	.25	19.6	6.22	121.6
70	0	DB	2.97	.28	.58	31.5	.054	2.9	1.37	124.4	.25	23.2	7.26	132.3
0	40	DB	2.58	.28	.48	23.9	.071	3.4	1.27	96.3	.26	19.5	6.28	113.4
Significance			**	NS	+	NS	NS	NS	**	*	NS	NS	NS	NS
BLSD (.05)			.30	-	-	-	-	-	.08	21.5	-	-	-	-
CV (%)			5.7	4.8	13.2	20.0	30.8	21.5	3.5	10.3	7.8	8.1	10.4	8.0

[1] N Source - Urea (46-0-0), P_2O_5 Source - Triple superphosphate (0-46-0).

[2] SB = Surface broadcast, DB = Deep bands on a 12-inch spacing with Wil-Rich Air Seeder with chisel points at a depth of 8-10 inches.

EFFECT OF FERTILIZER ON CORN GRAIN YIELD AND N CONTENT OF THE EAR LEAVES

West Central Experiment Station - Morris

S. D. Evans, A. C. Caldwell, and Greg Buzicky

Plot areas were established in the fall of 1972 on a Doland silt loam at the West Central Experiment Station to study the effect of fertilizer treatments on corn yield and nutrient content and on chemical elements added to soils. Reported below are some of the observations during the nine years of the experiment.

A 95-day hybrid was planted each year at about 22,000 seeds/A during the first three weeks in May. Corn rootworm and weed control chemicals were used. A starter fertilizer (6-24-24) was applied along the row at 143 lb/A at planting time. Nitrogen in addition to the starter was applied broadcast as urea, at the times indicated in Table 1. An organic source of N was applied as soybean oil meal, which supplied some P and K as well. The 80-lb rate of meal supplied 8 and 25 lb/A of P and K, respectively; the 120-lb rate of meal, 12 and 39 lb/A of P and K, respectively. An overall application of 100 lb/A of P_2O_5 and 100 lb/A of K_2O was made in the spring of 1981. All materials were incorporated soon after application. The treatments were replicated 4 times.

Grain yield was determined on mature corn. Sixth corn leaf samples were collected for analysis at silking.

Corn Grain Yield

Yields for each of the nine years and the average are given in Table 1. Significant yield differences occurred in 1974, 1979, 1980, and 1981. In no case was more than 80 lb N/A needed for maximum yield. In fact, in some years lesser amounts of N were adequate--1976 - 40 lb/A, 1977 - starter only, and 1978 - 40 lb/A. The nine-year average shows maximum yield at 80 lb N/A.

In most years there was little difference between fall and spring applications of N. In 1975 and 1978 some fall treatments yielded slightly more than corresponding spring treatments. The nine-year average shows no difference between fall and spring applications.

Treatments receiving the organic N source, soybean oil meal, were not significantly different from the corresponding urea treatments 4 and 5. However, there was some year-to-year variation. In 1973 the 80-lb organic treatment was lower yielding than the 80-lb urea treatment, possibly due to inadequate mineralization. In 1975 the 120-lb organic treatment yielded more than the 120-lb urea treatment and in 1979 the 80-lb organic treatment yielded more than the 80-lb urea treatment. The nine-year average again shows no difference between organic and urea N sources.

The extra 30 lb P/A (treatment 12) did not yield significantly better than treatment 4, but in 1976 the yield difference was 11.3 bu/A. There was no significant effect on the nine-year average. Soil test in the fall of 1980 showed Bray exchangeable P levels averaging 13 on treatment 4 and 43 on treatment 12. For this reason additional P was applied in the spring of 1981.

Results of the first nine years of this trial show that (1) 80 lb N/A were needed for maximum yield, (2) there was no difference between fall and spring urea applications, (3) there was no difference between urea and soybean oil meal as N sources, and (4) the amount of P supplied in the starter was adequate, but soil test levels had decreased to 13 lb/A.

N Content of Sixth Leaf

All the values for ear leaf N are given in Table 2. Significant differences occurred in all years except 1977. There was considerable year-to-year variation in N contents within a specific treatment. For example, the 80-lb spring applied urea (treatment 4) varied from a low of 2.53% in 1973 to a high of 3.37% in 1974. In all years there was an increase in the leaf N content as urea rates increased to the 120-lb rate, even though yields reached a maximum at the 80-lb rate. In 1973, 1975, 1976, and 1979 treatments 1 and 2 (starter only) had values in the deficient range (<2.45% N). The 40-lb urea treatment had N contents in the deficient range in 1973 and 1979, in the low range (2.46-2.75%) in 1975 and 1976, and in the sufficient range (2.76-3.50%) in 1974, 1977, 1978, 1979, and 1980. In all years except 1974 and 1976, leaf N levels were a good indicator of the adequacy of N for maximum

yields. In 1974 all N levels were high even though it took 80 lb N/A for maximum yields. In 1976 yields were very low due to the extreme drouth and maximum yield was at the 40-lb N/A rate.

Soil NO_3-N Content

A summary of the fall soil NO_3-N levels are given in Table 3. In general the NO_3-N levels are related to the N applied. With 80, 120, and 160 lb N/A there was a large increase in soil NO_3-N in 1973 and 1974. In the fall of 1975 levels in all treatments dropped drastically. This was probably due to the high yield in 1975 (Table 1) and the high precipitation from June thru August (Table 4). Samples were taken to a depth of 8 feet in 1974 and 1975 and a comparison of these values shows that considerable NO_3-N moved below the 8-foot depth. With the poor crop in 1976, levels again increased and the evidence of this increase was still present in the samples taken in the fall of 1978. Since 1978 soil NO_3-N levels in the 0, 40, and 80 lb/A N rates have not changed much. With the 120 lb/A N rate there has been an increase in the 0-2 foot zone but a decrease in the NO_3-N in the total 4-foot profile. With the 160 lb/A N rate there has been a considerable buildup down to the 4-foot depth.

Table 1. Effect of fertilizer treatments on corn grain yield.

Fertilizer Treatments				Grain Yield									
		In addition to starter											9-year
No.		N[2]	P	1973	1974	1975	1976	1977	1978	1979	1980	1981	average
		— lb/A —		— bu/A —									
1	Starter[1]	0	0	112.5	77.3	99.4	19.9	101.8	117.9	79.6	67.4	87.6	84.8
2	"	0	0	116.3	70.7	104.5	20.1	100.6	117.4	75.0	67.9	78.8	83.5
3	"	40	0	122.1	81.7	104.7	24.2	101.4	128.2	107.9	95.8	104.0	96.7
4	"	80	0	129.8	94.0	110.9	24.4	103.3	129.3	112.2	104.0	111.4	102.1
5	"	120	0	128.2	91.2	112.5	21.2	102.5	126.7	111.0	103.6	113.2	101.1
6	"	120(SD)	0	126.5	90.4	119.8	19.6	103.1	126.4	116.3	112.0	111.2	102.8
7	"	160(SD)	0	128.9	91.9	110.7	25.6	99.3	125.7	105.8	103.2	107.6	99.9
8	"	80(F)	0	118.2	92.8	119.0	23.2	99.6	135.7	115.7	113.6	108.3	102.9
9	"	120(F)	0	128.9	90.2	125.7	21.2	103.4	128.6	115.8	106.1	112.7	103.6
10	"	80(ORG)	8	122.2	87.8	114.7	25.4	99.4	129.0	121.9	102.6	107.5	101.2
11	"	120(ORG)	12	127.7	96.9	119.2	22.0	101.0	130.7	113.1	109.6	100.2	102.3
12	"	80	30	123.6	91.8	108.9	24.7	104.2	127.8	123.5	105.4	109.2	102.1
Significance				NS	**	NS	NS	NS	NS	**	**	**	
BLSD(.05)				-	16.9	-	-	-	-	12.0	9.8	11.2	

[1] Starter (6-24-24) was applied along the row at planting time at 143 lb/A.

[2] Nitrogen sources were urea except for treatments 10 and 11 which were soybean oil meal. All treatments were spring applied except 8 and 9 which were applied in the fall. Two treatments received split applications of nitrogen: Treatment 6 received 80 lb at planting and 40 lb sidedressed and treatment 7 received 80 lb at planting and 80 lb sidedressed.

Table 2. Effect of fertilizer treatments on the nitrogen content of the sixth leaf at silking.

Fertilizer treatments		In addition to starter		N content of sixth leaves									
No.		N[2]	P	1973	1974	1975	1976	1977	1978	1979	1980	1981	9-year average
		- lb/A -		%									
1	Starter[1]	0	0	2.20	2.96	2.26	2.25	3.11	2.64	1.85	2.46	2.88	2.51
2	"	0	0	2.18	3.04	2.27	2.09	3.00	2.65	1.71	2.41	2.81	2.46
3	"	40	0	2.40	3.26	2.59	2.57	3.07	3.00	1.98	3.00	3.22	2.79
4	"	80	0	2.53	3.37	2.85	2.62	3.13	3.13	2.86	2.90	3.28	2.96
5	"	120	0	2.74	3.50	2.90	2.79	3.16	3.24	2.99	3.06	3.39	3.09
6	"	120(SD)	0	2.55	3.46	2.88	2.53	3.12	3.24	2.96	3.02	3.23	3.00
7	"	160(SD)	0	2.62	3.45	2.85	2.67	3.04	3.22	2.68	3.08	3.11	2.97
8	"	80 (F)	0	2.50	3.32	2.82	2.64	3.14	3.12	2.86	2.72	3.19	2.92
9	"	120 (F)	0	2.48	3.46	2.80	2.62	3.23	3.11	2.88	2.86	3.32	2.97
10	"	80(ORG)	8	2.52	3.42	2.84	2.54	3.23	3.16	3.00	2.95	3.29	2.99
11	"	120(ORG)	12	2.61	3.42	2.93	2.67	2.98	3.20	2.62	3.16	3.37	3.00
12	"	80	30	2.49	3.36	2.60	2.64	3.09	3.13	2.40	2.85	3.14	2.86
Significance				**	**	**	**	NS	**	**	**	**	
BLSD(.05)				.22	.19	.23	.16	-	.13	.59	.32	.29	

[1] Starter (6-24-24) was applied along the row at planting time at 143 lb/A.

[2] Nitrogen sources were urea except for treatments 10 and 11 which were soybean oil meal. All treatments were spring applied except 8 and 9 which were applied in the fall. Two treatments received split applications of nitrogen: Treatment 6 received 80 lb at planting and 40 lb sidedressed and treatment 7 received 80 lb at planting and 80 lb sidedressed.

Table 3. Effect of fertilizer treatments on fall soil NO_3-N content.

Sample Depth	Treatment No.	Annual Broadcast N Rate	Year									
			1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
- ft -		- lb/A -	lb NO_3-N/A									
0-2	1	0	39	48	47	10	54	35	28	16	23	20
0-3	1	0	54	64	63	10	68	63	39	23	28	27
0-4	1	0	65	87	85	15	82	88	57	50	42	41
0-2	3	40	27	-	40	7	79	41	33	21	22	24
0-3	3	40	46	-	64	11	105	100	89	53	41	38
0-4	3	40	80	-	103	18	134	132	140	100	79	63
0-2	4	80	23	64	100	30	115	86	40	23	46	53
0-3	4	80	40	91	128	48	143	186	174	115	176	163
0-4	4	80	65	125	159	57	168	218	245	219	247	217
0-2	5	120	39	112	178	40	187	234	87	49	118	112
0-3	5	120	63	152	220	70	233	470	311	259	269	256
0-4	5	120	89	185	256	81	270	528	458	392	385	350
0-2	7	160	37	-	174	80	258	149	100	100	274	257
0-3	7	160	59	-	211	122	314	299	370	370	569	486
0-4	7	160	87	-	244	141	347	365	596	603	723	641

Table 4. Total monthly precipitation at the West Central Experiment Station, April-November.

Month	Year 1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	95-year average
	inches										
April	2.61	1.09	1.37	2.76	.47	1.90	2.80	1.53	.15	1.78	2.28
May	4.40	3.80	2.59	1.53	.39	5.48	2.48	2.52	1.83	1.94	2.97
June	2.20	.98	2.40	6.84	1.63	2.72	5.52	6.30	6.69	6.68	3.94
July	6.28	5.55	3.88	2.03	1.07	3.52	2.08	2.71	2.40	3.76	3.53
August	1.72	1.76	4.79	4.39	1.76	3.20	2.63	1.15	2.94	2.67	2.93
September	.38	2.26	.72	1.61	.57	3.50	3.03	.22	2.32	.54	2.20
October	1.81	1.79	.68	1.59	.08	3.25	.08	4.26	1.23	3.28	1.62
November	1.43	.95	1.17	1.77	.14	3.13	1.25	.60	.13	.64	.95
Total	20.83	18.18	17.60	22.43	6.11	26.70	19.87	19.29	17.69	21.29	20.42

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. 1981 Operations

In 1981 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 5. Silage yields were taken on September 23 and grain yields on October 20.

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

Treatment	1981 yield	1966-81 yield
Silage, low fertility	6.30	5.67
Silage, high fertility	6.86	6.09
Grain, low fertility	6.65	5.66
Grain, high fertility	6.61	5.91

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

	1981 yield	1966-81 yield
Grain, low fertility	99.32	91.49
Grain, high fertility	104.47	94.36

V. Check Yields

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

	1981 yield	1966-81 yield
Grain (0 + 0 + 0)	48.37 Bu/A	50.26 Bu/A
Silage (0 + 0 + 0)	4.32 Tons/A	3.77 Tons/A

VI. Discussion

A. In 1981 there were no significant differences in silage yields but the silage high fertility plots yielded slightly more than the low fertility plots.

B. The 16-year average yields show very little difference between silage and grain plots, but there is still a slight advantage for the higher fertility level.

SOIL TEST LAB COMPARISON

West Central Experiment Station - Morris

S. D. Evans, C. R. Schrader 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 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. Results from the 1980 trials were summarized previously (Soil Series 109).

In the fall of 1980 soil samples of the plow layer and the 0-2 foot zone (corn only) were taken from each plot except the check. The soil from the four replications was combined to make two samples (plow layer and 0-2 foot) from each treatment. The samples were dried thoroughly, mixed and subdivided and sent to the same laboratory as that treatment in 1980. Recommendations were requested for corn at a yield goal of 130 Bu/A and spring wheat at a yield goal of 65 Bu/A. Analyses requested were (1) a complete analysis on the plow layer samples and (2) a nitrate-N analysis and recommendation on the 0-2 foot samples on the treatments to be planted to wheat. After receiving the soil tests and recommendations (Tables 1 and 2), the fertilizer treatments were calculated with an adjustment for soil buildup with Lab C. With Lab C there was no indication that the 0-2 foot sample was used for the nitrogen recommendation on wheat.

General

The experiment was set up as a randomized complete block with four 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. A storm on August 3 with high winds, caused severe lodging in the wheat and corn.

Wheat

The N, P, K, and S treatments for wheat were applied broadcast by hand in a dry form on April 7. The copper was dissolved in water and sprayed to the plots the same day. All plots were then worked with a field cultivator and drug. On April 8 the plots were seeded to Era wheat @ 1 3/4 Bu/A. On May 19 bromoxynil (.25 lb/A) and MCPA ester (.25 lb/A) were applied for weed control. The upper 2 leaves were sampled prior to flowering on June 12 for nutrient analysis. On July 17 at the soft dough stage whole plant samples were taken for nutrient analysis. The plots were harvested with a plot combine on August 5. Samples of grain were saved for protein analysis.

Corn

The N, P, K and S treatments for corn were applied broadcast by hand on May 1. The copper was dissolved in water and applied to the plots the same day. All plots were then dug with a field cultivator, drug and planted to variety Trojan TXS99 @ 22,000 seeds/acre. There was no starter fertilizer used. An insecticide, Counter, was applied in the row @ 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 4. Early plant height and samples were taken on June 22. Leaf samples at mid-silk were collected on July 28. The plots were harvested with a plot combine on October 15. Samples of grain were saved for protein analysis.

Results and Discussion of the Wheat Trial

As shown in Table 1, the soil tests and fertilizer recommendations varied greatly with laboratory. Two commercial labs recommended sulfur and one recommended copper. There were also wide variations in N, P and K recommendations.

Upper leaf nutrient concentration differences among laboratories were found for P, Ca, Fe, Zn and Mn. In most cases Lab C had the highest concentration and Lab E the lowest concentration. The P concentration appeared to be related to the total P applied over the two-year period. Lab C received the highest Zn application in 1980 but Lab D had the highest concentration and never received Zn. Lab C had the highest Mn concentration having received an Mn application in 1980. Soft dough nutrient concentration differences between laboratories were found only for Ca and Fe (Table 4).

Table 1. Soil test results and the suggested fertilizer program for wheat in 1981.

Test	Soil Test Results[1]				
	LAB A	LAB B	LAB C	LAB D	LAB E (UM)
pH	7.8	7.6	7.7	7.8	7.8
Phosphorus (Bray 1)	16-H	16-M	15	18-H	9
($NaHCO_3$)	-	39-M	15	-	-
Potassium	132-H	151-M	130	144-H	106
Organic matter (%)	4.2	3.6-H	4.5	-	M
Calcium	3350	2720-H	4000	3200-M	-
Magnesium	555	580-VH	560	500-M	-
Sodium	16	-	31	-	-
Sulfur	5.5-M	6-L	20	18-ADQ	7
Iron	7.8-H	15-M	2.8	-	-
Manganese	6.6-VH	11-M	14.8	9-H	-
Zinc	1.01-H	2.3-M	2.8	3.0-ADQ	1.7
Copper	.38-H	0.7-L	0.8	0.8-H	-
Boron	-	1.0-M	1.1	-	-
ENR (lb/A)	-	102	-	-	-
Nitrate nitrogen (lb/A)	108(0-2 ft)	86(0-2 ft)	5	84(0-2 ft)	160(0-2 ft)
C.E.C. (meq/100 g)	27.7	18.1	25.1	-	-
Soluble salts (mmhos/cm)	.69	-	.30	-	-

Nutrient	Suggested Fertilizer Program[2]				
	LAB A	LAB B	LAB C	LAB D	LAB E (UM)
Nitrogen	44	0	95	80	0
Phosphorus (P_2O_5)	0	55	50	0	40
Potassium (K_2O)	30	105	180[3]	22	30
Sulfur	-	12	8	-	-
Zinc	-	-	-	-	-
Manganese	-	-	-	-	-
Copper	-	0.5	-	-	-
Boron	-	-	-	-	-

[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 65 bushels of wheat per acre.

[3] Values include maintenance plus 1/2 of suggested buildup.