Table 2. Treatment description for P-efficiency study.

Treatment Number	Placement	P Rate # P/A
1	Broadcast	0
2	Broadcast	10
3	Broadcast	20
4	Broadcast	30
5	Broadcast	40
6	Knife *	0
7	Knife *	10
8	Knife *	20
9	Knife *	30
10	Knife *	40
11	Row +	0
12	Row +	10
13	Row +	20
14	Row +	30
15	Row +	40

* 15-inch width at wheat-soybean location
\+ 5-7 inches from row in soybean and corn - applied with seed in spring wheat.

Broadcast and knife applied:	Crookston	October 25, 1985
	Lamberton	October 20, 1985
	Waseca	October 22, 1985
Row applied:	Crookston	May 16, 1986 - Soybean
	Crookston	May 19, 1986 - Spring Wheat
	Lamberton	May 7, 1986 - Corn and Soybean
	Waseca	May 21, 1986 - Corn and Soybean

Table 3. Phosphorus rate and method means for corn grain yield, corn forage yields, soybean grain yield, and soybean forage yield at Waseca, 1986.

Method	P Rate # P/A	Corn Grain Yield Bu/A	Corn Forage Yield #/A	Soybean Yield Bu/A	Soybean Forage Yield #/A
Broadcast	0	94.3	9425	33.1	4850
	10	102.3	9895	35.8	5175
	20	110.4	10995	36.4	4915
	30	125.1	10910	37.3	5630
	40	117.3	11270	37.9	5715
Knife	0	103.5	9890	33.5	5120
	10	107.4	11015	35.9	5430
	20	120.4	10670	36.1	5115
	30	125.5	11635	36.0	5090
	40	122.4	11380	36.9	5640
Row	0	97.6	9850	32.3	4640
	10	114.2	10760	34.4	5150
	20	110.8	10660	35.6	5040
	30	112.4	11090	37.5	5925
	40	115.0	11250	37.9	5720
Broadcast		113.8	10768	36.8	5359
Knife		118.9	11175	36.2	5319
Row		113.1	10940	36.3	5459
	0	98.5	9722	32.9	4870
	10	107.9	10557	35.4	5252
	20	113.9	10775	36.0	5023
	30	121.0	11212	36.9	5548
	40	118.2	11300	37.5	5692
Statistical Analysis					
Method		0.37	0.56	0.70	0.73
Broadcast vs Knife and Row		0.56	0.38	0.41	0.85
Knife vs Row		0.20	0.54	0.89	0.45
P Rate		0.0006	0.003	0.0004	0.001
Linear		0.0001	0.0002	0.0001	0.0002
Quadratic		0.095	0.25	0.21	0.62
Method x P Rate		0.57	0.86	0.88	0.46
C.V.		11.3	9.5	6.7	9.7

Table 4. Phosphorus rate and method means for corn grain yield, corn forage yield, corn ear leaf P concentration, soybean grain yield, soybean forage yield, and soybean leaf P concentration at Lamberton, 1986.

		Corn			Soybean		
Method	P Rate # P/A	Grain Yield Bu/A	Forage Yield #/A	Ear Leaf P %	Grain Yield Bu/A	Forage Yield #/A	Leaf P %
Broadcast	0	133.0	11105	0.219	32.0	5465	0.289
	10	133.3	12615	0.236	33.6	5485	0.307
	20	143.5	13230	0.254	34.9	5835	0.360
	30	145.5	13385	0.275	35.9	6105	0.343
	40	144.5	12975	0.277	34.9	5935	0.360
Knife	0	125.3	11895	0.212	31.4	5350	0.309
	10	134.8	12280	0.218	31.5	5230	0.276
	20	145.8	11830	0.232	31.5	5390	0.311
	30	133.8	12695	0.247	32.2	5295	0.309
	40	139.5	12750	0.243	33.6	5625	0.324
Row	0	130.0	11465	0.211	31.3	5315	0.282
	10	139.3	10740	0.220	33.4	5415	0.308
	20	143.5	11970	0.231	32.6	5610	0.314
	30	129.5	11645	0.233	32.6	5540	0.316
	40	144.0	13240	0.242	34.6	5560	0.337
Broadcast		141.7	13051	0.260	34.8	5840	0.343
Knife		138.4	12389	0.235	32.6	5385	0.305
Row		139.1	11899	0.231	33.3	5531	0.319
	0	129.4	11488	0.214	31.5	5377	0.294
	10	135.8	11878	0.225	32.8	5377	0.297
	20	144.3	12343	0.239	33.5	5612	0.328
	30	136.3	12575	0.252	33.6	5647	0.323
	40	142.7	12988	0.254	34.4	5707	0.340
Statistical Analysis							
Method		0.55	0.001	0.0001	0.0006	0.04	0.005
Broadcast vs Knife and Row		0.28	0.001	0.0001	0.0002	0.01	0.002
Knife vs Row		0.84	0.10	0.55	0.19	0.40	0.21
P Rate		0.001	0.001	0.0001	0.0006	0.32	0.0007
Linear		0.002	0.0001	0.0001	0.0001	0.04	0.0001
Quadratic		0.09	0.84	0.34	0.38	0.88	0.78
Method * P Rate		0.28	0.07	0.75	0.27	0.90	0.85
C.V.		6.4	7.0	7.4	4.5	8.8	9.2

Table 5. Phosphorus rate and method means for wheat grain yield, wheat bushel weight, wheat grain protein, wheat forage yield, soybean grain yield, and soybean forage yield at Crookston, 1986.

		Wheat				Soybean	
Method	P Rate # P/A	Grain Yield Bu/A	Bushel Weight #/Bu	Grain Protein %	Forage Yield #/A	Yield Bu/A	Forage Yield #/A
Broadcast	0	43.2	59.8	14.8	7065	37.3	4755
	10	44.8	59.2	14.7	6474	35.7	4441
	20	45.7	59.2	14.8	6314	39.3	5027
	30	46.1	59.7	15.0	6400	38.6	4486
	40	44.8	59.8	14.8	6340	35.5	4367
Knife	0	42.4	60.0	15.0	6146	34.6	3845
	10	45.4	59.6	15.0	6431	37.7	4810
	20	45.6	59.4	15.1	6591	34.3	4588
	30	46.0	59.7	15.0	6980	37.3	4985
	40	42.9	58.9	14.8	6199	35.0	4747
Row	0	44.3	59.1	15.1	6291	34.1	4054
	10	43.4	58.9	14.9	6817	33.1	4337
	20	47.0	59.6	15.0	6413	36.5	4175
	30	45.4	59.7	14.9	6284	35.4	4850
	40	45.4	58.2	14.8	6931	34.5	4795
Broadcast		45.4	59.5	14.8	6382	37.3	4580
Knife		45.0	59.4	15.0	6550	36.1	4783
Row		45.3	59.1	14.9	6611	34.9	4539
	0	43.3	59.7	14.9	6501	35.3	4218
	10	44.6	59.2	14.9	6574	35.5	4529
	20	46.1	59.4	14.9	6440	36.7	4597
	30	45.8	59.7	15.0	6555	37.1	4774
	40	44.4	58.9	14.8	6490	35.0	4637
Statistical Analysis							
Method		0.92	0.69	0.29	0.49	0.28	0.59
Broadcast vs Knife and Row		0.82	0.56	0.18	0.25	0.16	0.71
Knife vs Row		0.75	0.52	0.43	0.43	0.76	0.43
P Rate		0.06	0.51	0.45	0.98	0.65	0.32
Linear		0.15	0.37	0.49	0.94	0.79	0.08
Quadratic		0.01	0.72	0.39	0.97	0.23	0.27
Method x P Rate		0.72	0.72	0.64	0.29	0.67	0.59
C.V.		5.8	2.0	1.7	9.4	11.1	14.3

THE EROSION-PRODUCTIVITY STUDY AT THE SOUTHWEST EXPERIMENT STATION, LAMBERTON, MN[1]

J.A. Staricka, M. Lindstrom, W.W. Nelson, and J.B. Swan

This experiment is part of RRF project NC-174, Soil Productivity and Erosion. The objectives of this study are "To asses the effect of erosion-modified soil physical properties on potential productivity of selected soils under rainfed conditions, with emphasis on evaluation of physically-based simulation models."

Methods and Materials: Plot for this study were located in areas of a field which have been slightly (SLT), moderately (MOD), and severely (SEV) eroded. Two tillage systems were used on the field: CONVentional (fall moldboard plow) and RIDGE-till.

The field has been planted in corn since the experiment started in 1984. Fertilizer was applied based on the soil test of each erosion treatment. The amounts of fertilizer applied are listed in Table 1. Additional management information is given in Table 2.

Stand counts and leaf number were recorded in June of both years and are listed in Tables 3 and 4. The weights of early plant samples taken in 1985 are listed in Table 5.

Grain yields are given in Table 6.

Summary of results: Both 1985 and 1986 had higher than normal growing season precipitation (17.13 and 16.61 inches versus the 26-yr avg. of 13.59 inches). We expect larger differences in yield between erosion levels during years having closer to normal growing season precipitation.

The yield difference between tillage systems was quite high and is due, at least in part, to using a continuous corn cropping sequence. In a related study at the station using a corn-soybean rotation (data not shown here) there was no difference in yield between the CONV and RIDGE treatments.

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[1] Please refer to the title page of this publication for information regarding application and use of this article.

Table 1. Applied Fertilizer.

Time	Plots[1]	N	P_2O_5	K_2O	Zn	Comments
		------- # / Ac -------				
Fall 1984	All	200	100	100	--	
Fall 1984	SEV	---	---	60	10	
Spring 1985	All	9	25	8	---	(starter)
Fall 1985	All	---	---	50	--	
Fall 1985	SEV	---	100	---	--	
Spring 1986	All	200	---	---	--	
Spring 1986	All	6	19	6	--	(starter)

Table 2. Management Information.

Item	type	rate	date
---------- 1985 ----------			
Secondary Tillage	digger	--	5/6/85
Insecticide	Counter	1.0 #/Ac	" "
Seed	Pioneer 3732	26,000 p/Ac	" "
Herbicides	Lasso	2.5 #/Ac	5/7/85
	Bladex	1.5 #/Ac	" "
---------- 1986 ----------			
Secondary Tillage	disk	--	5/13/86
Insecticide	Furadan	1.0 #/Ac	5/15/86
Seed	Pioneer 3732	26,500 p/Ac	" "
Herbicides	Lasso	3.0 #/Ac	" "
	Bladex	1.5 #/Ac	" "

[1] Key : Erosion Levels: SLT = Slight, MOD = Moderate, SEV = Severe
Tillage systems: CONV = Conventional (fall moldboard plow), RIDGE = Ridge-till

Table 3. Stand Counts.[2]

Treatment[1]	1985 CONV	1985 RIDGE	1985 Avg	1986 CONV	1986 RIDGE	1986 Avg
	plants (thousands) / Ac					
SLT	24.6	24.4	24.5	21.2	22.2	21.7
MOD	24.6	23.9	24.3	21.1	22.0	21.6
SEV	23.8	24.5	24.2	20.5	23.0	21.8
Avg	24.3	24.3	24.3	20.9	22.4	21.7

Table 4. Leaf Numbers.[2]

Treatment[1]	1985 CONV	1985 RIDGE	1985 Avg	1986 CONV	1986 RIDGE	1986 Avg
	Leaf Number					
SLT	4.13	4.18	4.16	7.52	7.38	7.45
MOD	4.08	4.08	4.08	7.39	6.86	7.13
SEV	3.67	3.83	3.75	7.47	7.54	7.50
Avg	3.96	4.03	4.00	7.46	7.26	7.36

Table 5. Early Plant Growth -- 1985[2]

Treatment[1]	CONV	RIDGE	Avg
	g / 10 plants		
SLT	486.5	400.0	443.3
MOD	462.0	371.5	416.8
SEV	348.5	293.0	320.8
Avg	432.3	354.8	393.6

[1] Key : Erosion Levels: SLT = Slight, MOD = Moderate, SEV = Severe
Tillage systems: CONV = Conventional (fall moldboard plow), RIDGE = Ridge-till

[2] Samples and measurements taken 4 June 1985 and 25 June 1986.

Table 6. Grain Yield.

Treatment[1]		Rep 1	Rep 2	Rep 3	Rep 4	Avg
		------- Bu / Ac @ 15.5% moisture -------				
---------- 1985 ----------						
SLT	CONV	165.2	157.3	177.8	164.6	166.2
SLT	RIDGE	166.9	159.4	170.9	155.8	163.3
MOD	CONV	163.3	157.5	172.4	176.9	167.5
MOD	RIDGE	156.2	139.8	160.7	165.6	155.6
SEV	CONV	167.6	159.0	152.9	150.7	157.5
SEV	RIDGE	168.5	151.1	145.0	126.8	147.8
---------- 1986 ----------						
SLT	CONV	171.8	172.4	160.9	166.5	167.9
SLT	RIDGE	160.4	141.5	146.6	164.1	153.2
MOD	CONV	159.9	166.4	161.1	156.1	160.9
MOD	RIDGE	140.7	136.0	145.7	143.4	141.5
SEV	CONV	162.6	153.8	173.1	166.2	163.9
SEV	RIDGE	165.3	154.8	156.7	138.6	153.9

1 Key : Erosion Levels: SLT = Slight, MOD = Moderate, SEV = Severe
Tillage systems: CONV = Conventional (fall moldboard plow), RIDGE = Ridge-till

Table 2. Influence of nitrogen form, nitrogen rates, and time of application on grain yield on a Webster loam, Southwest Experiment Station, Lamberton, MN 1986.

-- Nitrogen Trt. --			---------- Yield ----------				
Rate	Form	Time[1]	Rep. 1	Rep. 2	Rep. 3	Rep. 4	Av.
#N/Ac			------- Bu/Ac @ 15.5% moisture ------				
	Check		70.7	49.4	37.2	57.5	65.0
40	NH_4NO_3	FPD	64.5	82.7	57.2	91.5	83.0
40	Urea	FPD	68.2	105.1	63.9	76.9	87.0
40	NH_4NO_3	FS	89.9	70.5	79.4	88.5	80.0
40	Urea	FS	62.2	57.5	84.9	98.9	86.0
80	NH_4NO_3	FPD	77.8	122.9	84.8	105.2	104.0
80	Urea	FPD	86.1	199.6	113.4	128.0	103.0
160	NH_4NO_3	FPD	120.6	128.7	144.2	148.8	111.0
160	Urea	FPD	98.8	137.2	113.6	156.8	113.0
40	NH_4NO_3	STD	79.6	107.0	79.1	104.3	95.0
40	Urea	STD	84.1	75.2	94.1	92.0	92.8
80	NH_4NO_3	STD	103.3	107.3	130.7	117.1	106.4
80	Urea	STD	117.0	112.3	139.4	118.7	108.3
40	NH_4NO_3	SD	91.3	105.6	100.9	114.0	96.9
40	Urea	SD	103.7	104.7	122.3	136.4	97.2
80	NH_4NO_3	SD	134.5	117.9	149.6	145.8	103.0
80	Urea	SD	144.0	136.7	148.5	144.0	111.5
160	NH_4NO_3	SD	165.2	153.3	171.2	165.2	115.5
Sign.							>99
LSD 0.05							18.6

[1] FPD = Fall Plowed Down; FPS = Fall Plow Surface; STD = Spring Top Dress; SD = Side Dress.

Table 3: Distribution and statistics of relative yields of 80# urea FPD and SD for years 1970 to 1986

Class	FPD[1]	SD[1]
0.85-0.90	1	2
0.90-0.95	5	0
0.95-1.00	5	3
1.00-1.05	4	2
1.05-1.10	0	4
1.10-1.15	0	0
1.15-1.20	0	3
1.20-1.25	0	1
Median	0.97	1.05
Av	0.97	1.04
SD	0.058	0.108

Table 4: Correlation of relative yields of 80# urea FPD and SD for years 1970 to 1986 with soil water-related indices.

Index	FPD[1]	SD[1]
FSM[1]	0.130	0.435
May Prec.	0.171	0.226
June Prec.	-0.606*	0.382

*

Sign. @ 5%

[1]Key: FPD = Fall plowed down SD = Side Dress FSM = Fall Soil Moisture

WEST CENTRAL EXPERIMENT STATION
WEATHER SUMMARY - 1986

Month	Period	Precipitation 1986	Precipitation 100-yr. av.	Precipitation from av.	Temperature 1986	Temperature 100-yr. av.	Temperature Dev. from av.	Soil Temperature (10 cm depth) 1986	Soil Temperature (10 cm depth) 10 yr. av.
January	1-31	0.45	0.68	-0.23	13.8	8.0	+5.8	- -[1]	20.7
February	1-28	1.25	0.67	+0.58	10.0	12.8	-2.8	- -[1]	23.9
March	1-31	0.88	1.13	-0.25	28.7	26.7	+2.0	- -[1]	29.2
April	1-10	1.36	0.57	+0.79	45.0	38.0	+7.0	39.8	
	11-20	3.21	0.64	+2.57	41.9	44.4	-2.5	39.6	
	21-30	1.61	1.05	+0.56	46.8	48.3	-1.5	43.2	
Total or av.		6.18	2.26	+3.92	44.6	43.6	+1.0	40.9	41.4
May	1-10	2.33	0.77	+1.56	51.5	52.0	-0.5	47.0	
	11-20	0.64	0.95	-0.31	56.1	55.8	+0.3	54.3	
	21-31	0.88	1.25	-0.37	61.8	60.0	+1.8	58.1	
Total or av.		3.85	2.97	+0.88	56.7	56.1	+0.6	53.3	57.1
June	1-10	0.75	1.29	-0.54	66.4	63.0	+3.4	63.2	
	11-20	1.99	1.30	+0.69	66.7	66.3	+0.4	66.0	
	21-30	1.46	1.37	+0.09	70.3	68.1	+2.2	69.2	
Total or av.		4.20	3.96	+0.24	67.8	65.8	+2.0	65.4	69.3
July	1-10	0.43	1.44	-1.01	70.6	70.1	+0.5	69.2	
	11-20	3.36	1.06	+2.30	72.0	71.4	+0.6	73.5	
	21-31	2.67	1.01	+1.66	70.8	71.4	-0.6	73.4	
Total or av.		6.46	3.51	+2.95	71.1	70.9	+0.2	71.4	76.7
August	1-10	2.55	1.04	+1.51	66.8	70.4	-3.6	68.6	
	11-20	1.42	0.93	+0.49	66.2	69.0	-2.8	67.6	
	21-31	1.54	1.04	+0.50	58.9	66.9	-8.0	62.5	
Total or av.		5.51	3.01	+2.50	63.8	68.7	-4.9	66.1	73.9
September	1-30	3.22	2.20	+1.02	56.0	59.0	-3.0	57.6	61.5
October	1-31	0.28	1.74	-1.46	45.5	47.2	-1.7	47.1	47.8
November	1-30	1.35	0.97	+0.38	23.9	29.7	-5.8	32.6	33.6
December	1-31	0.01	0.68	-0.67	22.6	15.2	+7.4	27.0	23.4
April-August Growing Season		26.20	15.71	+10.52	60.8	61.0	-0.2	59.5	63.8
January-December Annual		33.64	23.78	+9.86	42.2	42.0	+0.2	- -[1]	46.7

[1] Missing data

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

S. D. Evans, P. R. Goodrich and R. C. Munter
Morris, 1986

The experiment initiated in 1970 was continued. Manure was applied in 1970 and 1971 only. Fertilizer has been applied to the fertilized checks each year.

I. Planting Information

The plots were planted with Pioneer 3901 on May 21, 1986, @ 24,300 seeds/acre. Counter was applied @ 12 lb/acre (1.8 lb/acre active ingredient) in the row to the entire area at planting. The fertilized plots received 120 + 50 + 50 ($N + P_2O_5 + K_2O$) lb/acre on October 28, 1985. The plots were moldboard plowed following fertilizer application. Lasso @ 3 lb/acre and Bladex @ 2.2 lb/acre were broadcast on May 22. Silage samples were taken by hand on September 29 and the grain harvest was taken with a plot combine on October 14.

II. Soil Sampling and Analysis

NO_3-N was measured in the fall of 1985 (Table 1). The total amount of NO_3-N in the 0-4 foot profile is less for all treatments as compared to the fertilized check. The impact of these low amounts of NO_3-N is seen on the yield results (Table 3) where the fertilized check is significantly higher than all the other treatments.

III. Plant Tissue Analysis

The nutrient concentrations in the ear leaves at silking in 1986 are given in Table 2. There are significant effects on most elements. The fertilized check has significantly greater amounts of N and Zn as compared to all other treatments.

IV. Yield Measurements (Table 3)

A. Grain - For the first time since the study was started all treatments yielded significantly less than the fertilized check.

B. Silage - The LH treatment had significantly less silage D.M. yield/acre as compared to the fertilized treatment.

V. Summary

For the first time since manure treatments were applied in 1970 and 1971 the grain yields were significantly less for all treatments as compared to the fertilized check. The amount of N in the ear leaf at silking is also significantly less for all the manure treatments.

Table 1. Levels of NO_3-N in a Tara soil fifteen years (Fall 1985) after the application of high rates of manure.

	Treatment				
Depth	CK	FE	SD	LB	LH
- ft -	- - - - - - - -		NO_3-N, ppm	- - - - - - - -	
0-1	5.2	11.4	9.0	10.5	7.5
1-2	2.4	13.1	4.1	4.6	3.0
2-3	1.5	21.0	7.3	9.4	2.5
3-4	1.4	25.8	18.8	25.4	7.5

Please refer to title page of this publication for information regarding application and use of this article.

Table 2. Summary of analysis of corn leaves at silking - 1986.

Treatment	Elements									
	N	P	K	Ca	Mg	Fe	Zn	Cu	Mn	B
	- - - - - - % - - - - - -					- - - - - ppm - - - - -				
CK	1.47	0.15	1.77	0.47	0.25	76.2	10.0	3.8	65.4	4.7
FE	2.51	0.23	2.04	0.41	0.22	84.0	24.6	3.5	59.9	3.5
SB	1.57	0.25	2.11	0.39	0.16	66.4	11.6	2.7	54.1	3.3
LB	1.68	0.35	2.14	0.38	0.18	75.4	15.8	2.5	49.5	3.6
LH	1.50	0.26	2.11	0.38	0.18	65.1	14.0	3.2	55.9	3.7
Signif. level (%)	>99	>99	98	98	96	91	>99	97	69	87
BLSD (.05)	0.37	0.07	0.22	0.05	0.06	NS	3.6	0.9	NS	NS
CV (%)	11.4	14.6	5.4	6.7	15.8	10.7	13.1	13.6	15.3	16.3

Table 3. Summary of plant measurements - 1986.

Treatment	Early plant height	Early plant (10) dry weight	Grain		Silage		
			Moisture at harvest	Yield at 15.5% moisture	Dry matter at harvest	Silage yield (D.M.)	Ear wt. as a % of silage
	inches	- grams -	- - % - -	bu/acre	- - % - -	lb/acre	- - % - -
CK	11.5	6.0	40.8	29.3	37.2	5080	52.4
FE	15.1	12.4	36.2	103.9	43.6	11687	57.5
SB	16.6	19.7	36.9	64.5	46.2	8651	52.5
LB	15.9	18.2	37.2	67.9	40.5	8917	55.1
LH	15.2	14.8	37.6	56.3	45.7	7646	53.6
Signif. level (%)	>99	97	92	>99	99	99	96
BLSD (.05)	1.9	8.5	NS	25.0	4.7	3098	3.7
CV (%)	6.8	29.9	4.6	20.9	5.7	19.0	3.4

MANURE RATE STUDY

S. D. Evans, P. R. Goodrich and R. C. Munter
Morris, 1986

Solid and liquid beef manures were applied at three rates and the effects were compared against check plots. 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 with Pioneer 3901 on May 21, 1986, @ 24,300 seeds/acre. Counter was applied @ 12 lb/acre (1.8 lb/acre active ingredient) in the row to the entire area at planting. The fertilized plots received 120 + 50 + 50 (N + P_2O_5 + K_2O) lb/acre on October 28, 1985. The plots were moldboard plowed following fertilizer applications. Lasso @ 3 lb/acre and Bladex @ 2.2 lb/acre were broadcast on May 22. Silage samples were taken by hand on September 29 and the grain harvest was taken with a plot combine on October 14.

II. Soil Sampling and Analysis

NO_3-N was measured in the fall of 1985 (Table 1). Only the SB3 treatment had a greater amount of total NO_3-N as compared to the fertilized check.

III. Plant Tissue Analysis

The nutrient concentrations in the ear leaves at silking in 1986 are given in Table 2. There are significant effects on most elements. The fertilized check is significantly higher in N than the SB1, LB1, and LB3 treatments. The fertilized treatment also has greater amounts of Zn than all the other treatments.

IV. Yield Measurements (Table 3)

A. Grain - In 1985 no treatments were significantly less in yield than the fertilized check. In 1986 the fertilized treatment outyielded all liquid beef treatments.

B. Silage - As it did last year, the LB1 treatment yielded significantly less than the fertilized check.

V. Summary

The 1986 season was the eighth since manure has been applied. All liquid beef treatments yielded significantly less grain 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 1985.

	Treatment							
Depth	CK	FE	SB1	SB2	SB3	LB1	LB2	LB3
- ft -	- - - - - - - - - - - - - - - - NO_3-N, ppm - - - - - - - - - - - - - - - - - -							
0-1	5.7	29.8	11.2	14.1	18.6	8.7	12.5	6.9
1-2	2.9	44.8	9.6	15.2	50.2	4.7	8.0	24.9
2-3	2.6	43.7	26.4	31.0	69.4	8.2	20.4	22.1
3-4	2.2	40.8	26.5	66.8	98.2	12.9	29.8	30.1

Please refer to title page of this publication for information regarding application and use of this article.

Table 2. Summary of analysis of corn leaves at silking - 1986.

Treatment	Elements									
	N	P	K	Ca	Mg	Fe	Zn	Cu	Mn	B
	- - - - - - - -		%	- - - - - - - -		- - - - - - - -		ppm	- - - - - - - -	
CK	1.50	0.17	1.77	0.39	0.26	75.7	11.9	3.6	58.0	4.2
FE	2.85	0.26	2.05	0.45	0.23	88.1	28.0	4.1	82.7	3.7
SB1	1.89	0.23	2.15	0.41	0.18	73.7	12.3	3.3	62.5	3.5
SB2	2.55	0.34	2.43	0.37	0.17	89.9	16.2	4.0	57.1	3.3
SB3	2.53	0.35	2.41	0.35	0.13	97.8	19.1	3.1	55.9	3.2
LB1	1.92	0.21	1.91	0.43	0.23	74.2	11.0	4.0	71.3	3.7
LB2	2.51	0.26	1.88	0.47	0.27	81.6	13.0	4.7	81.6	3.7
LB3	2.21	0.27	2.12	0.41	0.22	82.5	13.0	4.1	73.7	3.5
Signif. level (%)	>99	>99	>99	99	>99	97	>99	87	84	81
BLSD (.05)	0.49	0.05	0.18	0.07	0.05	16.7	2.5	NS	NS	NS
CV (%)	12.5	11.8	5.3	8.4	12.9	10.1	10.2	16.5	20.7	11.4

Table 3. Summary of plant measurements - 1986.

Treatment	Early plant height	Early plant (10) dry weight	Grain		Silage		
			Moisture at harvest	Yield at 15.5% moisture	Dry matter at harvest	Silage yield (D.M.)	Ear wt. as a % of silage
	inches	- grams -	- % -	- bu/acre -	- - % - -	lb/acre	- - % - -
CK	12.2	7.6	38.0	47.4	39.7	5173	50.3
FE	14.0	10.9	36.9	139.3	39.9	11464	58.6
SB1	16.8	15.0	35.3	92.6	45.6	8958	54.8
SB2	19.5	28.6	34.5	134.2	43.4	12705	60.6
SB3	18.3	23.7	36.4	136.5	39.8	13514	59.1
LB1	13.8	9.2	37.8	55.4	41.9	5911	55.0
LB2	15.3	12.3	36.9	87.8	44.0	8522	56.0
LB3	16.5	19.5	34.7	67.4	42.0	10216	57.5
Signif. level (%)	>99	>99	63	>99	82	>99	>99
BLSD (.05)	2.9	8.3	NS	49.5	NS	3858	4.3
CV (%)	10.3	30.2	5.9	28.9	9.5	22.5	4.2

CONTINUOUS CORN SILAGE

S. D. Evans
Morris, 1986

I. Experimental Description

In 1965 an experiment was initiated on a 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 lb/acre of zinc as zinc sulfate in the fall of 1965.

II. 1986 Operations

In 1986 the variety was Dekalb 461 and was planted @ 24,300 seeds/acre. Counter was applied @ 12 lb/acre at planting on May 29. Lasso @ 3 lb/acre and Bladex @ 2.2 lb/acre were applied broadcast on May 29. Silage yields were taken on October 13 and grain yields on October 22.

III. Silage Yields - Dry matter, tons/acre

Treatment	1986 Yield	1966-86 Yield
Silage, low fertility	1.95	5.43
Silage, high fertility	3.53	5.98
Grain, low fertility	2.20	5.49
Grain, high fertility	4.10	5.89

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

	1986 Yield	1966-86 Yield
Grain, low fertility	20.9	86.7
Grain, high fertility	70.0	93.0

V. Check Yields

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

	1986 Yield	1966-86 Yield
Grain (0 + 0 + 0)	11.0	44.1
Silage (0 + 0 + 0)	1.44	3.49

VI. Discussion

A. The grain high fertility and the silage high fertility silage yields were significantly higher than the grain low fertility or silage low fertility treatments.

B. The 21-year average yields show very little difference between silage and grain plots, but there is a slight advantage for the higher fertility level.

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Figure 1. The effect of Tillage and Nitrogen on Corn Grain Yield of Pioneer 3906.

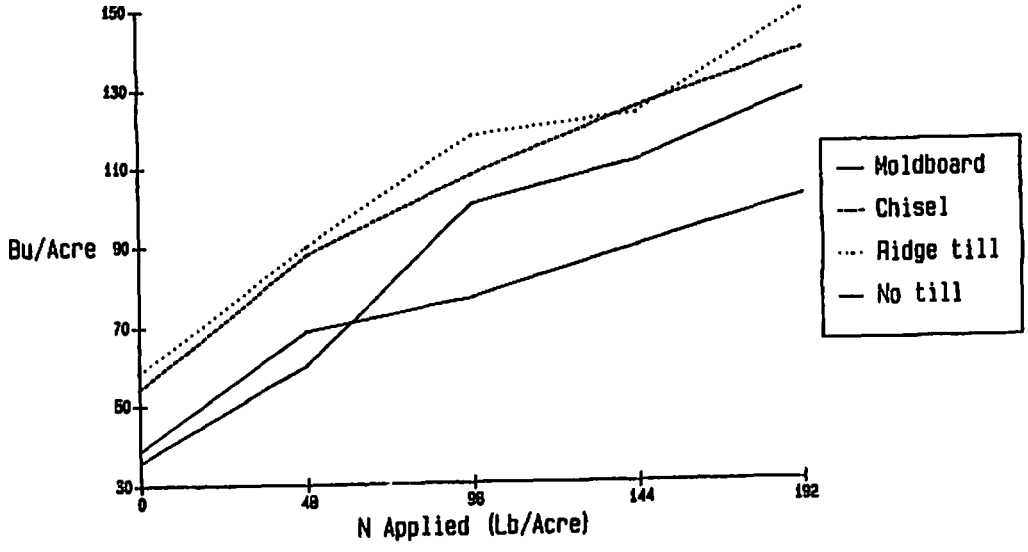
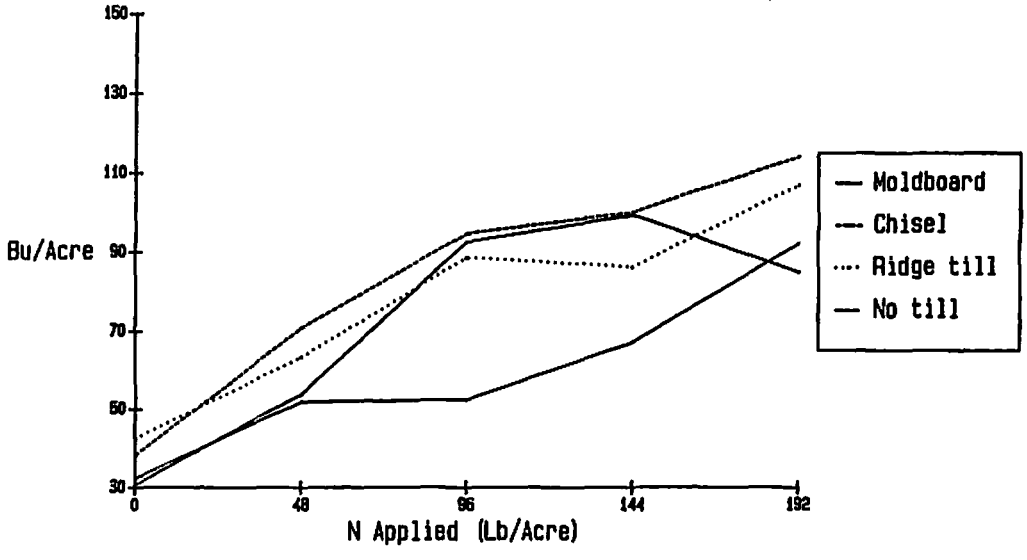


Figure 2. The effect of Tillage and Nitrogen on Corn Grain Yield of Dekalb XL8.



INVESTIGATIONS OF TILLAGE, N RATE, AND CORN HYBRID ON A PACHIC UDIC HAPLOBOROLL (TARA SILT LOAM)

S. D. Evans, J. F. Moncrief, and A. E. Olness
Morris, 1986

The purpose of this study was to investigate (1) the interaction of corn hybrid and N response, (2) the effect of tillage on the rate of N transformation of applied N and its availability, and (3) the effect of tillage on corn hybrid performance.

Experimental Procedures

The experimental site is located in west central Minnesota on a Pachic Udic Haploboroll (Tara silt loam). The experimental design is a split-plot with tillage as main plots, N rates as subplots, and hybrids as sub-subplots. There are four replications. Plot size is 10 feet by 40 feet. The experimental area has been in continuous corn from 1982-86. Nitrogen treatments have been located on the same areas starting in 1984. The hybrids (Pioneer 3906 and Dekalb XL8) are rotated each year within a nitrogen block. In 1982 the area was in a study with a number of hybrids while in 1983 the entire area was planted to Pioneer 3906. The experiment as it now stands was established in the fall of 1983.

The moldboard plow and chisel plow treatments were tilled on November 4, 1985. The stalks were not chopped on these two tillage treatments. The nitrogen had been applied as anhydrous ammonia on November 1, 1985. The moldboard plow plots were field cultivated twice and the chisel plow plots were disked once on May 22. The plots were planted on May 23 with a Hiniker planter. The row clearing disks were raised on the moldboard, chisel, and no-till treatments while they were lowered to clearing position for the ridge till treatments. The plots were planted at 30,000 seeds/acre to allow for sampling during the season.

Weed control was obtained with Lasso at 3 lb/acre a.i. and Bladex at 2.2 lb/acre a.i. preemerge broadcast on May 24. Row fertilizer was applied at planting (9.4 gal/acre of 7.4-25-0).

Residue measurements were made by the line intercept method on the 48 N and 144 N plots on May 30 with the row and interrow areas measured separately.

Stand counts were made on a 30-foot section of the center two rows. Tasseling and silking dates were estimated visually as the date 50% of the plants tasseled or silked.

The moldboard, chisel, and no-till plots were not cultivated. The ridge till plots were cultivated on July 3 and then ridged the same day.

Silage yields were taken by hand on September 30 from one 20-foot border row of each plot. The ears and stover were weighed separately and samples were taken for moisture and chemical analysis.

Grain yields were taken on October 15 with a modified JD 3300 combine. The two center rows of each plot 30 feet long were harvested and weighed on the combine. A grain sample was saved for moisture and chemical analysis.

Results and Discussion

Residual levels in the row (Table 2) varied from 2% with the moldboard plow to 28% with no till. The residue levels between the rows were about the same as in the row area with moldboard, chisel, and no till. There was a two-fold difference between row and interrow residue with ridge till.

The final emerged stands were affected by tillage (P>99%) and hybrid (P>99%) as shown in Table 1.

Tassel and silk dates were significantly affected by many factors (Table 2). The moldboard, chisel, and no-till treatments tasseled and silked slower with the 0 N treatment than with all other N treatments. The ridge till system tasseled and silked about the same day, regardless of N rate. The tillage x hybrid interaction appeared to be due to more delay with Dekalb XL8 than with Pioneer 3906 at the 0 N rate. At all other N rates there was no difference in date.

Grain and silage yields and harvest index were significantly affected by hybrid (Tables 2 and 4). Pioneer 3906 always had a higher value than Dekalb XL8 for all three variables. The tillage x nitrogen interaction for grain yield is shown in Figures 1 and 2 for each hybrid even though the 3-way interaction was not significant. Both hybrids responded well to nitrogen. With Pioneer 3906, moldboard and no till were lower yielding at the low N rates than chisel and ridge till. At the higher N rates, chisel, ridge till, and no till were higher yielding than moldboard. With Dekalb XL8,

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chisel, ridge till, and no till were similar and higher in yield than moldboard. At the 192 N rate, the no-till treatment did drop in yield.

Table 1. Treatment summary at Morris, 1986.

Treatment:	Fall moldboard plow Fall chisel plow Ridge till No till
N Rate:	0, 48, 96, 144, and 192 lb/acre applied November 1, 1985, as anhydrous ammonia. Previous rates on these same treatments were 0, 40, 80, 120, and 160 lb/acre, respectively.
Hybrid:	Pioneer 3906 Dekalb XL8

Table 2. Significance levels of treatment effects on measured variables.

Variable	Residue Cover after Planting Row	Residue Cover after Planting Interrow	Emerged Population	Tassel Date	Silk Date	Grain Yield	Silage Yield	Harvest[1] Index
	Significance level[2] (%)							
Tillage (T)	>99	>99	>99	>99	>99	>99	>99	93
Nitrogen (N)	>99	>99	43	>99	>99	>99	>99	>99
T x N	>99	>99	42	>99	>99	>99	98	94
Hybrid (H)	45	96	>99	34	34	>99	>99	>99
T x H	34	14	72	77	77	93	15	42
N x H	74	86	17	>99	>99	93	85	>99
T x N x H	40	06	41	85	85	40	81	12

[1] Harvest index is defined as ear dry matter as a percent of the total dry matter.

[2] Probability that differences are not due to chance.

Table 3. Main effects of tillage, N rate, and hybrids on residue cover, tassel date, and silk date.

Tillage	N Rate	Hybrid	Residue Level[1] after Planting Row	Residue Level[1] after Planting Interrow	Emerged Population	Tassel Date	Silk Date
	lb/acre		%		plants/acre	Day in July	
Moldboard			2.0	3.3	25193	26.7	28.7
Chisel			12.7	12.0	25534	25.1	27.1
Ridge till			8.8	19.4	26050	25.9	27.9
No till			28.0	27.4	27189	27.8	29.8
BLSD (.05)			3.8	2.6	1048	1.1	1.1
	0		- -	- -	26282	27.9	29.9
	48		31.1	37.3	25828	26.5	28.5
	96		- -	- -	25656	25.9	27.9
	144		33.2	40.4	26237	25.8	27.8
	192		- -	- -	25955	25.7	27.7
	BLSD (.05)		2.6	2.6	NS	0.4	0.4
		Pioneer 3906	12.4	14.3	24943	26.3	28.3
		Dekalb XL8	13.2	16.8	27041	26.4	28.4
CV (%)			65.1	46.3	6.5	2.7	2.5

[1] Residue measurements were made only on the 48 N and 144 N plots.

Table 4. Main effects of tillage, N rate, and hybrid on grain yield, silage yield, and harvest index.

Tillage	N Rate	Hybrid	Grain Yield	Silage Yield	Harvest Index
	lb/acre		bu/acre	lb DM/acre	- % -
Moldboard			67.3	7347	52.4
Chisel			93.2	10183	54.2
Ridge till			92.6	8971	56.2
No till			79.8	10093	52.0
BLSD (.05)			9.8	1084	NS
	0		41.3	5523	46.7
	48		68.4	8297	53.6
	96		91.4	9669	54.6
	144		100.2	10859	56.4
	192		114.7	11396	57.2
	BLSD (.05)		5.4	647	1.9
		Pioneer 3906	93.3	9866	56.0
		Dekalb XL8	73.1	8432	51.4
CV (%)			16.7	20.2	8.8

SOIL TEST LAB COMPARISON

S. D. Evans and G. A. Regimbal

Morris, 1986

In west central Minnesota there are several laboratories where soil samples are analyzed and fertilizer recommendations given. Recommendations of commercial laboratories sometimes differ greatly from the University of Minnesota Soil Testing Laboratory. In order to develop educational material for extension soils specialists, trials were started at the West Central Experiment Station in 1980 on a corn-wheat rotation. Results from 1980-85 trials were summarized previously (Soil Series 109 and Misc. Publ. 2-1982 to 1986).

In the fall of 1985 soil samples from the plow layer and 0-2 foot zone (corn only) were taken from all plots 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, subdivided and sent to the appropriate laboratory. Recommendations were requested from five laboratories for corn at a yield goal of 130 bu/acre and spring wheat at a yield goal of 65 bu/acre. 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 for 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 Harris Labs. Harris Labs gave no indication that the 0-2 foot sample was used for the nitrogen recommendation on wheat. The treatment labeled

Table 1. Soil test results and the suggested fertilizer program for wheat in 1986.

	Soil Test Results				
Test	Agvise	A & L	Harris	Eco-Agri	U of MN
pH	8.0	8.0	8.0	8.0	7.7
P (Bray 1), ppm	-	13L	-	12	11
(NaHCO3), ppm	10M	-	15	21	10
K, ppm	132H	148M	185	148	108
O.M., %	3.4	3.4H	3.7	3.6	3.4M
Ca, ppm	4950	2830H	4396	3520	-
Mg, ppm	475	460VH	436	530	-
Na, ppm	5	33VL	19	70	-
S, ppm	4L	8M	6	9	10
Fe, ppm	17.9VH	17H	15	13	-
Mn, ppm	9.4VH	10M	7.6	8.4	-
Zn, ppm	1.13H	2.6M	1.6	1.9	1.2
Cu, ppm	.7H	1.5H	0.7	0.68	-
B, ppm	-	1.3M	1	3.7	-
ENR (lb/acre)	-	70	-	-	-
Nitrate-N (lb/acre)	124	-	42	117	75
C.E.C. (meq/100 g)	29	18.5	26.2	23	-
Soluble salts (mmhos/cm)	.27	0.8L	0.2	-	0.3

	Suggested Fertilizer Program[1]				
Nutrient	Agvise	A & L	Harris	Eco-Agri[2]	U of MN
	- - - - - - - -	- - - - - -	lb/acre	- - - - - -	- - -
Nitrogen	28	115	75	0	45
Phosphorus (P_2O_5)	53	60[3]	65	25	50
Potassium (K_2O)	46	85[3]	110	65	30
Sulfur	0	9	5	0	0
Manganese	0	1	0	0	0

[1] All values indicate pounds of nutrient suggested per acre for a yield goal of 65 bushels per acre for wheat.
[2] Suggested applications are the minimum to obtain the desired yield goal.
[3] Values include maintenance plus 1/2 of suggested buildup.

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as Eco-Agri was originally tested by Willmar Testing Lab, Willmar, MN from 1980-83. Tests in the fall of 1984 and again in the fall of 1985 were tested by Eco-Agri Laboratories, Willmar, MN.

Table 2. Soil test results and the suggested fertilizer program for corn in 1986.

	Soil Test Results				
Test	Agvise	A & L	Harris	Eco-Agri	U of MN
pH	7.6	7.7	7.7	7.9	7.7
P (Bray 1), ppm	-	20H	-	16	16
(NaHCO3), ppm	12M	-	17	17	11
K, ppm	155VH	198H	215	145	136
O.M., %	4.4	3.6H	4.1	3.6	3.9M
Ca, ppm	3800	2490H	3934	3200	-
Mg, ppm	550	597VH	524	462	-
Na, ppm	5	42VL	17	47	-
S, ppm	5L	6L	5	9	-
Fe, ppm	20.3VH	26VH	20.3	14	-
Mn, ppm	10.1VH	14H	9.4	9	-
Zn, ppm	1.52H	2.6M	1.8	2.1	1.9
Cu, ppm	.73H	1.3H	0.7	.66	-
B, ppm	-	1.4H	0.8	3.5	-
ENR (lb/acre)	-	84	-	-	-
Nitrate-N (lb/acre)	-	-	-	-	-
C.E.C (meq/100 g)	24	18.1	24.7	20	-
Soluble salts (mmhos/cm)	.38	0.8L	0.16	-	0.3

	Suggested Fertilizer Program[1]				
Nutrient	Agvise	A & L	Harris	Eco-Agri[2]	U of MN
	- - - - - - - -	- - - - - - -	lb/acre	- - - - - - - -	- - - -
Nitrogen	132	140	175	150	150
Phosphorus (P_2O_5)	86	50	75[3]	80	35
Potassium (K_2O)	30	90	90[3]	100	30
Sulfur	0	13	10	0	0

[1] All values indicate pounds of nutrient suggested per acre for a yield goal of 130 bushels per acre for corn.
[2] Suggested applications are the minimum to obtain the desired yield goal.
[3] Values include maintenance plus 1/2 of suggested buildup.

General

The experimental design is a randomized complete block with four replications on each crop. Two blocks, each with 24 plots, are adjacent and alternate between wheat and corn. The plot size is 15 feet by 40 feet. Row spacing on the corn is 30 inches.

Wheat

The fertilizer was applied by hand on October 29, 1985. All plots were then moldboard plowed. In the spring the plots were field cultivated and dragged. On May 7, 1986, the plots were seeded to Marshall wheat @ 1 3/4 bu/acre. Bronate was applied @ .25 + .25 lb/acre on June 4 and Hoelon @ 1.25 lb/acre on June 9. The plots were harvested with a plot combine on August 19.

Corn

The fertilizer was applied by hand on October 29, 1985. All plots were then moldboard plowed. In the spring the plots were field cultivated and dragged. On May 21, 1986, the plots were planted to Dekalb-Pfizer T950 @ 24,300 seeds/acre. Lasso @ 3 lb/acre and Bladex @ 2.2 lb/acre were applied broadcast on May 21. The plots were harvested on October 14 with a plot combine.

Results and Discussion of the Wheat Trial

The soil tests and fertilizer recommendations for wheat are shown in Table 1. For the major nutrients, there was very little difference in test results between labs. For Na, Cu, and B there were wide differences between labs. As in the past the recommendations for N, P, and K varied

widely between labs. The N recommendation varied from 0 with Eco-Agri to 115 lb/acre with A & L. The P and K recommendations varied over 2-fold with the highest values by Harris. The lowest P recommendation was by Eco-Agri and the low K by U of MN. The two labs (A & L and Harris) recommended sulfur and A & L recommended manganese.

Wheat yield (Table 3) was closely related to N application with the A & L recommendation giving the highest yield and Eco-Agri giving the lowest yield. The return over the check for wheat in 1986 (Table 4) was greatest for A & L at $40.33 and smallest for Harris at $23.70.

Table 3. Effect of fertilizer recommendations on various plant measurements - 1986.

	Wheat				Corn	
Lab	Plant Lodging	Plant Height at Harvest	Grain Yield	Grain Moisture	Grain Yield	Grain Moisture
	-Score[1]-	-inches-	Bu/A	%	Bu/A	%
Agvise	1	23.3	40.5	15.7	154.3	37.3
A & L	1	25.5	50.9	14.8	166.4	37.3
Harris	1	24.0	41.8	15.7	171.5	36.9
Eco-Agri[2]	1	21.0	32.5	16.2	149.8	38.3
U of MN	1	21.8	37.7	15.2	153.4	38.2
Check	1	19.3	17.2	15.9	78.9	38.7
Signif. level (%)	0	>99	>99	94	>99	78
BLSD (.05)	NS	2.3	7.0	1.1	17.7	NS
CV (%)	0	6.8	13.4	3.9	8.7	2.9

1 Lodging score: 1 = No lodging, 9 = Flat.
2 Tested by Willmar, 1980-83.

Table 4. Economic return over fertilizer costs - 1986.

	Wheat				Corn			
Lab	Value of Crop @ $2.50/Bu	Fertilizer Cost[1]	Return over Fertilizer	Return over Check	Value of Crop @ $2.00/Bu	Fertilizer Cost	Return over Fertilizer	Return over Check
	- - -	- - -	- - -	- - - $/A	- - -	- - -	- - -	- - -
Agvise	101.25	19.78	81.47	38.47	308.60	43.60	265.00	107.20
A & L	127.25	43.92	83.33	40.33	332.80	46.94	285.86	128.06
Harris	104.50	37.80	66.70	23.70	343.00	57.40	285.60	127.80
Eco-Agri[2]	81.25	10.85	70.40	27.40	299.60	52.00	247.60	89.80
U of MN	94.25	20.80	73.45	30.45	306.80	36.70	270.10	112.30
Check	43.00	0	43.00	-	157.80	0	157.80	-

1 Values used ($/lb) were: N = $0.18, P_2O_5 = $0.20, K_2O = $0.09, S = $0.28, Zn = $0.40, Mn = $1.05.
2 Tested by Willmar 1980-83.

Results and Discussion of the Corn Trial

The soil tests and fertilizer recommendations for corn are shown in Table 2. For the major nutrients the tests do not vary much between labs. Wide ranges in soil tests show up for Na, Cu, and B. The nitrogen recommendations range from 132 lb/acre with Agvise to 175 lb/acre with Harris. The phosphorus recommendations range from 35 lb/acre with U of MN to 86 lb/acre with Agvise. For K the range is from 30 lb/acre with Agvise and U of MN to 100 lb/acre with Eco-Agri. Both A & L and Harris have a recommendation for sulfur.

Corn yield (Table 3) ranged from 149.8 bu/acre with Eco-Agri to 171.5 bu/acre with Harris. The highest yield occurred with the highest N recommendation, but the lower yields were not directly related to N application. The return over check for corn in 1986 (Table 4) was greatest for A & L and Harris and lowest for Eco-Agri.

Seven-Year Summary

The combined average return per year for 1980-86 shows a range of $49.81 (Harris) to $89.77 (U of MN) over the check (Table 5). For wheat, Harris shows the smallest return over check while U of MN shows the greatest. For corn, A & L, Harris, and Eco-Agri are low and show similar results while Agvise and U of MN are high and show similar results.

Table 5. Seven-year summary of yields and economic returns 1980-1986.

	Wheat[1]				Corn[2]				
Lab	Aver. 7-year Yield	Total 7-year Fertilizer Cost	Economic Return over Fertilizer	Return over Check	Aver. 7-year Yield	Total 7-year Fertilizer Cost	Economic Return over Fertilizer	Return over Check	Combined Average Return per Year
Agvise	59	184.30	1384.40	343.70	120	352.29	1712.40	205.74	78.49
A & L	62	298.92	1333.58	292.88	119	419.02	1618.94	112.28	57.88
Harris	61	325.43	1277.87	237.17	122	483.11	1618.19	111.53	49.81
Eco-Agri[3]	58	217.68	1311.62	270.92	118	431.04	1608.94	102.28	53.31
U of MN	61	153.23	1455.12	414.42	119	292.12	1720.60	213.94	89.77
Check	39	0	1040.70	-	86	0	1506.66	-	-

[1] Wheat valued at $4/bu, 1980-84, $3.50/bu for 1985, and $2.50/bu for 1986.
[2] Corn valued at $3.00, $2.40, $2.00, $3.00, $2.80, $2.07, and $2.00/bu in 1980, 1981, 1982, 1983, 1984, 1985, and 1986, respectively.
[3] Tested by Willmar, 1980-83.

Final Soil Tests

Soil samples from the 0 to 8-inch zone were taken from each plot at the conclusion of the study in the fall of 1986. The samples were combined by treatment. Samples from the two blocks (one in corn each year and the other in wheat) were kept separate. All samples were sent to the U of MN lab for analysis. The results are reported in Table 6 along with the total N, P_2O_5, K_2O, and Zn applications for each treatment within each block

The total nitrogen application rate varied 3- to 4-fold between labs while the yields (Table 5) show no significant difference in average yield. The range in P application rates was 92 lb/acre on Block 1 and 159 lb/acre on Block 2. The higher rates generally resulted in a buildup of the soil P levels. The K application rate also varied widely with about a 4-fold difference between labs. Again the higher rates are reflected in higher K soil test levels. The Zn application with A & L, Harris, and Eco-Agri are also reflected in higher Zn soil tests. However, the Minnesota research results show that 1.0 ppm is adequate and only when levels are below 0.5 ppm is Zn required for sensitive crops.

Overall, the seven-year study shows the labs which gave fertilizer recommendations similar to the U of MN have yields which were not significantly different from labs which gave considerably higher total plant food recommendations. The higher application rates of P, K, and Zn are reflected in soil tests, so future applications of these fertilizers could be reduced.

Table 6. Total N, P, K, and Zn applications and final soil test results.

Block 1

Lab	Total 7-year Fert. Appl. N	P_2O_5	K_2O	Zn	Soil Test Results pH	Bray P	Olsen P	Ex. K	Zinc	Org. Matter
	- - - - lb/acre - - - -					- - - lb/acre - - - -			ppm	%
Agvise	659	457	325	0	8.0	38	27	204	1.3	4.3
A & L	737	405	670	6.0	7.9	37	27	249	1.8	4.5
Harris	858	452	938	7.5	7.9	39	29	249	1.8	4.5
Eco-Agri[1]	774	401	584	8.0	8.0	37	26	276	2.3	4.2
U of MN	580	365	200	0	8.0	30	21	198	1.2	4.0
Check	- -	- -	- -	- -	8.0	20	16	226	1.5	4.3

Block 2

Lab	Total 7-year Fert. Appl. N	P_2O_5	K_2O	Zn	Soil Test Results pH	Bray P	Olsen P	Ex. K	Zinc	Org. Matter
	- - - - lb/acre - - - -					- - - lb/acre - - - -			ppm	%
Agvise	607	506	375	0	8.1	5	24	216	1.0	3.3
A & L	860	485	665	8.5	8.1	26	21	219	1.6	3.9
Harris	815	566	1238	6.0	8.2	14	23	283	1.3	3.4
Eco-Agri[1]	489	407	645	14.0	8.1	23	18	232	2.1	3.9
U of MN	545	425	318	0	8.1	23	19	190	1.1	3.9
Check	- -	- -	- -	- -	8.2	2	10	186	1.0	3.5

[1] Willmar recommendations followed from 1980-83.

EFFECT OF LIQUID STARTER RATE, PLACEMENT, AND ANALYSIS ON CORN GROWTH AND YIELD

S. D. Evans and G. A. Regimbal

Morris, 1986

With the increase in reduced tillage systems, many new types of fertilizer placement devices have been developed to overcome the adverse effects of plant residues on operation of fertilizer placement disks or knives outside the seed opener area. One of these devices is a knife mounted inside the double disk opener on minimum tillage row crop planters. This device supposedly places the liquid fertilizer 1/2 to 3/4 inch to the side and 1/2 to 1 inch below the seed. The close proximity to the seed may cause seedling damage at high starter rates. This study was set up to examine the effect of three liquid fertilizers (7-21-7, 9-18-9, and 10-34-0) with three seed placements (with the seed, near the seed, and 2" x 2" placement).

Experimental Procedures

The study was located on a Hamerly clay loam (Aeric Calciaquoll). Nitrogen as urea was applied to provide 120 lb/acre of N. The area was field cultivated once before the urea application and once after in preparation for planting. The soil tests were: pH=7.1, O.M.=High, Bray P=60 lb/acre, and exchangeable K=501 lb/acre.

The design was a split-split plot with four replications. Main plot treatments consisted of three liquid starters (7-21-7, 9-18-9, and 10-34-0), subplot treatments of three rates of each fertilizer (5, 10, and 15 gal/acre for 7-21-7 and 10-34-0 and 4, 8, and 12 gal/acre for 9-18-9), and sub-subplot treatments of three placement methods (with the seed, near the seed and 2 inches to the side and 2 inches below the seed). There was a zero starter check in each subplot.

Corn (Pioneer 3906) was planted in 30-inch rows with a Hiniker minimum tillage planter with Kinze planter units at 24,300 plants/acre on May 6-7. Chemical weed control consisted of 3 lb/acre of Lasso and 2.2 lb/acre of Bladex applied broadcast on May 14.

Plant counts to obtain emergence rate, final emerged stand and harvest stand were taken from one row for a length of 40 feet. Grain yield was determined by harvesting 2 rows 40 feet long with a modified JD 3300 combine.

Results and Discussion

In the two days following planting over 2 inches of rain fell (Table 1). This possibly diluted the fertilizer bands and lessened potential salt damage. There was also 0.78 inch of rain the fifth day after planting. Temperatures at the 2-inch depth ranged from 47° to 62°F and averaged 55°F.

Salt values (Table 2) ranged from 5.8 lb/acre at the 5-gal/acre rate of 10-34-0 to 23.5 lb/acre at the 15 gal/acre rate of 7-21-7 and the 12 gal/acre rate of 9-18-9. The Minnesota salt limit for placement with the seed is 5-7 lb/acre on fine-textured soils.

Emergence rate was significantly affected by placement (Figure 1) with the check (CK) and with the seed (WS) treatments emerging before the near the seed (NS) and 2" x 2" treatments. Material and rate of material did not affect emergence rate. The emerged population shows a significant rate x placement interaction (Figure 2). All treatments except the NS treatment showed a decrease in emerged population as rate was increased.

The WS and NS treatments were significantly taller than the 2" x 2" and CK treatments as measured on June 13 (Figure 3). All treatments were the tallest at the medium fertilizer rate and decreased in height at the high rate. Material and the rate x material interaction effects on height were not significant.

There was a significant three-way interaction (P=96%) between rate x material x placement (Figure 4). For 10-34-0 yield increased from 5 to 10 gal/acre and then either leveled off or decreased at 15 gal/acre. The 7-21-7 material showed very little yield variation due to rate for the WS and NS treatments. The 2" x 2" treatment was highest yielding at the 5 gal/acre and then decreased sharply

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at 10 and 15 gal/acre. The NS treatment for 9-18-9 behaved similarly. Yield decreased from 4 to 8 gal/acre and then leveled off from 8 to 12 gal/acre. The NS treatment averaged approximately 10 bu/acre greater than the CK. The WS treatment increased 10 bu/acre from 4 to 8 gal/acre and then decreased 10 bu/acre from 8 to 12 gal/acre. The 2" x 2" treatment varied only a few bushels for all rates.

Summary

The application of liquid starter did not enhance the emergence of corn in 1986 because of check treatment with no fertilizer emerged as fast or faster than all other treatments. There was some indication of a detrimental effect of the high rate of fertilizer with the seed on emerged population and early plant height, but some of the other placement methods also showed this effect. There was no significant difference between materials for emerged population or early plant height.

The effects on grain yield were quite varied. The near seed placement yielded more than the check in all cases except for the low rate of 10-34-0. The with seed placement showed a decrease in yield at the high rate with 10-34-0 and 9-18-9. The with seed placement on 7-21-7 showed no effect on yield regardless of rate.

The 1986 results indicate some precaution should be taken in applying liquid fertilizer with or near the seed. The differences and trends observed in 1986 were small due to rainfall soon after planting, average soil temperatures, and the high phosphorus soil test.

Table 1. Daily precipitation and average soil temperature (2" depth) in the 2-week period following planting.

Days after planting	Avg. Soil temperature (2")	Precipitation
	- °F -	- inches -
1	47	1.85
2	48	0.18
3	55	Trace
4	62	0
5	62	0.78
6	57	0
7	59	0
8	59	0
9	56	0
10	48	0
11	51	0
12	54	0
13	56	0
14	56	0

Table 2. Salt rate as influenced by starter fertilizer material and rate of application.

Application rate	Liquid fertilizer 10-34-0	7-22-5	9-18-9
		- lb N + K_2O -	
Low	5.8	7.8	7.8
Medium	11.7	15.6	15.7
High	17.6	23.5	23.5

Figure 1. Influence of Liquid Starter Fertilizer Placement on Emergence Rate.

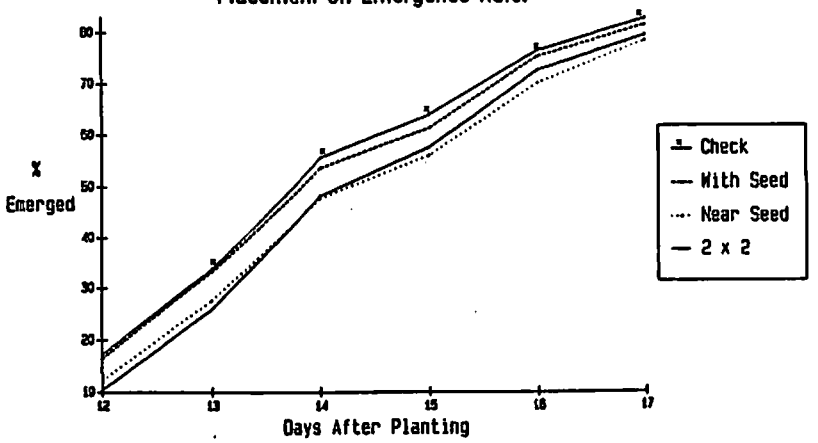


Figure 2. Influence of Liquid Starter Fertilizer Application Rate and Placement on Emerged Population.

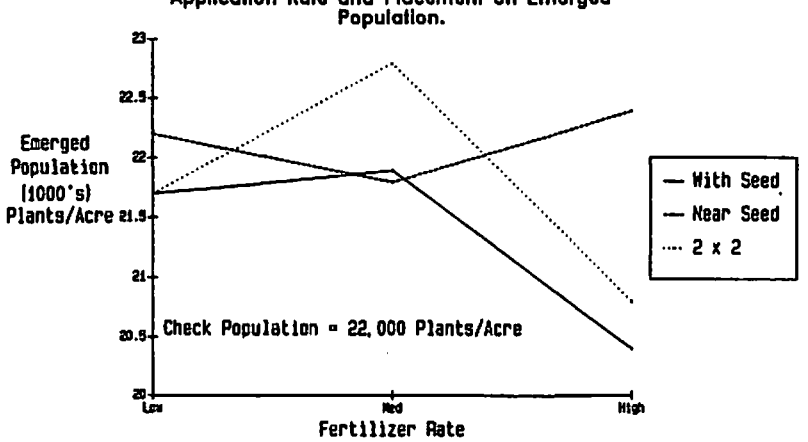


Figure 3. Plant Height on 6-13-86 as affected by Liquid Starter Fertilizer Application Rate and Placement.

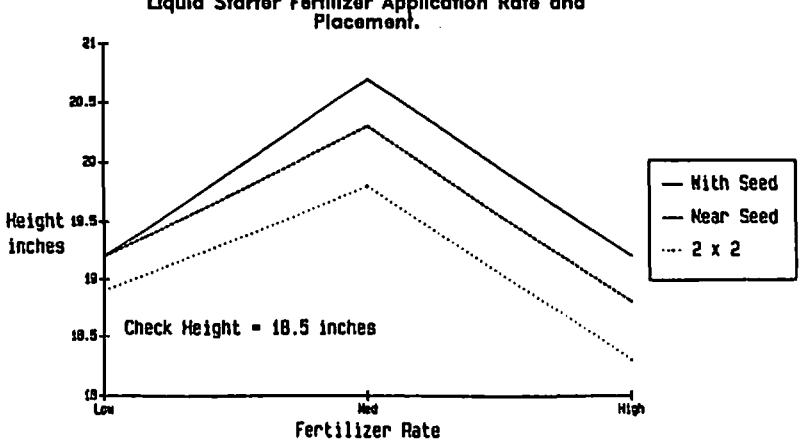
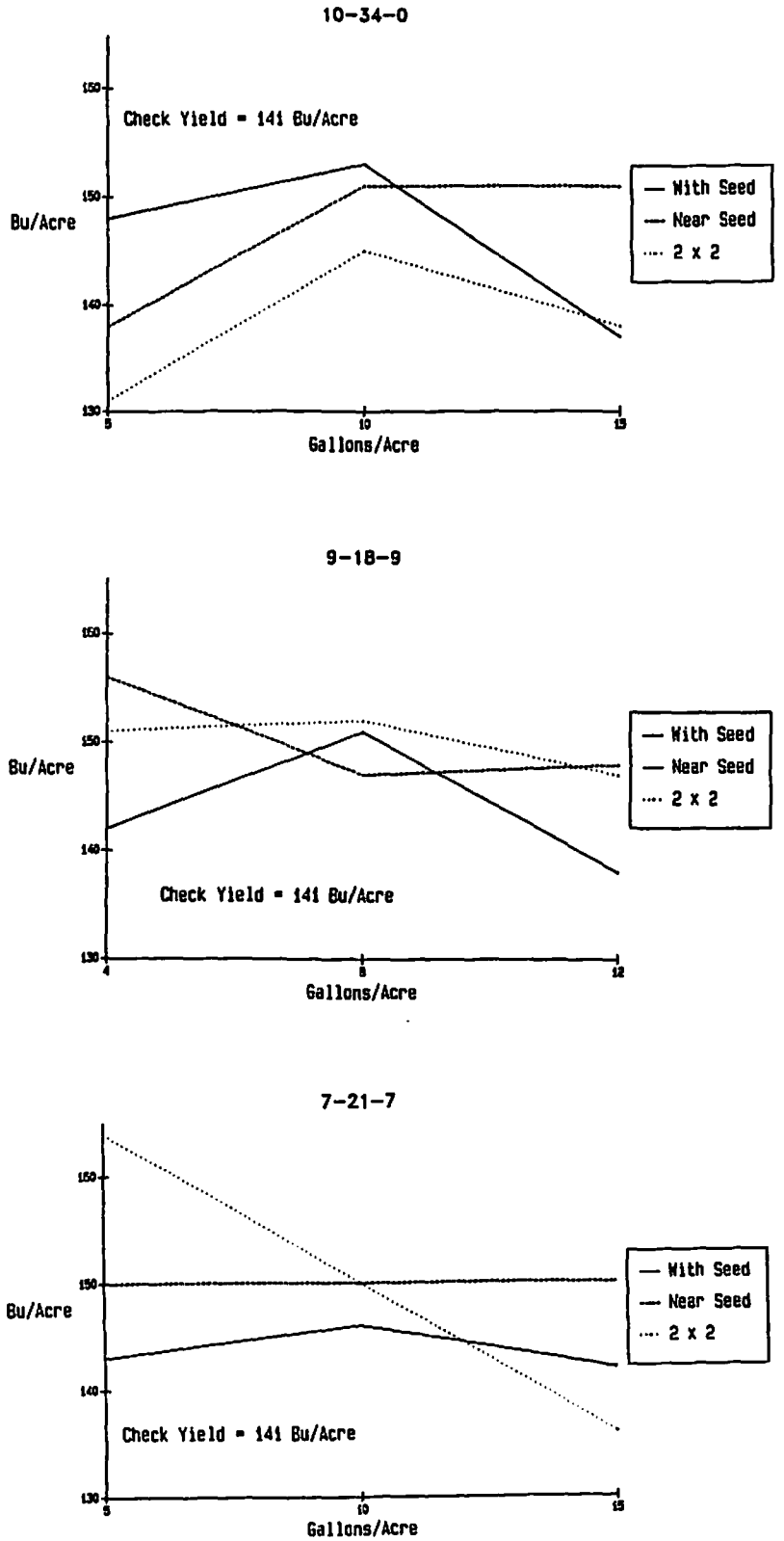


Figure 4. Influence of Liquid Starter Fertilizer Material, Application Rate, and Placement on Corn Grain Yield.



SOYBEAN TILLAGE STUDY

S. D. Evans, J. F. Moncrief, and G. A. Regimbal
Morris, 1986

The purpose of this study was to investigate various methods of no-till seeding of soybeans into the previous year's wheat stubble where the straw was chopped. In a previous study at the West Central Experiment Station stands were reduced in some years for soybeans no-till seeded in 10-inch rows into standing wheat stubble. This was particularly evident in areas of concentrated chaff from the combine.

Experimental Procedures

The experimental site is located at the West Central Experiment Station on a Aastad clay loam (Pachic Udic Haploboroll). The experimental design is a randomized complete block with four replications. The treatment descriptions are given in Table 1 and the cultural practices in Table 2. Stand counts were made on one 10-foot row in each plot. Residue levels were measured on June 2 by the line intercept method. With the Hiniker and Haybuster treatments, row and interrow areas were measured separately. All of the implements worked well except in treatment 7 were the soil was so loose it tended to pile up in front of the drill and was pushed to the end of the plot. The plots were handweeded once on June 19 to remove the yellow goatsbeard which were present in a number of the no-till plots.

Results and Discussion

The residue levels soon after planting are shown in Table 4. The levels in the row varied from 16% to 86%. Most of the no-till treatments had the highest levels of residue while the Hiniker, moldboard, spring disk, and chisel treatments had much lower levels of residue. Comparison of the row vs. between row residue levels shows a greater difference with the Hiniker than with the Haybuster.

The rate of soybean emergence as measured by percentage of final stand on various dates during the emergence period (Table 3) were not significantly affected by tillage. All treatments were at least 90% emerged by day 17 except the Haybuster treatment which emerged slower.

Comparing all treatments planted with the GT drill, the spring disk, spring chisel plow, and drag treatments were the lowest in population (Table 4) while treatments 3 and 8 (no-till) were highest in population. The Hiniker and Haybuster treatments had the highest populations and it is not possible to determine if this is a treatment effect or due to an increased seeding rate with these implements.

Weed population differences were estimated just prior to harvest (Table 4). The highest level of broadleaf control was with the Hiniker treatment which was cultivated twice and with treatment 8 which had Basagran in addition to Lasso. The lowest levels were with spring disk, drag, and fall moldboard. The no-till treatments and spring chisel were intermediate. There were no significant differences in foxtail control.

Volunteer wheat was present in many plots and the population was also estimated on October 8 (Table 4). Populations were highest with the Haybuster and the drag treatments.

Plant height and lodging (Table 5) were significantly affected by tillage. The treatments with the lowest populations tended to be taller while the higher population treatments were shorter. Lodging appeared to be inversely related to height.

Grain yield (Table 5) was not significantly affected by tillage. However, the slight differences that did occur seem logical. Treatment 1 with the Hiniker on 30-inch rows was the 2nd lowest yielding while treatment 8 with the extra herbicide was the highest yielding. The drag treatment was lowest yielding. This may be due to a combination of factors such as high residue level in the row, low population, low broadleaf and foxtail control and a high level of volunteer wheat.

Overall, the no-till treatments with the GT drill yielded quite well. The Haybuster treatment did not work well in the moist soils of the spring of 1986. Weed control was a problem, particularly the pigweed and lambsquarters, but the populations were reduced by an application of Basagran.

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Table 1. Treatments included in soybean tillage study, Morris, 1986.

Treatment No.	Treatment Description+
1	No-till, Hiniker 30-inch row crop planter
2	No-till, Haybuster 10-inch hoe drill
3	No-till, GT 10-inch no-till disk drill
4	Spring Disk 2X, GT 10-inch no-till disk drill
5	No-till, Drag stubble 1X, GT 10-inch no-till disk drill
6	Fall moldboard plow, Spring disk 2X, Drag 1X, GT 10-inch no-till disk drill
7	Spring chisel plow, Spring disk 1X, GT no-till disk drill
8	No-till, GT 10-inch no-till disk drill

+ Weed Control:
(1) Treatments 2-7, Lasso (3 lb/acre a.i.) + Paraquat (½ lb/acre a.i.), preemerge to the soybeans, broadcast on May 31.
(2) Treatment 1, Lasso (3 lb/acre a.i.) + Paraquat (½ lb/acre a.i.), preemerge to the soybeans, 15-inch band over row on May 31, 2 cultivations (6/20 & 7/3).
(3) Treatment 8, Lasso (3 lb/acre a.i.) + Paraquat (½ lb/acre a.i.), preemerge to the soybeans, broadcast on May 31 + Basagran (1 lb/acre a.i.) + oil (1 qt/acre), broadcast on July 2.

Table 2. Cultural practices, 1986.

Preceding Crop
Hard red spring wheat
Stubble height - approximately 12 inches

Plot Size - 20 feet wide x 50 feet long

Tillage
No-till
Chisel plow - spring, May 30
Moldboard plow - October 25, 1985

Soil Tests (Fall 1985) by Rep
pH - 6.7 to 7.4
Bray P - 63 to 92 lb/acre, Ave. = 78 lb/acre
Exch. K - 354 to 506 lb/acre, Ave. = 445 lb/acre

Fertilizer - None applied

Variety - Evans, planted May 30

Seeding Rate
Hiniker planter - 65 lb/acre
Haybuster drill - 70 lb/acre
GT drill - 70 lb/acre

Harvest - October 10 with plot combine

Harvest Area
30-inch rows: 2 rows x 40 feet
10-inch rows: 5 rows x 40 feet

Table 3. The effect of tillage on rate of soybean emergence.

Trt. No.	Treatment Description: Tillage	Planter	Row Width	Days after Planting: 7	10	12	14	17	19	26
				% of final stand						
1	No till	Hiniker	30	19	75	82	91	100	100	100
2	No till	Haybuster	10	4	49	56	66	83	88	100
3	No till	GT	10	10	68	73	81	97	97	100
4	Spring Disk	GT	10	3	65	76	94	96	96	100
5	No till, Drag	GT	10	0	47	55	76	92	96	100
6	Moldboard	GT	10	12	55	61	75	95	100	100
7	Chisel	GT	10	13	71	79	92	98	98	100
8	No till[1]	GT	10	19	71	75	84	96	96	100
Significance Level:				82	57	76	84	52	35	0

[1] Extra herbicide = Basagran + oil

Table 4. The effect of tillage on various parameters.

Trt. No.	Treatment Description: Tillage	Planter	Row Width	Residue Level[1] on June 2: 0	R	B	Final Emerged Stand	Weed Control[2] on October 8: Broadleaf	Foxtail	Volunteer[3] Wheat on October 8
			- in -	- -	%	- -	pl/acre x 10^{-3}	- - - -	%	- - - -
1	No till	Hiniker	30	-	49	82	143	85	81	2.0
2	No till	Haybuster	10	-	82	87	121	69	92	3.2
3	No till	GT	10	76	-	-	97	64	91	2.5
4	Spring Disk	GT	10	52	-	-	58	51	94	1.5
5	No till, drag	GT	10	84	-	-	62	55	78	3.5
6	Moldboard	GT	10	16	-	-	74	48	88	1.0
7	Chisel	GT	10	50	-	-	64	68	89	1.5
8	No till[4]	GT	10	50	-	-	88	94	96	1.5
Significance Level:				-	>99[5]	>99[5]	>99	96	94	>99
LSD (.05) :				-	7	8	30	9	-	1.5

[1] Residue Level: 0 = Overall, R = 10 cm area centered on row, B = area between the rows

[2] Weed Ratings: (1) Broadleaf - mainly pigweed and lambsquarters worst area, 5-6 plants/m^2
(2) Foxtail - worst area, 2 plants/m^2

[3] Wheat: 1 = no wheat, 5 = highest population, worst area = 1 plant/m^2

[4] Extra herbicide = Basagran + oil

[5] Row area significance level and LSD calculated from row residue for the first two treatments and overall residue from other treatments. Between row significance level and LSD calculated from between row residue from the first two treatments and overall residue from the other treatments.

Table 5. The effect of tillage on harvest measurements.

Trt. No.	Treatment Description			Plant Height	Lodging[1]	Grain Moisture	Soybean Yield
	Tillage	Planter	Row Width				
			- in -	- in -		- % -	bu/acre
1	No till	Hiniker	30	39	2.2	12.8	45.7
2	No till	Haybuster	10	36	3.0	13.2	49.9
3	No till	GT	10	41	3.0	12.8	47.8
4	Spring Disk	Gt	10	42	4.0	13.7	49.6
5	No till, Drag	GT	10	36	3.0	12.9	41.8
6	Moldboard	GT	10	40	3.2	13.3	50.8
7	Chisel	GT	10	42	3.5	13.2	49.4
8	No till[2]	GT	10	37	2.2	12.7	52.7
Significance Level:				95	>99	50	73
LSD (.05) :				4	0.7	- -	- -

[1] Lodging Score: 1 = Erect, 5 = Flat

[2] Extra herbicide = Basagran + oil

ALFALFA FERTILITY-MANAGEMENT STUDY

S. D. Evans, C. C. Sheaffer and G. A. Regimbal
Morris, 1986

With the newer alfalfa management procedures, higher yields have resulted. In many cases this might put the plant under greater stress, so it is important to investigate the effect of P and K fertilization on alfalfa yield and stand longevity. Therefore, a study was set up at Morris in 1983 to investigate the effect of (1) P and K fertilization, (2) alfalfa cutting schedule and (3) variety on alfalfa.

Experimental Procedures

The experiment was set up in 1983 on a Tara silt loam (Pachic Udic Haploboroll) site that tested medium in Bray P (19 lb/acre) and high in exchangeable K (234 lb/acre). The experiment was direct seeded on May 23-24, 1983. The design was a split-split plot with four replications. The main plots were cutting schedule. The first split was P and K fertilizer and the second split was variety. In 1983 the area was harvested but no yields were taken and no fertilizer applied. In 1984-1986 the cuttings were taken as scheduled. Fertilizer was applied by hand after the first cutting except for the 300- and 400-lb K rates where 200 lb/acre was applied after the first cutting and the remainder after the second cutting. The 4-cut schedule was harvested on May 29, June 27, July 30, and September 4. The 3-cut schedule was harvested on June 6, July 7, and August 13. Yields were taken with a small flail chopper, weighed and a moisture sample collected from each plot. Samples of the Answer variety were saved for chemical analysis. Soil samples were taken of the 0 to 2-inch and 2- to 8-inch zones in early September.

Results and Discussion

After three crop years no significant difference in total seasonal yield has occurred between the two varieties used (Tables 1 and 2). There was also very little difference between varieties at the individual cuttings (Table 4). In 1986 the 3-cut schedule outyielded (P = 93%) the 4-cut schedule (Table 3), similar to the results in 1985. The addition of P fertilizer has increased yields significantly in all years (Tables 1 and 2). The addition of K fertilizer affected yields very little in 1984 and 1985. In 1986 there was a trend for higher yields with increasing K rates, particularly on the 4-cut system (Tables 1 and 2). Dry matter percentage (Table 5) was significantly affected by PK treatment in all of the cuttings. In all cases the No-P treatment was drier than the 50-P and 100-P treatments.

Statistical analysis of the soil tests shows many significant fertilizer effects in the 0 to 2-inch and the 2- to 8-inch soil zones (Table 6). Increasing either P or K fertilizer generally increased both the P and K soil tests in the 0 to 2-inch and 2- to 8-inch zones (Tables 7 and 8). Cutting schedule also significantly affected P levels, especially at the high rate, with the lower yielding 4-cut schedule having higher P soil tests (Table 7). In 1985 the same effect was evident, but P = 87% for cutting schedule.

The summary of the plant analysis shows many elements significantly different depending on the cut and also the PK treatment (Table 9). Many elements other than P and K are significantly different even though only P and K were applied.

Only selected fertilizer treatments of the 3-cut system of Answer have been analyzed so far. They include the 0, 50, and 100 lb P_2O_5/acre treatments at a constant level of 200 lb K_2O/acre and the lowest and highest rates of K_2O (0 and 400 lb/acre) with a constant level of 50 lb P_2O_5/acre.

The summary of the plant analysis data shows many elements significantly affected by fertilizer treatment and cut (Table 9). All elements were significantly affected by cut. Elements affected by PK treatment were P, K, Ca, Mg, Na, Zn, and B. The interaction between cut and PK treatment was not significant.

The actual levels of P and K are shown in Table 10. Both P and K were highest in the 2nd cutting, intermediate in the 3rd cutting and lowest in the first cutting. Within a cutting the P levels increased with increasing P fertilizer and K levels increased with increasing K fertilizer.

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Table 1. Effect of cutting schedules, P and K fertilization and varieties on alfalfa yields at Morris in 1986.

Fertilizer Rate		1/2 Bud (4 cuttings) Variety			1/10 Bloom (3 cuttings) Variety			Average over Fertilizer
P_2O_5	K_2O	Vernal	Answer	Average	Vernal	Answer	Average	
- lb/acre -		Dry Matter (T/acre)						
0	200	2.78	2.71	2.75	3.08	3.08	3.08	2.91
50	200	4.18	4.25	4.21	4.81	4.75	4.78	4.50
100	200	4.47	4.52	4.49	5.14	4.86	5.00	4.75
50	0	3.92	3.98	3.95	4.19	4.47	4.33	4.14
50	100	3.93	4.07	4.00	4.78	4.52	4.65	4.33
50	200	4.27	4.04	4.16	4.69	4.69	4.69	4.42
50	300	4.26	4.15	4.20	4.75	4.77	4.76	4.48
50	400	4.40	4.49	4.44	4.70	4.85	4.78	4.61
Average		4.03	4.03	4.03	4.52	4.50	4.51	4.27

CV = 6.5%

Table 2. Effect of P and K fertilization and variety on alfalfa yields at Morris in 1986.

Fertilizer Rate		Varieties	
P_2O_5	K_2O	Vernal	Answer
- - lb/acre - -		Dry Matter (T/acre)	
0	200	2.93	2.89
50	200	4.49	4.50
100	200	4.80	4.69
50	0	4.05	4.22
50	100	4.36	4.30
50	200	4.48	4.37
50	300	4.50	4.46
50	400	4.55	4.67
Average		4.27	4.26

CV = 6.5%

Table 3. Effect of cutting schedule, P and K fertilization and variety on alfalfa yields.

Variable	Signif. level[1]
	- % -
Cutting Schedule (CS)	93
PK Treatment (PK)	>99
CS x PK	7
Variety (V)	17
CS x V	15
PK x V	22
CS x PK x V	36

[1] Probability that differences are not due to change.

Table 4. Effect of P and K fertilization and variety on alfalfa yields by individual cuttings.

Variable	3-cut Schedule 1st	2nd	3rd	4-cut Schedule 1st	2nd	3rd	4th
	Signif. level (%)[1]						
PK Treatment (PK)	>99	>99	>99	98	>99	>99	>99
Variety (V)	4	32	88	89	95	37	31
PK x V	60	47	84	11	76	62	63

[1] Probability that differences are not due to chance.

Table 5. Effect of P and K fertilization and variety on alfalfa dry matter percentage by individual cuttings in 1986.

Variable	3-cut Schedule 1st	2nd	3rd	4-cut Schedule 1st	2nd	3rd	4th
	Signif. level (%)[1]						
PK Treatment (PK)	>99	>99	>99	99	>99	>99	>99
Variety (V)	98	59	64	23	32	85	58
PK x V	71	51	77	97	76	75	38

[1] Probability that differences are not due to chance.

Table 6. Effect of cutting schedule and P and K fertilization on Answer only on soil test levels in September 1986.

Variable	Soil Tests (lb/acre) Bray P 0-2"	Bray P 2-8"	Olsen P 0-2"	Olsen P 2-8"	Exch. K 0-2"	Exch. K 2-8"
	Signif. level (%)[1]					
Cutting Schedule (CS)	98	98	98	87	73	0
PK Treatment (PK)	>99	99	>99	97	>99	96
CS x PK	>99	>99	>99	97	98	63

[1] Probability that differences are not due to chance.

Table 7. Effect of P rate on Answer only on soil test P of the 0-2 and 2-8 inch soil zones in September 1986.

Fertilizer Rate P_2O_5	K_2O	0-2 inch Bray P 3-Cut	Bray P 4-Cut	Olsen P 3-Cut	Olsen P 4-Cut	2-8 inch Bray P 3-Cut	Bray P 4-Cut	Olsen P 3-Cut	Olsen P 4-Cut
lb/acre		lb/acre				lb/acre			
0	200	7	7	5	4	7	6	4	4
50	200	12	16	9	11	7	9	4	5
100	200	29	59	22	48	6	11	4	7

Table 8. Effect of K rate on Answer only on soil test K of the 0-2 inch soil zone in September 1986.

Fertilizer Rate P_2O_5	K_2O	Exch. K 0-2 inch 3-Cut	0-2 inch 4-Cut	2-8 inch 3-Cut	2-8 inch 4-Cut
lb/acre		lb/acre			
50	0	190	189	177	178
50	100	232	204	183	178
50	200	250	250	172	182
50	300	364	452	185	199
50	400	516	646	204	199

Table 9. Summary of analysis of Answer alfalfa from the 3-cut schedule in 1985.

Variable	Element										
	P	K	Ca	Mg	Al	Fe	Na	Mn	Zn	Cu	B
	Signif. level (%)[1]										
Cut	>99	>99	99	>99	>99	>99	98	>99	99	98	76
PK	>99	>99	>99	>99	83	83	99	87	96	46	>99
PK x Cut	84	13	5	13	44	38	62	1	38	41	52

[1] Probability that differences are not due to chance.

Table 10. Effect of cut and fertilizer rate on P and K plant levels of alfalfa in 1985.

Fertilizer Rate		P			K		
P_2O_5	K_2O	1st Cut	2nd Cut	3rd Cut	1st Cut	2nd Cut	3rd Cut
lb/acre		%					
0	200	.120	.157	.127	1.94	2.72	2.19
50	200	.154	.238	.194	1.87	2.90	2.32
100	200	.168	.253	.215	1.99	2.85	2.18
50	0	.140	.255	.204	1.65	2.22	1.71
50	400	.147	.233	.196	2.09	2.91	2.43

METHOD OF FOLIAR NITROGEN APPLICATION ON THREE SPRING WHEAT VARIETIES

S. D. Evans, E. A. Oelke, and G. W. Rehm
Morris, 1986

The past two or three years there has been an increased interest in wheat protein levels because of premiums for high protein. This study was established to investigate the effect of application of small amounts of foliar nitrogen at the early anthesis on yield and protein level of spring wheat.

Experimental Procedures

The experiment was established on a Hamerly clay loam (Aeric Calciaquoll). Soil test levels in the spring of 1986 were as follows: pH = 7.4, Olsen P = 16 lb/acre, exchangeable K = 338 lb/acre, NO_3-N (0-2 ft) = 48 lb/acre, and O.M. = high.

A randomized complete block design with four replications was used. Plot size was 8 ft x 45 ft. Factorial treatments consisted of three hard red spring wheat varieties: Wheaton, Len and Stoa, and four nitrogen fertilizer rate/timing treatments as follows:

Symbol	Extra 50 lb/acre N Preplant	Cerone @ .25 lb/acre	10 lb/acre N-Foliar
Rec	No	No	No
+10 BC	No	No	Below Canopy
+10 TC	No	No	Above Canopy
+50	Yes	Yes	No

All treatments received 82 lb/acre of N as urea preplant incorporated, 100 lb/acre of 18-46-0 with the drill at seeding, and Dithane M-45 at 2 lb/acre + Tritron CS-7 at 1/2 pt/acre for disease control on June 24, July 7, and July 4. The plots were seeded on May 5. The seeding rates were adjusted for seed size and germination to provide the same number of viable seeds/acre. Hoelon was applied at 1.25 lb/acre a.i. on June 9 and Bronate at .25 + .25 lb/acre a.i. on June 13. The Cerone was applied on June 20 when the plants were in Feekes stage 8-9 (flag leaf emerged to collar visible). The foliar N was applied on June 24 in the late morning when the plants were in Feekes stage 10.1-10.2 (first spikelet to one-fourth of the head visible). The N source was 28-0-0 dissolved in water and applied at 20 gal/acre (635 cc 28-0-0/gal of spray). The below canopy treatments were applied with drop nozzles. The plots were harvested with a plot combine on August 12. Lodging evaluation and plant heights were taken on August 12 just prior to harvest. Samples of the grain were taken for moisture and protein determination.

Results and Discussion

There was a slight amount of leaf burn with the +10 TC treatment, but the plants recovered in 7-10 days following treatment. There was no apparent tissue damage with the +10 BC treatment.

There was both a variety and nitrogen effect on lodging as indicated in Table 1. Wheaton had the highest lodging, probably due to the fact that it matured slightly ahead of the other two varieties. Lodging was reduced on the +50 treatment where Cerone was applied. There was no significant variety x N treatment interaction.

Plant height (Table 2) was also significantly affected by variety and N treatment. Stoa was about 5 inches taller than the other two varieties. The +50 treatment was 2.0-2.7 inches shorter than the other treatments. The two-way interaction was not significant.

The yield by treatment is shown in Table 3. The variety x N treatment interaction was significant at the 98% level. Len did not increase in yield with the three extra N treatments and, in fact, there was an indication of a yield decrease with the +50 treatment. Both Stoa and Wheaton showed yield increases when Rec is compared to +50. The foliar treatments on Stoa showed a possible yield increase over Rec, while on Wheaton the foliar N treatments did not increase yield.

The protein levels (Table 4) were significantly affected only by variety. Wheaton was the lowest protein at 12.5%. The other two varieties were significantly higher and not different from one another. The N treatments had no significant effect on protein.

Overall, the canopy treatments had no effect on lodging, height, and protein as compared to the recommended N treatment. With the variety Stoa, there was an indication of a small yield increase over Rec with no difference between +10 BC and +10 TC. The +50 treatment increased yield significantly indicating that the 100 lb/acre of N applied preplant + drill application was insufficient with the rainfall amount and climate in 1986.

Please refer to title page of this publication for information regarding application and use of this article.

Table 1. Effect of variety and N treatment on lodging of wheat.

Variety	N Treatment				
	REC	+10BC	+10TC	+50	Mean
	lodging score, 1=erect, 5=flat				
Len	1.5	1.2	1.2	1.0	1.2
Stoa	1.5	1.8	1.5	1.5	1.6
Wheaton	2.0	2.5	2.2	1.2	2.0
Mean	1.7	1.8	1.7	1.2	

Signif. levels: Variety = >99%, N = >99%, V x N = 92%
LSD (.05) : Variety = 0.3 in., N = 0.3 in.

Table 2. Effect of variety and N treatment on height of wheat.

Variety	N Treatment				
	REC	+10BC	+10TC	+50	Mean
	in.				
Len	29.8	30.0	29.5	27.0	27.0
Stoa	33.5	33.0	32.8	31.5	32.7
Wheaton	28.2	28.2	27.2	25.0	27.2
Mean	30.5	30.4	29.8	27.8	

Signif. levels: Variety = >99%, N = >99%, V x N = 35%
LSD (.05) : Variety = 0.7 in., N = 0.8 in.

Table 3. Effect of variety and N treatment on yield of wheat.

Variety	N Treatment				
	REC	+10BC	+10TC	+50	Mean
	bu/a @ 13% M.				
Len	54.0	55.2	52.5	51.2	53.2
Stoa	60.8	63.2	63.3	68.1	63.8
Wheaton	66.1	68.6	67.6	70.0	68.1
Mean	60.3	62.3	61.1	63.1	

Signif. levels: Variety = >99%, N = 94%, V x N = 98%
LSD (.05) : Variety = 1.9 bu/a, V x N = 3.8 bu/a

Table 4. Effect of variety and N treatment on protein of wheat @ 13% moisture.

Variety	N Treatment				
	REC	+10BC	+10TC	+50	Mean
	%				
Len	14.2	14.4	14.4	13.8	14.2
Stoa	14.2	14.1	13.8	14.0	14.0
Wheaton	12.5	12.6	12.7	12.5	12.6
Mean	13.6	13.7	13.6	13.4	

Signif. levels: Variety = >99%, N = 35%, V x N = 21%
LSD (.05) : Variety = 0.4%

TOPDRESSING UREA ON SPRING WHEAT

S. D. Evans
Morris, 1986

Foliar application of nitrogen has the potential to burn the leaf tissue and possibly affect yield adversely. This study was established to investigate the effects of application of dry urea to spring wheat at early anthesis on yield and protein level.

Experimental Procedure

The experiment was established on a Hamerly clay loam (Aeric Calciquoll). Soil test levels in the spring of 1986 were as follows: pH = 7.4, Olsen P = 16 lb/acre, exchangeable K = 338 lb/acre, NO_3-N (0-2 ft) = 48 lb/acre, and O.M. = high.

A randomized complete block design with four replications was used. Plot size was 8 feet x 45 feet. The urea treatments included: (1) check, (2) 10 lb N/acre, (3) 25 lb N/acre, and (4) 50 lb N/acre. The urea was hand spread in a dry form when the plants were in Feekes stage 10-10.1 (awns showing on half the plants) on June 24 when the leaf tissue was dry. Nitrogen was applied to the entire area prior to seeding in the urea form to provide 82 lb/acre of N. The urea was incorporated in the land preparation. Marshall wheat was seeded on May 6. Dithane M-45 at 2 lb/acre and Tritron at ½ pt/acre were applied on June 24, July 7, and July 16 for disease control. Lodging evaluation and plant heights were taken on August 12 just prior to harvest with a plot combine. Samples of the grain were taken for moisture and protein determination.

Results and Discussion

There was no significant effect of the urea treatments on height, lodging, or protein. The N effect on yield was almost significant (94% level) but only the higher rates of 25 and 50 lb/acre of urea increased yield over the check.

With the growing season conditons in 1986, the application of small amounts of dry urea at the early heading stage had no measureable effect on grain yield or protein. Perhaps the urea should have been applied earlier; i.e., before Feekes stage 3 or before tillering was complete.

Table 1. Effect of topdressing urea on Marshall wheat.

N	Lodging+ Score	Height	Yield	Protein
lb/a		in.	lb/a @ 13% M	% @ 13% M
0	2.5	29.2	64.8	13.1
10	2.2	27.8	62.6	13.0
25	2.0	31.5	66.5	12.9
50	2.0	29.2	67.5	13.3
Signif. level (%)	48	80	94	24

+ 1 = Erect, 5 = Flat

Please refer to title page of this publication for information regarding application and use of this article.

MANAGEMENT OF BORON FOR CROP PRODUCTION ON IRRIGATED SANDY SOILS IN MINNESOTA

G.W. Rehm, B. Anderson, G. Cremers

Background and Justification:

Some past research trials in Minnesota have indicated that there is a potential for use of fertilizer boron (B) for the production of both corn and alfalfa. The potential for need is highest where these crops are grown on those sandy soils that have a low organic matter content.

The results of the previous research, however, have not been consistent. In one study, annual application of B did increase the yield of an alfalfa-grass mixture in northeastern Minnesota. In another study in north-central Minnesota, broadcast applications of B increased corn yield but had little effect on the production of alfalfa. Application of fertilizer B had no effect on corn yield at the irrigated Sand Plains Experimental Field.

Boron, like nitrogen (N) and sulfur (S), is considered to be a mobile nutrient in soils. The early trials in northeastern and north-central Minnesota showed that there was substantial downward movement of applied B through the soil profile. Management programs have been developed which, if followed, minimize the movement of nitrate-nitrogen (NO_3-N) to the ground water. In Minnesota, no research efforts have been directed to the development of management systems which will minimize the loss due to leaching of fertilizer B.

Previously, the B applied in research studies has been broadcast and incorporated before planting. It is possible that some of the B applied in this way was lost and this might help to explain some of the erratic responses noted to date. The study described in this report is designed to evaluate the effect of rate of applied B as well as frequency of application on production of both alfalfa and corn grown on an irrigated sandy soil.

Experimental Procedures:

This study was initiated in 1985 and continued in 1986. Treatments were reapplied to the original plots in April of 1986. The study is conducted at the Irrigation Research Center, Staples, Minnesota where the soil is classified as a Hubbard sandy loam. Relevant soil properties as determined from analysis of samples collected at the initiation of the study are listed in Table 1.

Table 1. Relevant soil properties (0-6 in.) of the experimental site prior to initiation of the study.

Property	Value
pH	7.0
P (Bray and Kurtz #1)	89 lb/acre
K (1 N $NH_4C_2H_3O_2$)	206 lb/acre
Mg	340 lb/acre
S	4 ppm
B	.24 ppm
Organic Matter	2.4%

Trials were conducted with both corn and alfalfa. Prior to treatment application, soil samples were taken from each corn plot at depths of 0-6, 6-12, 12-24 and 24-36 inches. Soil samples were collected from all corn plots in November, 1985 at the same increments to monitor changes in the B concentration in the soil.

In April, 1986, samples from the same increments were collected from selected treatments. These results are summarized in Table 2. All corn plots were again sampled in November, 1986. The results from this sampling date are summarized in Table 3. In all cases, the hot water soluble procedure was used to extract B from the soil.

Four rates of B (0,1,2,4 lb/acre) in either single or split applications were broadcast to established alfalfa each year. When split applications were used, 1/2 was applied in April and 1/2 after the second cutting. Adequate S (as gypsum) and K (as 0-0-60) were applied to all plots in April. Three cuttings were taken starting in early June and whole plant samples were collected from each plot at each cutting. Rainfall plus irrigation totaled 21.6 inches for the growing season.

Three rates of B (0,1,2 lb/acre) in either single or split application were broadcast for corn. Single applications were applied when the corn was at the 8-leaf stage. Where split applications were used, 1/2 was applied at the 8-leaf stage and 1/2 was applied at early silk. A treatment consisting of 2 lb. B/acre preplant, 1 lb. B/acre at the 8-leaf stage and 1 lb. B/acre at early silk was added in 1986. This treatment, however, could not be incorporated into the randomized complete block design of the study.

All corn plots received broadcast S (gypsum) and K (0-0-60) prior to planting. The N rate for all treatments was 200 lb/acre with 1/2 applied before planting and 1/2 applied at the 8-leaf stage. Seasonal rainfall plus irrigation was 21.4 inches. Other management practices needed to achieve high yields in the area were used.

Powdered borax was used to supply B throughout the study. This material was dissolved in water and the solution applied with a sprayer mounted on a small tractor. Application rate was constant at 40 gal./acre but concentration was varied to supply the desired rate of B.

Ear leaf samples were collected at early silk, dried, and analyzed for B. Both grain and total dry matter yields were recorded. Stover samples used to calculate dry matter production were analyzed for B in order to determine B removal by the corn crop.

Results and Discussions:

Boron Movement in Soil

One objective of this study was to monitor movement of B through the root zone of this sandy soil. Soil samples collected in the fall of 1985 indicated no major movement of B below 12 inches. The B concentration in the 0-6 in. and 6-12 in. depths, however, was increased by the use of B fertilizer.

Spring snow melt and early spring rainfall did not move B below 24 inches when 2 lb. B/acre was applied in either a single or split application (Table 2). The values recorded for these selected treatments in the early spring of 1986 were similar to those recorded from the late fall sampling of 1985 (1985 data not shown).

Table 2. Concentration of B in sandy soil from selected treatments applied in April, 1985. Samples collected in spring of 1986.

Treatment	Depth (in.)			
	0-6	6-12	12-24	24-36
	ppm B			
Control	.25	.28	.13	.10
2 lb. B/acre (single)	.38	.45	.25	.10
2 lb. B/acre (split)	.43	.50	.18	.10

With the exception of the 24-36 in. depth for soil samples collected in the spring of 1986, the B concentration in the soil increased with rate of applied B when averaged over both methods of application (Table 3). This increase was also linear. There was, however, a highly significant rate by method of application interaction for the B concentration at depths down to 24 in. The B concentration was lower when 1 lb. B/acre was split rather than added in a single application. When the B rate was 2 lb/acre, however, the B concentration was higher when a split application was used. The B concentration did not increase substantially when 4 lb. B/acre was applied in a split application (Table 3). This treatment was added for 1986, was not incorporated into the randomized complete block design, and thus could not be part of the statistical analysis.

Table 3. Concentration of boron at various depths at the end of the 1986 growing season.

Treatment	Depth (in.)			
	0-6	6-12	12-24	24-36
	ppm B			
Control	.24	.18	.10	.06
1 lb. B/acre (single)	.48	.41	.19	.09
2 lb. B/acre (single)	.49	.43	.22	.10
1 lb. B/acre (split)	.42	.32	.18	.10
2 lb. B/acre (split)	.56	.51	.28	.14
4 lb. B/acre (split)	.59	.47	.17	.08

The fact that the B concentration did not increase at the 12-24 in. and 24-36 in. depths suggests that there was no leaching of applied B through the root zone. This was also true for the 4 lb. B/acre rate. There is an accumulation of fine textured material at 12-24 in. depth and this probably prevented downward movement of soil and fertilizer B.

Alfalfa Yield

Neither rate nor method of B application had a significant effect on alfalfa yield in 1986 (Table 4). These data are consistent with the results recorded for alfalfa in 1985. This irrigated sandy soil is apparently capable of supplying the B needed for the alfalfa yield produced. We speculate that the majority of the B needed comes from the mineralization of the organic matter under these irrigated conditions. The concentration of B in the irrigation water is low (.04 ppm).

Table 4. Effect of rate and frequency of boron application on the yield of irrigated alfalfa.

	Cutting (1986)				
Treatment	1	2	3	Total (1986)	Total (1985)
	--------- ton dry matter/acre ---------				
Control	1.56	1.44	1.33	4.33	4.6
1 lb. B/acre (single)	1.54	1.49	1.32	4.35	4.2
2 lb. B/acre (single)	1.45	1.49	1.37	4.31	4.4
4 lb. B/acre (single)	1.47	1.51	1.35	4.33	4.2
1 lb. B/acre (split)	1.57	1.51	1.39	4.47	4.5
2 lb. B/acre (split)	1.52	1.38	1.31	4.21	4.3
4 lb. B/acre (split)	1.58	1.53	1.40	4.51	-

Corn Production

The 1986 data collected from the corn production portion of the study are summarized in Table 5. Again, the 4 lb. B/acre split treatment was not part of the original design and could not be included in the statistical analysis.

Table 5. Effect of rate and frequency of boron application on corn grain and total dry matter yield, B concentration in the ear leaf tissue at silking, B concentration in tissue at physiological maturity and B removed by corn.

Treatment	Grain Yield	Dry Matter Yield	B Conc. Ear Leaf	B Conc. Mature	B Removed
	bu/acre	ton/acre	ppm B		lb/acre
Control	161.2	5.9	12.6	4.7	.055
1 lb. B/acre (single)	153.2	6.4	15.5	5.7	.073
2 lb. B/acre (single)	160.8	5.7	21.7	6.2	.070
1 lb. B/acre (split)	154.7	5.7	15.5	4.9	.055
2 lb. B/acre (split)	160.3	5.4	14.6	6.3	.068
4 lb. B/acre (split)	162.6	6.3	-	-	-
CV: %	4.0	8.8	19.0	20.3	16.9

Application of fertilizer B had a significant effect on grain production. Yield was significantly reduced compared to all other treatments when 1 lb. B per acre was applied in either a single or split application. The use of 2 and 4 lb. B per acre, however, had no effect on yield when compared to the control treatment. Therefore, the yield reduction from the 1 lb. per acre rate is impossible to explain at this time. Since this effect was not observed in 1985, a large amount of significance cannot be attached to this reduction. A CV of 4% would certainly indicate that error and variability was kept to a minimum during the conduct of this study. Frequency of B application had no significant effect on yield and there was no significant rate by frequency interaction.

Total dry matter yield measured at physiological maturity was not significantly affected by either rate or frequency of B application. This is further evidence that the yield reduction observed with grain yield should not be heavily weighted.

The B concentration in the ear leaf tissue was influenced by both rate and frequency of application. There was also a significant rate by frequency interaction (Table 5). The B concentration increased linearly with rate of applied B and this would be expected. Highest B concentration was recorded when 2 lb. B per acre was used in a single application at the 8-leaf stage. Since the second application of B in the split application treatments was applied 2 days before ear leaf collection, it would be expected that B concentration would not be high in these treatments. The B concentrations in 1986 were higher than those recorded in 1985. This observation suggests that environmental conditions in any given year can have an effect on B uptake by corn.

Compared to the control, application of B increased the B concentration in the tissue sampled at physiological maturity. Frequency of application had no effect on this concentration and there was no significant rate x frequency interaction. Average concentration was 5.3 ppm when the B rate was 1 lb/acre. This increased to 6.3 ppm when applied B was 2 lb/acre.

The amount of B removed by the corn crop was small and was not significantly affected by either rate or frequency of application.

Conclusions:

After 2 years, the data gathered from this study lead to the following general conclusions.

1. Fertilizer B does not appear to move below 2 feet in the root zone when applied to this sandy soil. Highest B concentrations occur in the 0-6 and 6-12 in. increments for all treatments used.

2 Neither rate nor frequency of B application has increased the yield of irrigated alfalfa. Release of B from the organic matter under the irrigated conditions may supply the B needed by the alfalfa crop.

3. Effect of rate of fertilizer B on corn yield has been inconsistent. Little consideration should be given to the yield reduction recorded in 1986 when 1 lb. B per acre was applied. Frequency of application has had no significant effect on yield.

4. The concentration of B in the ear leaf tissue was affected by both rate and frequency of application. These data confirm that applied B is absorbed by the corn crop. Yet, native soil B plus the B released from organic matter is apparently adequate for irrigated corn production on this soil.

CORN - SOYBEAN ROTATION

H. Meredith and M. Weins

(Special appreciation to Dr. George Rehm, Greg Cremers and Brian Anderson)

The irrigaton corn-soybean rotation experiment inititated in 1981 at the Staples Station to evaluate continuous corn yields vs. corn yield following soybean continues.

Objective: Determine optimum corn and soybean yields under intensive management.

Discussion: This study applies management practices available to commercial farmers. Early planting, high plant population, hybrid selection, pest control, soil moisture, etc., receive special attention.

Note that 1986 was an excellent growing year for corn in the area. Kernel moisture at harvest was about the same for both hybrids in the study. Of particular interest is the 35 bushel yield differential from the 95-day R.M. over the 90-day R.M. As moisture content was the same at harvest the greater yield must be emphasized. This was the widest yield variance to date when two relative maturity hybrids were compared.

Temperatures were above normal in April through July as follows: April + 3.1°F, May + 2.3°F, June + 1.3°F, and July 1.1°F, August was 3.4°F below normal.

1986 Sequence of Events

	Corn	Soybeans
Disk	4/8	4/8
Plow, Disk & Smooth	4/22	4/22
Planting	4/25	5/20
Population (planting)	37,800	122,000 (est.)
Herbicide Dual	1 qt/A	1 qt/A
Insecticide, 1 lb/A a.i.	Counter	Counter
Varieties, Pioneer	3790 & 3881	Ossie
Rainfall, in. 5/1 - 8/31	22.2	22.2
Irrigation in. 5/1 - 8/31	7.5	7.5

Weed problems: wild buckwheat, ragweed, lambsquarters, hairy night shade.

Disease problems: eyespot

Insect problems: minimal

Fertilization (corn) 200-50-60
N applied 20 lbs. on 4/25; 60 lbs. each on 6/12, 6/25 and 7/23.

Harvest	10/2	10/2
Emergence	5/3	
Tasseling or flowering	7/3	7/17
Ear or pod set	7/17	7/31
Early dent	8/21	
Yellow and leaf drop		9/11
Forage samples	9/22	

Table 1. Corn yield, bu/A, Staples Station, Staples, MN 1986.

No.	Treatment	Yield 1981	1982	1983	1984	1985	1986	Avg.
		bu/A						
1	Continuous corn[1]	151	168	135	130	125	149	143
2	Continuous corn[2]	151	166	150	128	124	180	150
3	Soybean - Corn[1]	-	170	148	140	123	142	145
5	Soybean - SB - Corn[1]	-	-	-	-	-	144	144
	Averages	151	168	144	133	124	154	146

[1] 85-90 day relative maturity
[2] 95-day relative maturity

Table 2. Supportive Information Pertaining to Corn Yields at Staples Station, Staples, MN 1986.

Treatment Number	Harvest Population (x 1000)	Kernel Moisture (% H_2O)	Grain Yield T/A (DM)	Silage Yields T/A (DM)	Stover Yield T/A (DM)	Grain Silage Ratio
1	31.7	28.8[1]	3.52	6.27	2.75	.56
2	30.7	29.2[2]	4.26	7.58	3.32	.56
3	31.8	27.0[1]	3.36	6.98	3.62	.48
5	29.9	28.4[1]	3.41	6.68	3.27	.51

[1] Pioneer 3881, 90-day R.H.
2 Pioneer 3790, 95-day R.H.

Table 3. Nutrient Removal in Corn Grain - lb/A.

Treatment No.	N	S	P_2O_5	K_2O	Ca	Mg	Mn	Zn
1	140.6	8.9	58.1	41.4	.26	12.5	.05	.22
2	143.6	10.6	71.5	48.0	.36	13.5	.05	.24
3	125.8	8.0	59.8	40.6	.28	12.3	.04	.20
5	132.2	8.6	60.0	41.1	.25	12.6	.05	.20
Average	135.6	9.0	62.4	42.8	.45	12.7	.05	.22

Table 4. Nutrient Removal in Corn Stover - lb/A. (Average of 4 treatments).

N	P_2O_5	K_2O	Ca	Mg	Mn	Zn
27	6.8	157.2	28	7	.41	.07

Table 5. Nutrient Removal in Corn Silage (Grain + Stover).

Treatment No.	N	P_2O_5	K_2O	Ca	Mg	Mn	Zn	B
1	154	64.9	186	25	18	.43	.30	.09
2	169	78.3	211	31	20	.50	.30	.08
3	170	68.5	200	27	21	.43	.28	.07
5	160	66.8	205	28	20	.49	.28	.09
Average	163	69.6	200	28	20	.46	.29	.08

Table 6. Leaf Tissue Analyses at Silking.

Treatment No.	N	S	P	K
1	2.9	.20	.30	2.5
2	2.9	.21	.30	2.3
3	2.8	.20	.32	2.5
5	2.8	.20	.33	2.6

Table 7. Analyses of Corn Grain.

Treatment	N	S	P	K	Ca	Mg	Mn	Zn
	%						ppm	
1	1.6	.10	.28	.38	.003	.14	5.2	24.6
2	1.3	.10	.29	.37	.003	.12	5.0	22.4
3	1.5	.09	.30	.40	.003	.14	5.0	23.0
5	1.5	.10	.30	.39	.003	.14	5.4	23.0