Table 2. Effect of fertilizer recommendations on corn final population, grain yield and moisture on the very high testing site in 1983.

Lab	Fertilizer Recommendations	Final Population	Grain Yield	Grain H_2O
	lb/A[1/]	x 10^{-3}	bu/A	%
A	200N +50P + 90K +14S +2.5Zn	24.5	101.4	21.6
B	160N +70P +135K	23.9	102.9	21.6
C	167N +12P + 61K	24.2	110.3	21.7
D	244N +75P +112K +.12Fe +.12Mn +.62Zn	24.5	107.4	21.8
E(UM)	130N + 90K	23.5	104.2	21.5
Check		24.3	78.4	22.3
	Significance Level (%):	71	99	99
	BLSD (.05) :		11.2	.5
	CV (%) :	3.4	9.7	1.7

[1/] P and K expressed on oxide basis.

Earleaf P, Fe and Cu concentrations among the five laboratories were not significantly different (P=.05 level) (Table 3). The greater fertilizer N and K recommendation did result in a corresponding rise in corn leaf N and K concentrations. The Fe + Mn + Zn recommended by lab D resulted in higher leaf Mn than other labs but Fe and Zn were unaffected. Laboratory A's Zn recommendation resulted in the highest % leaf Zn of the five labs. The B and Cu concentrations among the five laboratories were not significantly different (P=.05). Leaf nutrient concentrations except Cu appeared to be adequate for optimum plant growth.

Table 3. Effect of fertilizer recommendations on corn leaf nutrient concentrations on the very high testing site in 1983.

Lab	N	P	K	Ca	Mg	Fe	Mn	Zn	Cu	B
	%					ppm				
A	3.00	.29	2.04	.44	.33	171	50	31	4.3	8.9
B	2.91	.29	2.14	.42	.32	162	45	28	3.9	8.5
C	2.87	.29	1.95	.44	.34	182	48	30	4.0	8.4
D	3.08	.30	2.06	.45	.33	174	57	28	4.3	8.8
E(UM)	2.81	.29	1.91	.42	.35	175	45	25	3.8	8.2
Check	1.90	.22	1.67	.36	.27	171	34	15	2.1	7.6
Signif.(%):	99	99	99	99	99	65	99	99	99	99
BLSD(.05) :	.1	.01	.12	.02	.02		5	2	.5	.6
CV(%) :	3.5	3.8	5.5	4.8	6.1	8.5	9.1	6.5	13.2	5.6

Medium-high testing site

The soil test results and the accompanying recommended fertilizer program of each laboratory are shown in Table 4 for the medium-high testing site. While the numeric values of the five laboratories were generally similar the corresponding interpretation (whether the soil tests high, low, medium, deficient etc.) varied substantially. Nitrogen, P and K recommendations among the labs were quite different. Also, various micronutrients and sulfur were recommended by two of the four private labs. Two of the four private labs recommended liming the soil.

The treatments that received fertilizer yielded significantly more than the check (Table 5). However, there were no significant yield differences among the fertilizer treatments. Grain moisture was reduced significantly from the control by all of the fertilizer treatments with no differences among the five laboratories. Final population was not different among the treatments.

Table 4. Soil test results and the recommended fertilizer programs on the medium-high testing site at Waseca in 1983.

Test	Soil Test Results[1/] Lab A	Lab B	Lab C	Lab D	Lab E (UM)
pH	6.4	6.7	6.4	5.8	6.2
pH (buffer)	6.7	---	6.9	6.8	---
Phosphorus	17 M	18 D	16 H	23 M	14 MH
Potassium	169 M	151 D	125 H	120 M	121 MH
Organic Matter (%)	4.2 H	5.3 A	3.4 M	3.9	H
Calcium	2870 H	4237 A	6250	4105 H	---
Magnesium	506 VH	631 A	750	600 M	552 A
Sulfur	7 L	15 A	18 H	5 L	5 LM
Iron	44.0 VH	41.4 A	8	5.6 VH	---
Manganese	29 H	21 E	2	2 VH	---
Zinc	2.3 M	1.8 A	1.3 H	1.9 M	1.0 M
Copper	1.3 H	1.1 A	.4	---	---
Boron	2.1 VH	1.1 A	1.9	---	---
ENR (lb/A)	114	---	---	50	---
C.E.C. (meq/100g)	20.9	26.8	37.9	28.7	---

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

Nutrient	Recommended Fertilizer Program[2/] Lab A	Lab B	Lab C	Lab D	Lab E (UM)
Nitrogen	185	155	167	244	130
Phosphorus (P_2O_5)	80	107[3/]	54	91	70
Potassium (K_2O)	105	200[3/]	68	155	90
Sulfur	15	---	---	---	---
Iron	---	---	---	.12[4/]	---
Manganese	---	---	---	.12[4/]	---
Zinc	2	---	---	.62[4/]	---
Copper	---	---	---	---	---
Boron	---	---	---	---	---
Lime (T/A)	1.5	---	---	2.3	---

2/ All values indicate pounds of nutrient recommended per acre for a yield goal of 160 bushels of corn per acre.

3/ Value includes maintenance recommendation, plus 50% of the buildup recommendation which was to be applied over a two-year period.

4/ As 5 qt/A of a material weighing 9.9 lb/gal and containing 5% Zn, 1% Fe, 1% Mn.

There was no significant difference among the five laboratories for leaf nutrients P, Fe, Mn, Zn, Cu or B (Table 6). The micronutrients recommended by two of the four private labs did not result in a corresponding increase in leaf concentrations. The high rate of lab D's nitrogen recommendation resulted in higher leaf N. Leaf nutrient concentrations from the check treatment were sufficient for optimum plant growth with the exception of K and Cu. Leaf K and Cu appeared low.

Table 5. Effect of fertilizer recommendations on corn final population, grain yield and moisture on the medium-high testing site in 1983.

Lab	Fertilizer Recommendations	Final Population	Grain Yield	Grain H_2O
	lb/A[1/]	x 10^{-3}	bu/A	%
A	185N + 80P +105K +15S +2Zn	23.9	122.6	20.2
B	155N +107P +215K	23.8	127.1	20.2
C	167N + 54P + 68K	25.0	126.6	20.7
D	244N + 91P +155K +.12Fe +.12Mn +.62Zn	24.8	125.9	20.7
E(UM)	130N + 70P + 90K	23.8	124.8	20.4
Check		24.2	77.3	22.5
	Significance Level (%):	68	99	99
	BLSD (.05) :		8.8	.5
	CV (%) :	4.5	7.0	2.1

[1/] P and K expressed on oxide basis.

Table 6. Effect of fertilizer recommendations on corn leaf nutrient concentrations on the medium-high testing site in 1983.

Lab	N	P	K	Ca	Mg	Fe	Mn	Zn	Cu	B
	Nutrient									
	%					ppm				
A	3.00	.29	1.62	.50	.39	184	51	25	4.2	9.4
B	2.91	.29	1.78	.48	.35	178	49	22	4.3	9.7
C	2.87	.29	1.43	.51	.42	178	52	22	4.1	9.8
D	3.08	.30	1.62	.50	.42	169	54	24	4.7	9.8
E(UM)	2.81	.29	1.41	.51	.41	175	49	22	3.7	9.5
Check	1.90	.29	1.22	.52	.39	168	39	19	2.6	8.9
Signif.(%):	99	2	99	99	98	44	99	94	99	33
BLSD(.05) :	.10		.15	.02	.05		9	4	1.0	
CV(%) :	3.5	10.0	9.1	3.3	8.8	9.5	14.5	13.7	20.5	10.5

SUMMARY - 1983

There were substantial differences among the laboratories' fertilizer recommendations at both sites. Nitrogen, P and K recommendations differed greatly among the laboratories. Sulfur and various micronutrient recommendations were provided by two of the four private labs. Differences among the leaf nutrient concentrations were noted but all with the exception of Ca and K (medium-high testing site only) were adequate for corn growth. Differences in grain yield, grain moisture and plant population were not observed among the five laboratories at both sites in 1983.

Fertilization resulted in only two of the five labs showing any profit on the very high testing site (Table 7). Fertilizer costs ranged from $41/A with lab E to $98/A with lab D. On the medium-high testing site a large return was gained from fertilizer ($39-88/A). Also, the laboratories' recommendations resulted in fertilizer costs ranging from $58-107/A while net return varied by $49.

Table 7. Effect of fertilizer recommendations on yield, value, fertilizer cost and the resulting economic return on both the very high testing site and medium-high testing site at Waseca in 1983.

	Very High Testing Site				Medium-High Testing Site			
Lab	Yield	Value @3.00/bu	Fert. cost[1/]	Return[2/]	Yield	Value @3.00/bu	Fert. cost[1/]	Return[2/]
	bu/A	$/A	$/A	$/A	bu/A	$/A	$/A	$/A
A	101.4	304	73	- 4	122.6	368	79	+57
B	102.9	309	70	+ 4	127.1	381	86	+63
C	110.3	331	50	+46	126.6	380	60	+88
D	107.4	322	98	-11	125.9	378	107	+39
E(UM)	104.2	313	41	+37	124.8	374	58	+84
Check	78.4	235	--	--	77.3	232	---	--

1/ Using May, 1983 prices for each nutrient expressed as dollars/lb as follows: N, 24; P_2O_5, .24; K_2O, .11; S, .22; B, .75; Zn, .38.

2/ Return yield value @ 3.00/bu - fertilizer cost - value of check trt.

Conclusions from the 1983 study can be summarized as follows:

1. Application of high rates of P & K to soils already testing high to very high is not practical.

2. No direct benefit or response was obtained with the addition of S or the micronutrients even though they were recommended by some laboratories.

FOUR-YEAR SUMMARY

Economic returns from the very high testing site showed benefit to fertilizer from two of the five laboratories. Net return from the 1980-1983 period ranged from $52/A with lab E to $76/A with lab A. Recommendations from lab D resulted in the highest fertilizer cost. Part of this negative return can be attributed to fertilizer recommendations made for a yield goal of 180 bu/A and 160 bu/A for 1980 and 1983, respectively. Due to drought-stress conditions the 1980 corn yield only averaged 100 bu/A.

On the medium-high testing site yield responses paid for the fertilizer recommendations by all five laboratories (Table 8). However, net return ranged from $60/A with lab D, whose recommendations resulted in the higher fertilizer cost, to $192/A with lab E which recommended the least amount of fertilizer.

Table 8. Effect of fertilizer recommendations on total yield, total fertilizer cost and the resulting economics on both the very high and medium-high testing site at Waseca from 1980-1983.

	Very High Testing Site 4-Year Total			Medium-High Testing Site 4-Year Total		
Lab	Crop value[1/]	Fert. cost	Return[2/]	Crop value[1/]	Fert. cost	Return[2/]
	$/A	$/A	$/A	$/A	$/A	$/A
A	1313	239	-76	1504	274	+101
B	1337	245	-58	1489	299	+ 61
C	1375	183	+42	1504	208	+167
D	1376	286	-60	1493	304	+ 60
E(UM)	1342	140	+52	1506	185	+192
Check	1150	0	--	1129	0	---

1/ 3.00, 2.40 and 3.00/bu used for corn in 1980, 1981 and 1983, respectively, and 5.50/bu for soybeans in 1982 for four-year total crop value.

2/ Return over 4-year period = crop value - fertilizer cost - value of check treatment.

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

Waseca, 1983

G. W. Randall and D. T. Walters

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

EXPERIMENTAL PROCEDURES

Four starter fertilizer treatments and a check with no starter fertilizer (Table 1) were applied in a randomized, complete-block design with eight replications on a Nicollet clay loam soil (Aquic Hapludoll). Soil test of this site averaged: pH = 5.9, Bray 1 extractable P = 38 lb/A and exchangeable K = 225 lb/A. Corn that had been moldboard plowed was the previous crop. Nitrogen as anhydrous ammonia was applied at a rate of 200 lb N/A on April 30.

Corn (Pioneer 3901) was planted on May 9 at a rate of 27700 plants/A with a 4-row John Deere 7000 Max-Emerge planter. This planter was used to apply the dry material in a 2 x 2 band and the liquid in the row with the seed. The 7-21-7, 5-12-5 and 8-20-8 were obtained from local fertilizer dealers while the 9-18-9 was obtained from Na-Churs. The 5-12-5 dry material applied at the 95-lb rate yields approximately the same amount of N + P + K as 5 gal/A of the two liquid materials. The 140-lb rate of the 8-20-8 is closer to a more conventional rate of a dry fertilizer while still using a 1:2.5:1 material. Furadan at a rate of 1 lb/A (active) was band-applied to control rootworms. Lasso (3½ qts/A) and Bladex (3 lb/A) were applied preemergence to control weeds.

Ten randomly selected plants from the outside 2 rows of these 4-row plots were sampled on June 20 for early plant growth measurements and for nutrient analysis. Plant heights were measured on July 11 (prior to tasseling) and on August 3 (shortly after tasseling). Leaf samples opposite and below the ear were taken at silking for analysis. Grain yields were determined by combine harvesting the center two rows of each plot with a JD 3300 modified plot combine. Moisture and protein analyses were determined on those samples.

RESULTS

Climatic conditions in the 3-week period after planting were much wetter and cooler than usual. These conditions resulted in rather slow germination and emergence. Early plant growth measurements taken six weeks after planting showed significant differences in plant weight (Table 1). All starter treatments showed larger plants than when no starter was applied. No difference in early plant growth was found between the two liquid materials or between the liquid products and the dry product applied at the same rate. These data indicate a primary effect related to rate of application and no effect related to placement (banded with the seed compared to 2 x 2).

Small plant P concentration was higher with the dry materials than with the liquids (Table 1). No difference in small plant P was seen between the two liquid materials. Small plant K for the 8-20-8 dry starter treatment was statistically higher than the 9-18-9 liquid treatment. There was a significantly lower small plant K concentration with liquids when compared to dry materials (at 90% probability). Small plant Ca was increased by the 8-20-8 dry material when compared to the two liquid materials.

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

Table 1. Influence of starter fertilizer on the nutrient concentration in the small whole corn plants at Waseca in 1983.

Treatment Material	Rate	Small plant weight	P	K	Ca	Mg	Fe	Mn	Zn	Cu	B
		g DM/plt.	----------%----------				----------ppm----------				
No Starter		2.0	.47	4.74	.46	.28	1496	91	56	11.0	18.5
9-18-9 (liq)	5 gal/A	2.7	.46	4.68	.44	.26	1555	94	53	10.1	15.4
7-21-7 (liq)	5 gal/A	2.6	.47	4.70	.45	.26	1693	99	54	10.2	15.0
5-12-5 (dry)	95 lb/A	2.7	.50	4.92	.47	.27	1587	96	54	10.6	17.9
8-20-8 (dry)	140 lb/A	2.6	.49	4.95	.48	.27	1446	97	56	9.9	14.9
P Level (%): 1/		99	99	95	99	93	49	33	64	92	80
BLSD(.05) :		.3	.01	.25	.02						
CV(%) :		9.7	2.7	3.9	3.3	4.5	16.2	10.4	5.0	6.8	20.1

1/ Probability levels of significant difference among treatment means.

Nutrient uptake, the product of nutrient concentration times small plant weight (dry matter), was increased by the starter treatments over the no starter treatment primarily because of the larger plants associated with the starter treatments (Table 2). Highest nutrient uptake levels were associated with the 95 lb/A 5-12-5 treatment but these levels were not always statistically higher than the 8-20-8 or liquid treatments. Uptake of P was significantly higher with the 5-12-5 dry material than the 7-21-7 liquid material. No significant difference existed between the two liquid materials.

Table 2. Influence of starter fertilizer on the nutrient uptake in the small whole corn plants at Waseca in 1983.

Treatment Material	Rate	P	K	Ca	Mg	Fe	Mn	Zn	Cu	B
		----------mg/plant----------								
No Starter		9.6	96	9.3	5.7	3.0	.18	.11	.022	.009
9-18-9 (liq)	5 gal/A	12.8	132	12.3	7.4	4.3	.26	.15	.028	.006
7-21-7 (liq)	5 gal/A	12.4	125	12.1	7.0	4.5	.26	.14	.027	.006
5-12-5 (dry)	95 lb/A	13.8	136	12.9	7.4	4.4	.26	.15	.029	.006
8-20-8 (dry)	140 lb/A	12.7	128	12.4	7.0	3.7	.25	.14	.025	.006
P Level (%):		99	99	99	99	99	99	99	99	99
BLSD(.05) :		1.2	16	1.2	.8	.8	.03	.01	.004	.002
CV(%) :		8.8	11.2	9.2	9.6	16.7	11.8	9.3	11.2	23.4

Leaf nutrient concentrations shown in Table 3 were sufficient for optimum yields. Leaf Mn from the 8-20-8 treatment was significantly lower than the other starter treatments or the no starter treatment. Leaf Cu from the dry starter treatments was significantly lower than the 9-18-9 liquid or no starter treatments.

Table 3. Influence of starter fertilizer on the nutrient concentrations in the corn ear leaf at Waseca in 1983.

Treatment Material	Rate	N	P	K	Ca	Mg	Fe	Mn	Zn	Cu	B
		----------%----------					----------ppm----------				
No Starter		3.2	.30	1.94	.44	.25	208	84	30	3.6	9.1
9-18-9 (liq)	5 gal/A	3.1	.31	2.01	.43	.25	220	84	30	3.6	9.6
7-21-7 (liq)	5 gal/A	3.1	.31	1.98	.43	.25	212	84	31	3.3	9.4
5-12-5 (dry)	95 lb/A	3.2	.31	1.97	.43	.24	205	81	29	3.0	9.8
8-20-8 (dry)	140 lb/A	3.1	.31	2.05	.43	.24	203	75	29	3.1	9.3
P Level (%):		25	91	53	42	75	72	98	94	97	31
BLSD(.05) :								6		.5	
CV(%) :		2.2	2.3	4.2	4.1	6.0	7.8	6.8	5.9	12.1	10.2

Plant height at approximately the 13 to 14-leaf stage was significantly improved by the starter fertilizers and reflected the differences shown in early plant growth in mid-June (Table 4). However, differences in height did not exist among the treatments once tasseling occurred.

Reductions in final plant population have been reported when applying liquid fertilizers with the seed. The data shown in Table 4 indicate no deleterious effect of any of the starter treatments on plant population. No reason can be given for the higher population with 7-21-7.

Although a trend exists toward higher grain yields with some of the starter fertilizer treatments, grain yields were not increased significantly by the starters (Table 4). In addition, an economical return to the starter fertilizer per se would not have been realized with some of the treatments and return would have been marginal with the others. Grain moisture at harvest for the 9-18-9 liquid starter was significantly lower than other starter treatments. Grain moisture for the 8-20-8 dry starter was the highest of all of the starter treatments and did not differ from the no starter treatment.

Table 4. Influence of starter fertilizer on plant height, final population, grain yield and grain moisture at Waseca in 1983.

Treatment		Plant Height		Final	Grain	
Material	Rate	7/11	8/3	population	Yield	Moisture
		-----cm-----		x 10^{-3}	bu/A	%
No Starter		154	238	24.8	103.3	22.0
9-18-9 (liq)	5 gal/A	170	237	24.7	106.0	20.7
7-21-7 (liq)	5 gal/A	168	235	25.3	106.1	21.5
5-12-5 (dry)	95 lb/A	167	239	24.7	101.4	21.2
8-20-8 (dry)	140 lb/A	167	240	24.5	106.7	21.8
P Level (%):		99	86	58	51	99
BLSD(.05) :		3				.4
CV(%) :		1.9	1.5	3.3	6.5	2.1

SUMMARY

Under these soil test P (high) and K (medium-high) conditions early plant growth was enhanced by all starter fertilizer treatments. Differences were not seen among the liquid materials. Early growth appeared to be a function of application rate rather than fertilizer placement. These differences continued to be found up until tasseling when all treatments showed the same height. Nutrient concentrations in the small plants were only affected slightly. The greatest influence was on P with the dry materials. However, nutrient concentrations among the treatments at silking were generally not different. Grain yields were not improved significantly by the starter fertilizer treatments, whereas, grain moisture was reduced by all but the 8-20-8 dry material.

CONSERVATION TILLAGE STUDY

Waseca, 1983

G.W. Randall, J.B. Swan and D.T. Walters

With increasing emphasis on controlling erosion and minimizing energy requirements (time, labor and fuel), tillage practices of the future will undoubtedly change markedly within the next decade. As a result these practices may be commonly referred to as "conservation tillage" systems.

EXPERIMENTAL PROCEDURES

To evaluate some of the conservation tillage practices on continuous corn an experiment was established in 1975 on a Webster clay loam at the Southern Experiment Station, Waseca, Minnesota. Five tillage treatments (no tillage, fall plow, fall chisel, till-plant (ridge) and till-plant (flat) were replicated four times. Each plot was 20' wide by 125' long. Beginning in 1979, all plots were split into two, 4-row plots--one with 140 lb 9-23-30/A as starter fertilizer. In 1982 and 1983, 12 gallons of 7-21-7 was used as the starter fertilizer material. Tile lines spaced 75' apart lie perpendicular to the rows on all plots.

In 1983, soybeans were planted after 8 years of continuous corn to begin a long-term corn-soybean rotation phase of this experiment. Tillage and starter fertilizer treatments remained the same except the till-plant (flat) treatment was changed to a spring-disk treatment (Table 1).

Ridges for the till-plant (ridge) treatment were built by cultivation on corn rows in 1982. After the 1982 corn harvest stalks were chopped and the moldboard and chisel plow treatments were performed. On May 25 the moldboard and chisel plow treatments were field cultivated once with the chiseled plots receiving a prior disking. The spring disk treatment was disked twice on this same date. Ridges for 1984 corn were prepared in July.

Soybeans (Hardin) were planted in 30" rows at a rate of 160,000 plants/A on May 24. The no-tillage, fall plow, fall chisel and spring disk treatments were planted with a John Deere Max-Emerge planter equipped with 2" fluted coulters. A Buffalo-till planter was used for the ridge planted treatment.

Broadcast P and K were not applied for the 1983 soybean crop because of very high soil tests. Soil tests on this site averaged: pH=6.7, Bray 1 extractable P=48 lb/A and exchangeable K=358 lb/A. Chemical weed control consisted of 3 lb Amiben and 4 lb Lasso/A applied preemergence. In order to evaluate the effectiveness of the preemergence herbicide application on weed control, a plastic sheet 18" wide and 6' long was placed between the 4th and 5th rows of each plot during herbicide spraying to prevent the application of herbicide onto the soil surface. Weed counts (grass and broadleaf) were taken on June 16 from sprayed and unsprayed areas. On July 11, one-half of each replicate was treated with a postemergence application of Poast at a rate of 1/4 lb/A with 1 qt. of oil concentrate for grass control. Treatments 2, 3, 4 and 5 were cultivated on July 18.

Early plant growth was determined by harvesting the above ground portion of 40 plants in each plot 50 days after planting. Soybean leaf samples were taken on July 25 (R1 stage) by randomly sampling the uppermost fully mature trifoliate from each of the starter treatments within each tillage treatment. Yields were taken by combine harvesting the center two rows from each plot.

On June 22 soil samples were taken to a 9" depth from the ridge-planted plots which had starter fertilizer for the last nine years. These plots were sampled in 3 positions: directly down the center of the ridge, at 6" to the side of the ridge and midway between the ridges. Before compositing the 8 cores/plot they were separated into 0-2", 2-4", 4-6" and 6-9" increments. After drying at 100°F they were submitted to the University of Minnesota Soil Testing Lab for pH, Bray 1 extractable P and exchangeable K analyses.

Statistical interpretation of the data throughout this report is based on the percent probability (significance levels) of obtaining a response. A significance level of 95 indicates that we could expect a real difference to occur 19 times out of 20 and only 1 time out of 20 due to chance. A significance level below 50 would indicate less than 50:50 odds of being real.

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

RESULTS

Significant differences in early plant growth (EPG) and soybean yields were found among the tillage treatments (Table 1). Largest plants were associated with the moldboard plow (MP) and chisel plow (CP)

Table 1. Influence of tillage methods, starter fertilizer and Poast herbicide on soybean production at Waseca in 1983.

Treatment			Early plant growth	Seed	
Tillage	Starter[1] fert.	Poast[2] herb.		Moisture	Yield
			g/plant	%	bu/A
No tillage	S	P		16.6	37.5
"	S	NP	1.45	16.4	27.4
"	NS	P		16.8	37.3
"	NS	NP	1.55	16.5	24.1
Fall plow, f. cult.	S	P		16.8	41.6
" "	S	NP	2.23	16.4	47.0
" "	NS	P		17.1	43.2
" "	NS	NP	2.65	17.1	47.1
Fall chisel, d., f. cult.	S	P		16.5	44.2
" "	S	NP	2.41	16.6	40.5
" "	NS	P		17.1	41.7
" "	NS	NP	2.38	16.7	39.9
Till plant (ridge)	S	P		16.8	41.5
"	S	NP	2.03	16.7	46.6
"	NS	P		17.0	41.4
"	NS	NP	1.95	17.2	41.0
Spring disk (2x)[3]	S	P		16.4	40.9
"	S	NP	1.85	16.8	43.4
"	NS	P		16.9	41.8
"	NS	NP	2.11	16.9	45.5
Individual Factors					
Tillage					
No tillage			1.50	16.6	31.6
Fall plow			2.44	16.8	44.7
Fall chisel			2.40	16.7	41.6
Till plant (ridge)			1.99	16.9	42.6
Spring disk (2x)			1.98	16.7	42.9
Significance Level (%):[4]			99	73	99
BLSD (.05) :			.52		4.2
Starter Fertilizer					
Starter			1.99	16.6	41.1
No starter			2.13	16.9	40.3
Significance Level (%):[4]			91	99	53
Poast Herbicide					
Poast				16.8	41.1
No Poast				16.7	40.2
Significance Level (%):[4]				18	37
Interactions			Significance Levels(%)[4]		
Tillage x SF			77	13	37
Tillage x Poast				25	99
SF x Poast				14	52
Tillage x SF x Poast				35	28
CV(%)			9.6	2.8	10.3

[1] S = starter fertilizer used: NS = no starter fertilizer used.

[2] P = Poast herbicide used: NP = no Poast herbicide used.

[3] Formerly a till-plant (flat) treatment.

[4] Probability level of significant difference between means.

systems and were significantly larger than the no tillage (NT) system (P≥95). Early plant growth for the till-plant (ridge) (TP-R) and spring disk (SD) treatments were higher than EPG for the NT system at probability levels of 90 > p < 95. Starter fertilizer response averaged over tillage treatments resulted in significantly lower early plant weights (p=91%). The correlation of EPG and grain yield was not significant with starter fertilizer; however, without starter fertilizer grain yield was quadratically related to EPG (R^2 = 0.6**).

Seed moisture at harvest was unaffected by tillage treatments or Poast application. Starter fertilizer resulted in a significant reduction (0.3%) in seed moisture when averaged over tillage.

Soybean yields were highest with the MP system. Yields with the CP, TP-R and SD systems were slightly but not significantly lower than the MP treatment. Yields from the NT system averaged 10-13 bu/A less than the other tillage treatments. Starter fertilizer had no effect on yields.

Percent surface residue cover measured before spring tillage showed the highest amounts with the NT (98%) system followed by the till-plant (flat) (79%), TP-R (70%), CP (40%) and MP (6%) systems (Table 2). After planting, residue cover on the MP treatment increased 83% from 6 to 11 percent. Residue cover was reduced after planting on the TP-R, SD, CP and NT treatments by 61, 51, 7 and 3 percent respectively.

Table 2. Influence of tillage methods for soybeans after corn on surface residue before and after planting at Waseca in 1983.

Treatment	Surface Residue	
	Before planting	After planting
	%	%
No tillage	98	95
Fall plow	6	11
Fall chisel	40	37
Till-plant (ridge)	70	27
Spring disk (2x)[1/]	79	36
Significance Level (%):	99	99
BLSD (.05) :	12.3	12.7
CV (%) :	11.8	17.5

[1/] Formerly till-plant (flat) treatment.

The rate of seedling emergence was determined by counting the number of plants that had broken through the soil surface in 40' of row/plot/day from the 11th to the 20th day following planting. Emergence, as a percent of final stand, shown in Table 3 indicates the most rapid germination with the MP and TP-R treatments, followed closely (1 day) by the SD and CP systems. Slowest emergence occurred from the NT system.

Table 3. Influence of tillage methods on the emergence progress of soybeans following corn at Waseca in 1983.

Treatment	Days Post Planting								
	11	12	13	14	15	16	17	18	22
	% emerged								
No tillage	0	1	5	30	50	74	86	90	100
Fall plow	12	32	44	72	83	91	94	96	100
Fall chisel	2	19	27	63	74	87	94	96	100
Till-plant (ridge)	13	36	48	77	88	91	95	95	100
Spring disk (2x)	1	11	18	52	72	85	93	93	100

Leaf samples taken at the R1 stage were chemically analyzed (Table 4). With the exception of P, Cu, and Zn, nutrient concentrations were not significantly affected by the tillage systems. The NT, TP-R and SD treatments showed significantly higher P concentrations than the MP or CP treatments. Till-plant (ridge) and SD systems exhibited the highest Cu and Zn leaf concentrations. Starter

fertilizer showed slightly higher Fe and slightly lower Zn concentrations when averaged over tillage systems. All nutrient concentrations in the leaf were considered adequate for optimum yields.

Table 4. Influence of tillage methods and starter fertilizer for soybeans on early plant growth and leaf nutrient concentration at the R1 stage at Waseca in 1983.

Treatment		Nutrient								
Tillage	Starter fert.	P	K	Ca	Mg	Fe	Mn	Zn	Cu	B
		%				ppm				
No tillage	S	.37	2.01	1.14	.45	144	65	39	8.4	53
"	NS	.36	1.97	1.15	.46	139	64	39	8.8	53
Fall plow	S	.33	1.99	1.09	.44	147	55	38	7.2	49
"	NS	.33	2.00	1.15	.45	144	57	41	7.1	50
Fall chisel	S	.34	1.94	1.12	.45	151	63	37	7.2	52
"	NS	.35	1.91	1.17	.47	144	65	40	7.6	52
Till-plant (ridge)	S	.37	1.95	1.10	.47	153	59	43	9.4	56
" "	NS	.37	1.89	1.13	.48	148	55	43	9.6	54
Spring disk (2x)	S	.37	1.86	1.18	.51	149	58	41	10.0	53
" "	NS	.37	1.94	1.11	.49	143	54	42	9.6	54
Individual Factors										
Tillage										
No tillage		.36	1.99	1.14	.45	141	64	39	8.6	53
Fall plow		.33	2.00	1.12	.44	145	56	39	7.2	50
Fall chisel		.34	1.93	1.15	.46	147	64	38	7.4	52
Till-plant (ridge)		.37	1.91	1.12	.48	150	57	43	9.5	55
Spring disk (2x)		.37	1.90	1.14	.50	146	56	41	9.8	54
Significance Level (%):		99	70	20	89	41	64	95	97	67
BLSD (.05) :		.01						3.2	1.9	
Starter fertilizer										
Starter		.36	1.95	1.12	.46	149	60	39	8.4	53
No starter		.36	1.94	1.14	.47	143	59	41	8.5	53
Significance Level (%):		12	37	77	46	95	31	96	28	15
Interactions										
Tillage x SF										
Significance Level (%):		02	75	88	66	01	23	38	29	77
CV (%) :		4.6	3.0	3.4	3.1	4.5	9.1	4.1	7.0	2.2

Weed counts (broadleaf and grass) were taken between the 4th and 5th rows from 4 randomly placed 1 ft^2 sections/plot 23 days after preemergence herbicide application (Table 5). Weed pressure from broadleaf weeds was not great, as broadleaf weed counts were low from both herbicide treated and untreated areas. Grasses were controlled extremely well in the MP, TP-R, CP and SD systems. Grass control was inadequate in the NT system probably because the thick surface residue accumulation prevented the preemergence herbicides from fully contacting the soil. Postemergence application of Poast herbicide 47 days after planting provided excellent grass control for all tillage treatments. Seed yields were not significantly affected by Poast application when averaged over all tillage systems (Table 1). Yields were reduced slightly with the MP and TP-R systems by approximately 5 and 3 bu/A, respectively. Yield increases attributed to Poast averaged 3, 4 and 11 bu/A for the CP, SD and NT treatments, respectively. Hence, the significant (99% level) tillage x Poast interaction.

Soil samples taken from the ridge-plant treatment after planting (Table 6) showed that regardless of the position of sampling, pH, P and K levels were fairly uniform when compared within depth. Soil samples taken from these same plots in 1982 after planting and ridging showed very high levels of P and K in the top 2" within the ridge as compared to samples taken between the ridges. One might conclude from this that soil samples can be randomly taken from a ridge planted system that is relatively flat after planting but before ridging.

Table 5. Weed populations on June 24th as affected by tillage and herbicide for soybeans following corn at Waseca in 1983.

Treatment	Herbicide[1]		No Herbicide	
	Grasses	Broadleaves	Grasses	Broadleaves
	plants/10 sq. ft.[2]			
No tillage	226	5	857	3
Fall plow	2	2	8	1
Fall chisel	1	1	22	2
Till-plant (ridge)	0	3	2	2
Spring disk (2x)	2	0	43	1

[1] 3 lb Amiben and 4 lb Lasso/A preemergence

[2] Average over 4 replications

Table 6. Soil test pH, P and K after soybean planting and before ridging after 8 years continuous ridge planted corn at Waseca.

Profile depth	Position of ridge sample[1]		
	In row	6" to side of row	15" between row
inches	Soil pH		
0-2	6.5	6.4	6.2
2-4	7.0	7.0	6.7
4-6	7.1	7.1	7.0
6-9	7.1	7.2	7.1
	Soil P (ppm)		
0-2	49	51	40
2-4	21	26	24
4-6	13	15	17
6-9	8	8	9
	Soil K (ppm)		
0-2	300	293	299
2-4	190	176	221
4-6	151	138	150
6-9	123	130	139

[1] Average over 4 replications; 8 cores composited/replication

SUMMARY

A field experiment was established in 1975 to evaluate five tillage systems (no tillage, moldboard plow, chisel plow, till-plant (ridge) and till-plant (flat) on continuous corn grown on a Webster clay loam. Beginning in 1979 all plots were split to evaluate the effect of starter fertilizer with these tillage treatments. In 1983 soybeans were planted to begin a long-term corn-soybean rotation phase of this experiment. The till-plant (flat) treatment was changed to a spring disk (2x) treatment in 1983. The most rapid emergence was observed for MP and TP-R systems followed closely by the CP and SD systems. Delayed emergence and low EPG weights were associated with the NT system. P concentrations for the NT, TP-R and SD systems were significantly higher than the MP or CP systems. Soybean yields among the MP, CP, TP-R and SD systems were not significantly different but were higher than the no tillage system which was heavily infested with weeds. Postemergence application of herbicide resulted in excellent grass control and significantly improved seed yield for the NT system. Starter fertilizer did not improve yields with any of the systems. Soil sampling of the ridge-plant system in the ridge, 6" to the side of the ridge or between ridges showed no apparent differences in pH, P or K within depths when samples were taken after planting but before ridging.

SOYBEAN ROW WIDTH IN A RIDGE-PLANT TILLAGE SYSTEM

Waseca, 1983

G. W. Randall

One of the tillage systems that is rapidly gaining popularity is the ridge-plant system (sometimes referred to as till planting). With this system no primary tillage is done. Ridges are built sometime the previous year and the crop is merely planted on the ridge. Since most Corn Belt farmers are growing corn in 30" rows prior to soybeans in the crop sequence, ridges are built in a 30" row-width. Most recent studies, however, have indicated soybean yield responses of 0-20% by using 15" and narrower rows compared to 30" rows. Thus, the objective of this study was to evaluate 30" soybean rows planted on ridges compared to 30" and 10" rows planted on previously ridged areas that had been tilled lightly before planting.

EXPERIMENTAL PROCEDURES

An area of Nicollet clay loam which was planted to corn in 30" rows and ridged in June, 1982, was the site of this study. A split-plot design consisting of three row width-ridge treatments (30" row-on ridges, 30" row-with ridge disked, and 10" row-with ridge disked) and split into two varieties (Corsoy 79 and Hodgson 78) was used. A light 20" diameter blade tandem disk was used to disk the tops off of the ridges immediately prior to planting of the last two treatments. Each individual plot measured 60' long by 10' wide and was replicated six times. A Buffalo till planter was used to plant the 30"-ridge treatment, a John Deere 7000 Max-Emerge planted the 30"-disked ridge treatment, and an ALAMCO experimental planter was used for the 10" rows. Soybeans were planted on May 24 at a rate of about 160,000 seeds/A. Starter fertilizer was not used because of high soil tests. Weeds were controlled chemically with Lasso + Amiben.

Emergence rates were taken from June 3 thru June 20 by counting plants in either two 30-inch rows of four 10-inch rows per plot. Surface residue accumulation was measured with the line-transect method. All yields were determined by combine harvesting the center rows of each plot.

RESULTS AND DISCUSSION

Emergence rate of the soybeans was affected by the row width-tillage treatments and by the soybean variety (Table 1). Planting in 30" rows directly into the ridges with the till-planter resulted in soybean emergence 11 days after planting with 95% of the beans emerged 18 days after planting. Disking the tops off of the ridges and planting in 30" rows with the Max-Emerge planter delayed initial and 95% emergence by about 1 day. Rate of emergence was slowest with the soybeans planted in 10" rows on the disked ridges. The first beans emerged 13 days after planting and the rate continued to be about 1-2 days behind the 30" ridge-planted beans. The Corsoy 79 soybeans consistently emerged about 1 day earlier than the Hodgson 78 variety regardless of row width-tillage treatment. These emergence rate differences followed the same pattern as in 1982; however, the differences were not as marked. The reason for this could be attributed to the precipitation which occurred on 5 of the first 10 days following planting in 1983.

Date of canopy closure estimated subjectively showed a large difference between row widths and a slight difference between ridge treatments. Average date of closure was July 12 with the 10" rows, July 30 with the 30" rows planted on the ridge, and August 8 for the 30" rows planted on the disked ridges.

Surface residue measurements taken prior to disking of the ridges indicated that 57% of the soil surface was covered by residue from the previous corn crop. After planting, surface residues covered approximately 25% of the soil surface with the ridges that had been disked lightly compared to 17% after planting with the till-planter (Table 2). As expected no difference in residues was observed between the varieties.

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

Final plant stand varied among the row width - tillage treatments primarily because three different planters were used in the study (Table 2). The final stand was also higher with the Corsoy 79 variety; probably because of the smaller seed which rolled out faster from the soybean feed cups used with the Buffalo and John Deere planters. A known (counted) number of seeds were planted with the Alamco 10" row planter which uses a cone-type seed distribution system. These final stand differences were not thought to have a large influence on final yield.

Soybean yields were affected significantly by the treatments (Table 2). Even though emergence was delayed slightly, yields from the 10" rows averaged about 5-6 bu/A better than the 30" rows. The 30" rows planted on the ridges yielded significantly higher (2.7 bu/A) than the flat-planted 30" rows. Part of the difference may have been due to the difference in plant population, however. Significant yield differences did not occur between the Corsoy 79 and Hodgson 78 varieties. The interaction between row width-ridge treatment and variety (significant at the 95% probability level) is shown by the higher yields with the Corsoy 79 variety on the disked, flat-planted treatments compared to higher yields with the Hodgson 78 variety planted on the ridges.

Table 1. Influence of row width-ridge treatment and soybean variety on soybean rate of emergence.

Treatment		Days after planting											
Row width-ridge	Variety	11	12	13	14	15	16	17	18	20	22	24	27
		% emerged											
30", ridge	Corsoy 79	4	18	29	60	82	90	95	96	97	98	99	100
"	Hodgson 78	1	6	12	34	59	82	90	91	95	98	99	100
30", flat	Corsoy 79	1	7	15	39	67	82	91	94	96	98	98	100
"	Hodgson 78	0	3	5	22	54	72	86	91	94	96	98	100
10", flat	Corsoy 79	0	0	5	27	52	70	82	91	97	100	100	100
"	Hodgson 78	0	0	5	18	48	65	77	87	94	100	100	100

Table 2. Influence of row, plant population, width-ridge treatment and soybean variety on surface residues and soybean yields.

Treatment		Surface residue after planting	Final stand	Seed yield
Row width-ridge	Variety	%	plants/Ax10^{-3}	bu/A
30", ridge	Corsoy 79	15	205.	43.0
"	Hodgson 78	19	153.	45.7
30", flat	Corsoy 79	25	164.	42.7
"	Hodgson 78	29	112.	40.5
10", flat	Corsoy 79	25	132.	49.2
"	Hodgson 78	23	135.	47.9
Individual Factors				
Row width-ridge				
30", ridge		17	179	44.3
30", flat		27	138	41.6
10", flat		24	134	48.6
Signif. Level (%):[1/]		98		99
BLSD (.05) :		6.		1.6
Variety				
Corsoy 79		22	168	45.0
Hodgson 78		24	132	44.7
Signif. Level (%):[1/]		63		32
Row width-ridge x variety interaction				
Signif. Level (%):[1/]		55		95
CV (%) :		29.		5.

[1/] Probability of a significant difference among the treatment means.

SUMMARY

Date from the second year of this two-year study indicated that a light disking of ridges could be performed easily and satisfactorily to enable narrow row planting of soybeans in a ridge-plant corn-soybean sequence. Surface residue amounts can be maintained at satisfactory levels and yields increased with the 10" row soybeans planted in this manner. This, of course, necessitates building the ridges for corn (if one desires to do so) after the soybean crop is harvested.

ACKNOWLEDGMENT

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EFFECT OF TIME OF RIDGING SOYBEANS ON SOYBEAN PRODUCTION IN A RIDGE-PLANT SYSTEM

Waseca, 1983

G. W. Randall

The ridges in a ridge-plant system are usually considered one of the keys in making the system work. This is especially important in wet, poorly-drained soils planted to corn, which is sensitive to cold soil temperatures. The ridge warms up and dries more quickly; thus allowing earlier planting.

Construction of the ridges in soybeans for corn the next year poses some potential problems. If the ridging is done during the growing season, are the soybeans damaged to the point of yield reduction? Is pod height lowered so as to increase harvest losses? On the other hand, if narrow-row soybeans are planted, is it possible to build the ridges post-harvest? What are the effects of this late ridging treatment on surface residue cover?

The purpose of this study was to evaluate three times of ridging soybeans for corn on soybean production.

EXPERIMENTAL PROCEDURES

The experimental site (Webster clay loam) was planted to corn in 30" rows and ridged in 1982. Two varieties of soybeans (Corsoy 79 and Hodgson 78) were planted in 30" rows with a Buffalo till planter on May 18 at a rate of 160,000 seeds/A. No starter fertilizer was used. Weeds were controlled chemically with Lasso + Amiben. The ridging treatments were superimposed over varieties at three stages of soybean growth (early bloom (R1), mid-bloom (R2.5), and post harvest). A Hiniker cultivator was used to build the ridges. This split-plot design with ridge treatments as the main plot was replicated six times.

Plant height at maturity and the height of the lowest pod above the soil surface were measured from 10 randomly selected plants/plot just prior to harvest. All yields were determined by harvesting each plot with a modified JD3300 plot combine.

RESULTS AND DISCUSSION

The ridging operation at the R1 stage (July 18) presented some problems again in 1983. Since no prior cultivation had been conducted, the soil surface was hard and, consequently, slabs of soil tended to knock some of the plants over. Speed and depth of cultivation had to be watched carefully. Experiences such as these lead to the recommendation of cultivating soybeans at least 2 weeks prior to the ridging operation. All plots were cultivated on July 18 in preparation for the mid-bloom ridging treatments. At the mid-bloom stage (R2.5) on July 29, the plants were larger and were not as sensitive to cultivation speed. Also, the prior cultivation had loosened and dried the surface soil which permitted building the ridges with soil almost free of large clods and slabs.

Soil conditions were much drier for the late ridging treatment compared to the July 18 ridging. Ridge height after ridging was estimated to be about 5-6" (amplitude).

Plant height at maturity from the July ridged treatments averaged 1½-2" higher than the non-ridged treatment (Table 1). Corsoy 79 soybeans were 6" taller than the Hodgson 78 variety. A time of ridging by variety interaction was not found.

The height of the lowest pod above the soil surface was much higher than in 1982 but was affected significantly by ridging (Table 1). The ridging operations during the summer reduced the pod height by 1.5 to 1.8 cm when averaged over varieties. The pod height of the Group I variety (Hodgson 78) was significantly lower than the Group II variety (Corsoy 79).

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

Table 1. Influence of time of ridging on soybean plant height, pod height, seed moisture, and seed yield.

Treatment		Plant height at maturity	Height of lowest pod	Seed	
Ridging time[1]	Variety			Moisture	Yield
		inches	cm	%	bu/A
July 18	Corsoy 79	39	12.0	12.6	50.1
"	Hodgson 78	32	10.2	11.8	41.1
July 29	Corsoy 79	38	12.6	12.6	48.6
"	Hodgson 78	31	10.2	11.9	43.2
Post Harvest	Corsoy 79	36	13.4	12.7	52.0
" "	Hodgson 78	31	12.5	11.9	45.7
Individual Factors					
Ridging time					
July 18		35.4	11.1	12.2	45.6
July 29		34.9	11.4	12.3	45.9
Post-harvest		33.5	12.9	12.3	48.9
Signif. Level (%):[2]		99	97	53	99
BLSD (.05) :		1	1.4		1.6
Variety					
Corsoy 79		37.8	12.7	12.7	50.2
Hodgson 78		31.4	11.0	11.9	43.3
Signif. Level (%):[2]		99	99	99	99
Ridge time x variety interaction					
Signif. Level (%):[2]		32	51	28	94
CV (%) :		5	12.	1.	4.

[1] Corresponds to R1 (July 18) and R2.5 (July 29) stages.

[2] Probability of a significant difference among treatment means.

Seed moisture at harvest was influenced by the variety but was not influenced by the time of ridging (Table 1).

Soybean yields when averaged over the two varieties were significantly reduced by 3.0 and 3.3 bu/A by ridging during the R2.5 and R1 stages, respectively (Table 1). When examining the harvest losses (Table 2), it does not appear that the yield reductions were due to harvest problems. Also, the height of the lowest pod was sufficiently high to permit rather easy harvesting. An explanation for this yield reduction may be that the ridge cultivation pruned some roots and/or increased the soil water loss during this very dry July-August period. Corsoy 79 significantly outyielded Hodgson 78 by 6.9 bu/A when averaged over the time of ridging. The significant (94%) interaction between time of ridging and variety is shown by the Hodgson 78 yields being decreased more when ridged at the R1 stage while the lowest Corsoy 79 yields were associated with ridging at the R2.5 stage.

Harvest losses were quite low and were not affected by the time of ridging (Table 2). Losses were greater with the Hodgson 78 variety; perhaps due to lower seed moisture and lower pod height.

Ridge heights were measured within 10 days after the fall post harvest ridging operation was conducted. At that time the post harvest ridges were approximately 1" higher than the ridges formed in July (Table 2). More significantly the percent surface covered by the residue was decreased to 32% with post harvest ridging compared to approximately 70-75% with the July ridge treatments when measured by the line-intercept method.

Slightly but significantly more residue was found on the soil surface with the Corsoy 79 variety.

Ridge heights from the 1982 experiment were measured on April 25, 1983 and are shown in Table 2. Ridge height averaged between 4-5" and significant differences among the time of ridging treatments were not apparent.

Table 2. Influence of time of ridging and soybean variety on harvest loss, ridge height, and surface residue cover.

Treatment		Harvest	Post Harvest		Spring '83
Ridging time[1/]	Variety	loss	Ridge height	Residue	ridge height
		bu/A	cm	%	cm
July 18	Corsoy 79	.4	14.3	75	11.4
"	Hodgson 78	1.4	14.2	68	10.3
July 29	Corsoy 79	.6	13.0	78	10.4
"	Hodgson 78	.9	13.1	72	10.3
Post Harvest	Corsoy 79	.3	16.8	35	10.6
" "	Hodgson 78	1.2	16.9	29	10.9
Individual Factors					
Ridging time					
July 18		.9	14.3	71	10.9
July 29		.8	13.1	75	10.4
Post-Harvest		.7	16.8	32	10.8
Signif. Level (%):	2/	91	99	99	
BLSD (.05)	:	.2	1.3	5	
Variety					
Corsoy 79		.4	14.7	62	10.8
Hodgson 78		1.2	14.7	56	10.5
Signif. Level (%):	2/	99	8	97	
Ridge time x variety interaction					
Signif. Level (%):	2/	96	8	3	
CV (%)	: 2/	38	5	13	

1/ Corresponds to R1 (July 18) and R2.5 (July 29) stages.

2/ Probability of a significant difference among treatment means.

SUMMARY

Results from the second year of this study indicate that soybean yields were depressed by approximately 3.0 bu/A when ridging was done at the R1 and R2.5 stages compared to post harvest ridging. These data agree fairly well with the previous year's and suggest a preference for post-harvest ridging in the fall for the next year's crop.

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NITROGEN AND SULFUR APPLICATIONS TO CORN IN SOUTHERN MINNESOTA

1983

G. W. Randall and W. E. Jokela

Corn yield response to varying N rates and application times in Southern Minnesota have been documented frequently. However, response by corn to sulfur (S) on these soils has not been frequently and consistently reported. Recently, ammonium sulfate as a source of both N and S has become more common as a fertilizer material in the northern Corn Belt. The purpose of this study was to evaluate preplant vs split applications of ammonium sulfate compared to preplant application of urea on corn production on two soils of Southern Minnesota.

EXPERIMENTAL PROCEDURES

Two sites which had been planted to corn in 1982 were selected for this study. One location was on a Mt. Carrol silt loam (Mollisol) on the William Quiggle farm in Goodhue County. This soil represents a large acreage of well-drained, low organic matter, loessial soils cropped to corn in Southeastern Minnesota. The other location was at the Southern Experiment Station, University of Minnesota in Waseca County. This Webster clay loam soil has inherently poor drainage, high organic matter content, and is extensively cropped to corn and soybeans. It represents a large acreage of soils in Southern Minnesota and Northern Iowa.

Tillage at the Goodhue County site consisted of fall chisel plowing and then spring disking and field cultivating prior to planting. The site in Waseca County was fall moldboard plowed and spring field cultivated. Soil tests for the Goodhue and Waseca sites follow: pH = 6.7 and 6.6; Bray extractable P_1 = 87 and 56 lb/A (both Very High); exchangeable K = 248 and 386 lb/A (High and Very High); and extractable SO_4-S = 5 and 8 ppm, respectively for the two locations.

Eight N and S treatments were replicated four times at the Goodhue site and 6 times at the Waseca site in a randomized, complete-block design. Each plot measured 15' wide (6-30" rows) x 30' long in Goodhue County and 10' wide (4-30" rows) x 55' long in Waseca County.

Corn (Pioneer 3906) was planted with a JD Max-Emerge planter on May 23 at a population of 27700 plants/A in Goodhue County and May 16 at a population of 29900 in Waseca County. Weeds were chemically controlled with a preemergence application of Lasso + atrazine at both locations. Furadan was applied with the planter to control rootworms at both locations.

The preplant applications of both N sources were applied and incorporated by secondary tillage on May 5 and 11 at the Goodhue and Waseca sites, respectively. The split application treatments were applied ½ preplant and ½ sidedressed at the 8 to 9-leaf stage on July 12 and July 6 at the Goodhue and Waseca locations, respectively. Application rates of N and S for the Goodhue and Waseca locations are shown in Tables 1 and 3, respectively.

Ten randomly selected leaves opposite and below the ear were taken at silking for total N and S analyses. Fodder and grain yields were obtained at physiological maturity by hand harvest techniques at the Goodhue location while plots were combine harvested at Waseca. All fodder and grain analyses were conducted on samples gathered at harvest. Chemical analyses were performed by the Research Analytical Laboratory, University of Minnesota.

RESULTS AND DISCUSSION

Goodhue County: Leaf N, silage yield and total N uptake in the silage were increased significantly over the check by the urea and AS treatments (Table 1). Trends toward higher fodder N concentrations and fodder yields with the urea and AS treatments were evident; however, greater experimental error negated statistically significant differences at the 95% level. Differences among the urea with and without S treatments and AS were not statistically significant for any of these parameters.

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When examining the effect of N rate averaged over N source and time of application, leaf and fodder N concentrations and total N uptake were greater with the higher N rate (Table 1). Fodder and silage yield were not influenced by N rate. The N source-method of application, when averaged over N rates, had no effect on any of the above parameters. Moreover, there was no interaction between N rate and N source-time of application.

Table 1. Influence of rate, source and time of application of N and S on leaf N, fodder N, fodder yield, silage yield, total N uptake and final population at GOODHUE in 1983.

N Rate	N Source[1/]	S Rate	S Source	Applcn method[2/]	Leaf N	Fodder N	Fodder yield	Silage yield	Total N uptake	Final population
lb/A		lb/A			%	%	----T DM/A----		lb N/A	ppA x 10^{-3}
Check					2.46	.73	2.49	5.33	111	26.4
67	Urea	-	-	PP	3.05	.82	3.13	6.41	143	26.4
67	Urea	79	Gypsum	PP	3.14	.70	3.20	6.72	145	26.5
67	AS	79	AS	PP	3.09	.78	2.94	6.11	137	26.0
67	AS	79	AS	Split	3.13	.69	2.88	6.31	136	25.4
134	Urea	-	-	PP	3.43	.83	2.77	6.17	147	26.0
134	AS	158	AS	PP	3.31	.87	3.09	6.74	159	27.3
134	AS	158	AS	Split	3.34	.85	2.73	6.40	151	25.9
Significance Level (%):[3/]					99	91	84	99	99	31
BLSD (.05)				:	.18			.72	17	
CV (%)				:	4.3	12.	12.6	7.2	8.1	5.2
Individual Factors										
N rate (lb/A)										
67					3.09	.76	2.98	6.28	139	25.9
134					3.36	.85	2.86	6.44	152	26.4
Significance Level (%):[3/]					99	94	57	57	99	62
N source-time of application										
Urea - PP					3.24	.83	2.95	6.29	145	26.2
AS - PP					3.20	.82	3.01	6.43	148	26.6
AS - Split					3.23	.77	2.80	6.35	144	25.6
Significance Level (%):[3/]					26	51	50	15	24	69
Interactions										
N rate x N source-time										
Significance Level (%):[3/]					81	64	61	78	64	59

[1/] AS = ammonium sulfate

[2/] PP = preplant, Split = ½ at PP and ½ at 8 to 9-leaf stage

[3/] Probability level of significant difference among treatment means

Grain yield, N concentration, and N removal were significantly improved by the urea and AS treatments over the check (Table 2). Grain yield for the urea + gypsum treatment was significantly higher than with comparable rates of N and S applied as AS; however, this effect was not noted for any of the other parameters. Factorial examination of the main effects showed significantly higher grain yield, N concentration, and grain N removal with the higher N rate when averaged over N source-time of application. Differences among the N source-time of application treatments were not significantly different when averaged over N rate; however, yields were 5.4 bu/A higher with the split application. In addition, no interaction between N rate and source-application time was noted.

Leaf, grain, and fodder samples from the three high N rate treatments were additionally analyzed for total S. Results shown in Table 3 indicate a significant (93% level) increase in leaf S with the PP application of AS compared to urea. Grain and fodder S concentrations, total S uptake in the silage, and grain S removal (product of grain yield times grain S concentration) were not affected by the S treatments on this low organic matter soil which showed a rather low extractable SO_4-S

level (5 ppm). However, N:S ratios were reduced from 13.6, 12.2 and 14.1 with urea to 11.0, 10.2 and 13.7 with the PP application of AS for leaf, fodder and grain, respectively.

Table 2. Influence of rate, source and time of application of N and S on grain yield, moisture, N and N removal at GOODHUE in 1983.

N Rate	N Source[1/]	S Rate	S Source	Applcn method[2/]	Ear moisture	Grain Yield	Grain N	Grain N removal
lb/A		lb/A			%	bu/A	%	lb/A
Check					48.2	104.4	1.52	75.1
67	Urea	-	-	PP	47.4	121.8	1.59	91.7
67	Urea	79	Gypsum	PP	46.9	130.4	1.60	99.0
67	AS	79	AS	PP	48.0	117.0	1.65	91.6
67	AS	79	AS	Split	47.1	126.6	1.60	95.9
134	Urea	-	-	PP	46.8	124.7	1.71	100.9
134	AS	158	AS	PP	46.7	133.7	1.66	104.8
134	AS	158	AS	Split	46.1	134.9	1.64	105.0
Significance Level (%):[3/]					87	99	99	99
BLSD (.05)						11.6	.08	9.3
CV (%)					2.1	6.4	3.2	6.8
Individual Factors								
N rate (lb/A)								
67					47.5	121.8	1.62	93.1
134					46.5	131.1	1.67	103.6
Significance Level (%):[3/]					97	99	97	99
N source-time of application								
Urea - PP					47.1	123.2	1.65	96
AS - PP					47.4	125.4	1.66	98
AS - Split					46.6	130.8	1.62	100
Significance Level (%):[3/]					63	79	62	48
Interactions								
N rate x N source-time								
Significance Level (%):[3/]					16	72	86	20

[1/] AS = ammonium sulfate

[2/] PP = preplant, Split = ½ at PP and ½ at 8 to 9-leaf stage

[3/] Probability level of significant difference among the treatment means

In summary, grain and silage yields, N concentration in the plant parts, and N uptake were improved by the urea and AS treatments. The highest N rate (134 lb/A) generally produced the highest yields and N concentrations. Evaluation of the data indicates that this N rate was close to optimum under the 1983 growing conditions. A consistent and significant advantage for the split application of AS over the PP application was not obtained. This was expected under the adequate but not excessive rainfall conditions at this site. Leaching and/or denitrification conditions apparently did not exist after the PP applications in early May. Significant and consistent differences between the urea + gypsum treatment and the AS treatment did not occur. With the exception of leaf S concentration, the S applications did not consistently improve corn production even though the SO_4-S level of this low organic matter soil was relatively low (5 ppm).

Table 3. Influence of N source and time of ammonium sulfate application on leaf S, grain S, fodder S, total S uptake and grain S removal at GOODHUE in 1983.

N source[1/]	Application method[2/]	Leaf S	Grain S	Fodder S	Total S uptake	Grain S removal
		%	%	%	lb/A	lb/A
Urea	PP	.253	.121	.068	11.0	7.1
AS	PP	.300	.121	.085	12.9	7.7
AS	Split	.276	.117	.073	11.5	7.5
Significance Level (%):[3/]		93	88	82	89	81
BLSD (.05)	:	.042				
CV (%)	:	8.4	2.0	15.2	9.6	4.7

1/ AS = ammonium sulfate; Both N sources applied at rate of 134 lb/A

2/ PP = preplant, Split = ½ at PP and ½ at 8 to 9-leaf stage

3/ Probability level of significant difference among the treatment means

Waseca County: Results from the study in Waseca County were considerably different than from Goodhue County. This was primarily due to the extremely dry and hot conditions which began immediately following the sidedress application. Rainfall totaled only 1.80" over the 7 weeks following the split application of AS at the 8-9 leaf stage (July 6).

Leaf N concentration, fodder and silage yield, and total N uptake in the silage were increased over the check by all of the urea and AS treatments (Table 4). Fodder N was increased over the check by only the 178-lb N/A treatments. Differences among the urea with and without S treatments and AS applied PP were not statistically significant for any of the parameters.

Examination of the main effect of N rate averaged over N source-time of application indicates that leaf and fodder N, silage yield, and total N uptake were increased significantly (90% level) by the high N rate (Table 4). Fodder yield was not influenced by N rate. The N source-time of application had a substantial effect on leaf N, fodder and silage yield, and total N uptake when averaged over N rates. The PP applications of urea and AS resulted in almost identical results. However, splitting the AS application into ½ at PP and ½ at the 8 to 9-leaf stage produced significantly lower leaf N concentration, fodder and silage yield, and total N uptake. Apparently the sidedress portion of the split application remained near the soil surface and was never moved down into the root system where it could have been utilized by the plants. A significant interaction between N rate and N source-time of application was not found for these parameters. Grain yield and grain N removal were increased substantially and grain moisture reduced significantly by all of the urea and AS treatments compared to the check (Table 5). Only the 178-lb N rate increased grain N over the check. The urea + gypsum treatment and the PP applied AS treatments did not improve yield, N concentration, moisture content and N removal of the grain over the standard urea treatments.

Factorial examination of the main effects showed a highly significant improvement in all of the grain parameters with the high N rate when averaged over N source-time of application (Table 5). Differences among the N source-time of application treatments were also highly significant when averaged over N rates. Corn grain yield, moisture content, N concentration and N removal were almost identical with the PP urea and AS treatments. However, the split application of AS gave significantly lower grain yield, N concentration, N removal and higher moisture content than the PP application of AS. Positional unavailability of the sidedress portion applied at the 8 to 9-leaf stage was thought to be the primary reason for the poor performance of the split AS treatments.

Table 4. Influence of rate, source and time of application of N and S on leaf N, fodder N, fodder yield, silage yield, total N uptake and final population at WASECA in 1983.

N Rate	N Source[1/]	S Rate	S Source	Applcn method[2/]	Leaf N	Fodder N	Fodder yield	Silage yield	Total N uptake	Final population
lb/A		lb/A			%	%	----T DM/A----		lb N/A	ppA x 10^{-3}
Check					1.73	.53	1.58	3.08	48	25.6
89	Urea	-	-	PP	2.74	.54	2.33	5.23	91	24.9
89	Urea	105	Gypsum	PP	2.77	.51	2.35	5.33	94	25.7
89	AS	105	AS	PP	2.79	.54	2.27	5.33	89	25.2
89	AS	105	AS	Split	2.43	.54	2.05	4.75	77	25.8
178	Urea	-	-	PP	3.24	.67	2.33	5.64	120	26.9
178	AS	210	AS	PP	3.29	.68	2.41	5.57	120	26.6
178	AS	210	AS	Split	2.94	.61	2.23	5.02	102	24.9
Significance Level (%):[3/]					99	99	99	99	99	86
BLSD (.05)				:	.12	.05	.24	.49	7	
CV (%)				:	4.3	8.5	9.7	9.2	7.1	5.4
Individual Factors										
N Rate (lb/A)										
89					2.66	.54	2.22	5.10	86	25.3
178					3.16	.65	2.32	5.41	114	26.2
Significance Level (%):[3/]					99	99	85	93	99	94
N source-time of application										
Urea - PP					2.99	.61	2.33	5.43	106	25.9
AS - PP					3.04	.61	2.34	5.45	105	25.9
AS - Split					2.69	.58	2.14	4.89	89	25.4
Significance Level (%):[3/]					99	80	95	99	99	44
BLSD (.05)				:	.08		.19	.41	5.4	
Interactions										
N rate x N source-time										
Significance Level (%):[3/]					2	77	43	9	49	97

[1/] AS = ammonium sulfate

[2/] PP = preplant, Split = ½ at PP and ½ at 8 to 9-leaf stage

[3/] Probability level of significant difference among treatment means

Table 5. Influence of rate, source and time of application of N and S on grain yield, moisture, N and N removal at WASECA in 1983.

N		S		Applcn	Grain			
Rate	Source[1/]	Rate	Source	method[2/]	Yield	Moisture	N	N removal
lb/A		lb/A			bu/A	--------%	---------	lb/A
Check					45.1	21.8	1.45	31.1
89	Urea	-	-	PP	93.3	19.5	1.49	65.6
89	Urea	105	Gypsum	PP	99.1	19.8	1.49	69.6
89	AS	105	AS	PP	93.5	19.7	1.46	64.7
89	AS	105	AS	Split	78.0	20.3	1.49	54.9
178	Urea	-	-	PP	114.3	19.3	1.65	89.5
178	AS	210	AS	PP	113.1	19.2	1.63	87.6
178	AS	210	AS	Split	103.3	19.6	1.52	74.4
Significance Level (%):					99	99	99	99
BLSD (.05)				:	6.7	.6	.07	4.7
CV (%)				:	7.0	2.6	4.4	6.7
Individual Factors								
N rate (lb/A)								
89					88	19.9	1.48	61.7
178					110	19.4	1.60	83.8
Significance Level (%):					99	99	99	99
N source-time of application								
Urea - PP					103.8	19.4	1.57	77.5
AS - PP					103.3	19.4	1.55	76.1
AS - Split					90.6	19.9	1.50	64.7
Significance Level (%):					99	98	97	99
BLSD (.05)				:	5.2	.4	.05	3.7
Interactions								
N rate x N source-time								
Significance Level (%):					44	54	99	49

1/ AS = ammonium sulfate

2/ PP = preplant, Split = ½ at PP and ½ at 8 to 9-leaf stage

3/ Probability level of significant difference among treatment means

Sulfur analysis conducted on the plant tissue from the 178-lb N rate treatments showed highly significant increases in S with both of the AS treatments compared to urea (Table 6). This resulted in significantly higher total S uptake with both AS applications and grain S removal with the PP application. Ratios of N:S for leaf, fodder, and grain were reduced from 14.1, 8.5 and 14.9 with urea to 10.1, 5.4 and 12.8 with the PP application of AS, respectively. These results were somewhat surprising on this high organic matter soil which had a moderate extractable SO_4-S level (8 ppm).

Table 6. Influence of N source and time of ammonium sulfate application on leaf S, grain S, fodder S, total S uptake and grain S removal at WASECA in 1983.

N source[1/]	Application method[2/]	Leaf S	Grain S	Fodder S	Total S uptake	Grain S removal
		%	%	%	lb/A	lb/A
Urea	PP	.229	.111	.079	9.7	6.0
AS	PP	.325	.127	.125	12.9	6.8
AS	Split	.365	.127	.141	12.5	6.2
Significance Level (%):	[3/]	99	99	99	99	96
BLSD (.05)	:	.026	.006	.014	1.2	.6
CV (%)	:	7.2	4.3	10.4	8.4	7.5

1/ AS = ammonium sulfate; Both N sources applied at rate of 178 lb N/A

2/ PP = preplant, Split = ½ at PP and ½ at 8 to 9-leaf stage

3/ Probability level of significant difference among treatment means

In summary, grain and silage yields, N concentration in the plant parts, and N uptake were improved by the urea and AS treatments. The highest N rate (178 lb N/A) produced the highest yields and N concentrations and was judged to be an optimum N rate under the growing conditions in 1983. The split application of AS consistently resulted in significantly lower yields and N uptake when compared to the PP application in early May. This was primarily due to positional unavailability of the early July N application which apparently was not moved down into the active zone of root activity during the hot and dry 7-week period in July and August. Significant and consistent differences between the urea + gypsum treatment and the AS treatment did not occur. Even though S concentrations in the plant parts were significantly improved, yield response to the added S was not obtained.

CONCLUSION

Under the hot, dry conditions of 1983 corn yields and N uptake were significantly improved by the urea and AS treatments at both locations. Yields were not improved by the S treatments, although S concentrations in the plant parts were increased significantly at the Waseca location. Corn production was not improved with the split application of AS at the Goodhue location. Yields and N uptake were reduced significantly with the split application of AS at Waseca.

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PLACEMENT OF NITROGEN SOLUTIONS UNDER DIFFERING TILLAGE SYSTEMS

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The use of 28% N solution for corn production has increased over the last several years in Minnesota. The popularity of this product stems at least partially because of its handling characteristics and its convenience as a carrier for herbicide applications. With the increasing emphasis on conservation tillage increased concerns are being expressed related to placement and/or management of 28% N solution. These concerns are related to the potential volitalization losses or immobilization of N that may take place if applied to soils with high surface residues (conservation tillage). The objectives of these experiments were therefore to: (1) evaluate surface vs. injected applications of 28% N solution under different tillage systems, and (2) with surface applications of 28% N solution compare uniform broadcast applications to surface dribble applications under different tillage systems.

MATERIALS, METHODS, AND OBSERVATIONS

Experimental sites - In 1983 experiments were established at two locations. One location was in East Central (EC) Minnesota at the University of Minnesota Sand Plains Research Farm near Becker, Minnesota. The second location was in South Eastern (SE) Minnesota on a producers field in Goodhue County. The soils at the EC location are formed from glacial outwash and are deep, coarse textured, and contain medium to high levels of organic matter. The soils are typically classified as a Hubbard loamy sand (Udorthentic Haploboroll) and because of their coarse texture and low water holding capacity must be irrigated to attain high production levels. The soils at the SE location are loess derived silt loam soils typically classified as either Seaton (Typic Hapludalf) or Mt. Carroll (Mollic Hapludalf).

Experimental treatments - The treatment combinations at each location were incomplete factorial arrangements of either four (EC) or three (SE) tillage treatments at three nitrogen rates (84, 168, and 336 kgN/ha - 75, 150, 300 #N/a), with three methods of 28% N solution application (broadcast, injected, or surface dribble). The 28 treatments established at the EC location consisted of four tillage systems (no till, ridge till, chisel, and moldboard plow) with all methods of 28% N application at the low N rate (84 kgN/ha), plus all application methods at two additional N rate (168 and 336 kgN/ha) on two tillage systems (no till and chisel), plus control treatments (zero N) for each tillage system (12 + 12 + 4 = 28). The 24 treatments established at the SE location were set up in an identical manner except that only three tillage systems were included (9 + 12 + 3). No moldboard plow treatment was included because this is no longer a standard practice in this area. All treatments were replicated four times utilizing a split-split plot design. The main plots were tillage with the first sub-plots being N rate and the second sub-plot being method of application. The smallest experimental sub-units were four rows wide (4m) and 15m long.

Cultural practices - A summary of the management practices utilized at each location are summarized in Table 1.

Table 1. Management practices utilized at the EC and SE experimental locations.

Management Practice	EC (Becker)	Date	SE (Goodhue)	Date
Tillage	Moldboard plow & plowpacker	4/20		
	Chisel & disc	4/21-4/25		5/10-1/10
	Ridge Till Cultivation	6/28		7/6
Planting date[1]	No till	5/3		5/10
	Other tillage	5/4		5/10
Corn variety	Pioneer 3906		Pioneer 3906	
Seeding rate	7.74 seeds/m^2		6.92 seed/m^2	
Row spacing	76 cm		97 cm	
Fertilizer treatment application	5/9		5/11	
Starter fertilizer	170 kg/ha, 8-10-30		1601/ha, 7-21-7	
Other fertilizer	250 kg/ha, 0-0-22		225kg/ha$CaSO_4$ $2H_2O$	6/6
			1 kg/ha, Zn	7/8
Insectidice	Lorsban 7 kg/ha	5/3-5/4	Dyfonate, 6 kg/ha	5/10
Herbicide[2]	Atrazine 2 kg/ha	5/6	2 kg/ha	5/10
	Metolachlor 1.5 kg/ha	5/6	2 kg/ha	5/10
	Glyphosphate 2.3 kg/ha (no till)	5/10	2.3 kg/ha	5/24
	2,4-D amine 0.5 kg/ha	6/6	2,4-D amine + 0.3 kg/ha	
	Atrazine + oil 2 kg/ha+ 10 l/ha	6/7	dicamba 0.15 kg/ha	6/9
Irrigation	17.4 cm 8.8 cm	July August		

1 At the EC location the ridge till treatments were planted with a Buffalo till planter (disc trash cleaners) and a white (5 cm fluted coulter). At the SE location a Hinéker planter was used for all treatments (trash discs were raised for no till and chisel treatments).

2 Excellent weed control was obtained at the EC location but giant foxtail was a problem on the no till treatments at the SE location.

Tillage treatment characterizations - A number of parameters including surface residue (cover), soil temperature, and crop emergence were collected to determine the impact of tillage. The factors can be important in assessing the interaction of nitrogen application method and its impact on crop production.

Surface Residue

Location	Tillage	Percent cover * In Row	Between
Becker (5/20)	Moldboard	5.3 (2.8)	7.3 (3.4)
	Chisel	46 (13)	46 (7.7)
	Ridge till	47 (17)	66 (15)
	No till	80 (13)	82 (13)
Goodhue Co. (5/31)	Chisel	50 (6.0)	46 (7.0)
	Ridge till	23 (13)	54 (7.6)
	No till	67 (11)	76 (6.0)

* In the row = A 20 cm area centered over the row and between is the remainder. The number in parentheses is the standard deviation, N=8.

With moldboard tillage there was very little residue remaining on the soil surfaces. The chisel plow treatment resulted in similar cover at both locations with about one half of the soil surface covered with crop residue. Both the modlboard and chisel treatments showed no difference in cover due to position relative to the row. The ridge till treatment resulted in more cover at the Becker site (probably due to higher levels of residue and planter differences), and large differences in and between the row. Differences relative to the row were less at the Becker site. This was probably due to planter differences and a higher moisture content of the corn residue at the time of planting.

Temperature: Becker site only

Tillage	Date and Time* 5/20 1400	6/1 1445	6/27 1315	6/30 1330	Average
Moldboard	14.7(.61)	24.8(78)	24.2(.57)	27.4(1.09)	22.8
Chisel	13.3(.38)	22.0(.31)	24.2(20)	26.7(.72)	22.0
Ridge till	12.9(.64)	20.5(1.25)	24.3(.18)	23.8(.87)	20.3
No till	12.7(.99)	19.9(1.88)	23.8(.91)	26.3(88)	20.7

* Temperatures are a mean of 12 observations (4 thermocouples with three gangs each) at a 5 cm depth in the row. The number in parenthesis is the standard deviation of the four thermocouple gangs.

The ridge till and no till treatments exhibited similar temperatures. The chisel plow treatment resulted in temperatures slightly cooler than moldboard plow tillage. Although average differences in soil temperatures due to tillage appear small, relatively small difference can result in large differences in early growth. The temperature with ridge till on 6/30 is much cooler because of the additional soil moved into the row at cultivation (6/28).

Location	Tillage	Percent Emergence* 5/17	5/20	6/1	Final* Population plants/m²
Becker	Moldboard	81(15)	95(3.8)	99(2.4)	7.45(.63)
	Chisel	40(22)	73(23)	97(3.4)	7.56(.71)
	Ridge till	3.4(5.3)	26(27)	97(7.2)	7.55(.43)
	No till	9.2(16)	22(12)	91(12)	7.32(.66)
		5/26	5/31		
	Chisel	51(23)	96(3.3)		6.74(.31)
	Ridge till	50(26)	97(3.8)		6.37(.43)
	No till	17(21)	77(16)		6.52(.20)

* The number in parenthesis is the standard deviation, N = 16.

There was no difference in final stand to tillage at either site. There was a dramatic difference in rate of emergence due to tillage at both sites. The differecne in cover in the row between sites with ridge tillage is reflected in the emergence rates. The rate of emergence with ridge till at the Becker site was similar to the no till treatment. At the Goodhue County site corn emerged much sooner with ridge till and reflects the cleaner row area at this site. Emergence at the Goodhue site was similar with the ridge till and chisel treatments even though there was half the cover with ridge till.

Crain yields and N utilization - Leaf samples from opposite and below the ear at mid-silking were collected on July 27th and August 2nd (no till) at the Becker location. Similar samples were obtained at the Goodhue location on July 28th and August 1st (no till). All leaf samples were dried, ground, and analyzed for Kjeldahl nitrogen. Total dry matter production was determined on September 22 and 23 at the Becker location and September 27-29 at the Goodhue location. At each location ears were separated from 12.2 m of row. Field weights of both ears and stalks from the above area were measured and subsamples of each collected for moisture and nitrogen determination. Grain yields were adjusted to 15.5% moisture.

RESULTS AND DISCUSSION - BECKER LOCATION (EC)

The results from the corn production components (grain, stover, and total) are presented in Table 2. Parameters used to evaluate the nitrogen status (concentration) of the crop and nitrogen uptake of the measured yield components are presented in Table 3. Treatment variables were evaluated utilizing analysis of variance. Since the experimental treatment combination was an incomplete factorial, two separate analysis of variance tables were conducted. The first procedure compared four tillage systems (no till, ridge till, and chisel, and moldboard plow) with three methods of 28% N solution application (broadcast, injected and dribble) at the low rate of N application (84 kgN/ha - 75 #N/A). The second method of analysis compared two tillage systems (no till and chisel) with all methods of 28% N application at three nitrogen rates. The analysis was conducted using models for a split plot and split-split plot experimental designs.

This location has a coarse textured soil with a low water holding capacity. With irrigation and proper N management these soils can be highly productive. In addition to the cool spring and hot summer the growing season at this location was also characterized by a large precipitation event (17 cm) on June 20th. Nitrogen applications were made approximately seven weeks prior to this large precipitation event. During that time substantial quantities of applied ammonium nitrogen (approximately 75% of 28% N solution) were converted to nitrate nitrogen. Since nitrate - N is susceptible to leaching, relatively large yield reductions were encountered at this location due to N leaching losses. This tended to lower yields across the entire experimental area, but may have had more of an influence on some treatment combinations than others. Although yields were significantly reduced due to leaching, relative comparisons can still be made concerning the effectiveness of treatment application.

With the first method of treatment comparisons experimental parameters are evaluated across four tillage systems and three methods of 28% N solution at the low rate of nitrogen. With grain yields the trends in the main effect would suggest that injection of 28% N solution was superior to either broadcast or dribble applications. A significant interaction suggests that the injection technique was only advantageous on the no till and till plant tillage treatments. Total dry matter production along with stover production also indicated a tillage X method of application interaction. The main effects would suggest that the till plant technique was inferior to the other methods and that injection of 28% was superior to the other application methods. The significant interaction with stover and total dry matter production would suggest that injection was the best technique for no till and chisel and with till plant all methods of application were inferior.

The nitrogen utilization characteristics are presented in Table 2. At the low N rate averaged over tillage and method of application there was no significant interactions with N concentrations in plant tissue. Leaf N concentrations were significantly influenced by both tillage and method of application. Moldboard plow treatments had a significanlty lower leaf N concentration than the other three tillage systems. Likewise injected treatments of 28% N solution resulted in higher leaf N concentration than either broadcast or dribble application. Concentration of N in the grain were significantly lower in no till than ridge till. Concentrations of N in the stover were highest on no till and ridge till followed by chisel and then moldboard plow with the lowest N concentration. Removal of N with the grain was substantially improved when 28% N was injected with no till but

provided no advantage with the other tillage systems. Removal of N with the stover was highest in the no till plots followed by chisel and then moldboard plow and till plant. Corn stover contained more total N when treatments of 28% N solution were injected. The significant interaction observed with total N removal appears to be associated with the superiority of the injected treatment with no till conditions.

The second method of treatment comparisons evaluated two tillage systems over three methods of application and three N rates. Not only were there sizeable differences in the main effects for the production parameters but a number of highly significant interactions. The trends established with the main effects of the production parameter would suggest that chisel was superior to no till, injected application of 28% solution were the best followed by dribble and then broadcast applications, and positive N responses up through the highest rate of N application. The significant interaction terms would suggest that regardless of tillage or N rate yields obtained with broadcast applications of 28% N solution were all extremely poor. Within no till treatments yields increased if N was injected or dribbled, but only when the highest rate of N had been applied. Injected and dribbled applications at the high N rate resulted in similar yields. Within the chisel treatments all broadcast treatments were poor, and injected treatments appeared superior to dribble applications. This was apparent with the sizeable yield increase that was obtained at the moderate N rate when it was injected but was not present with the dribble application.

Nitrogen concentration and N uptake in the different plant parts also exhibited a number of significant interactions. General trends appeared to follow similar relationships that were experienced with the production parameters.

GENERAL CONCLUSIONS

The results from this experiment support the fact that the management of 28% N solution is very important especially as we change tillage systems. In general, injected applications were better than dribble which were better than broadcast. The degree of improvement, however, varied with tillage and nitrogen rate.

Care should be exercised in the evaluation of this data. Original ideas were to characterize losses which may occur due to different methods of application when tillage systems change. The major N concerns with the original format are volitalization losses of ammonia and immobiliation of N due to surface residues. The significant rainfall in mid-June provided an additional major loss of N through leaching. Although differences between treatments were obtained, at least a portion of these differences may be due to differential leaching of N created from differential nitrification. For example, conservation tillage systems are designed to to leave plant residue on the soil surface. This residue tends to delay soil warming in the spring, thus slowing nitrification of ammonium N. Placement of N may also be important in this nitrification process. Those treatments which reflect reduced nitrification (more residue, deeper placement) would probably have more available N for crop use following the major leaching event.

RESULTS AND DISCUSSION - GOODHUE LOCATION (SE)

The results from the corn production components (grain, stover, and total) are presented in Table 4. Parameters used to evaluate the nitrogen status (concentration) of the crop and nitrogen uptake of the measured yield components are presented in Table 5. Treatment variables were evaluated utilizing analysis of variance. Interpretation and statistical procedures were conducted in a similar manner to the Becker location.

The growing season experienced in SE Minnesota during 1983 was characterized by being relatively cool and wet early and warm and dry the latter portion. The stress conditions experienced during the entire growing season were probably responsible for grain yields lower than what would be normally expected. In addition to this a rainfall (2 cm) occurred approximately 48 hours after treatment application. It is anticipated that this rainfall could have adversely influenced treatment difference obtained between methods of N application.

If comparisons of yield are made across tillage system and method of N application at the lower N rate a significant tillage X method interaction is observed. The trends established within the main effects would suggest that dribble applications were inferior to broadcast or injected applications across all tillage systems. The significant interaction however suggest that at low N rate injected

28% was the best method for till plant and the broadcast applications were better on the no till and chisel treatments. Stover yields were not significantly influenced by treatments, but total dry matter production was influenced in much the same manner as grain yields.

At the low rate of N across tillage and method of N application the concentration of N in the leaf opposite and below the ear at silking and stover samples at physiological maturity were not significantly (.05) influenced by treatment. The N concentration in the grain as well as grain N removal and total N removal were significantly influenced by treatment. The N concentration of the grain was significantly higher with the injected treatment than with either broadcast or dribble applications. This trend was also observed with the grain N removal and Total N removal, but a significant tillage X method interaction would suggest that injection was superior with ridge till and dribble application was inferior on the chisel treatment.

With the second method of analysis of variance two tillage systems (no till and chisel) are evaluated across the same three methods of application utilizing three N rates rather than one. The tillage system did not influence yield and the significant main effects of methods of application and N rate were confounded with a three way interaction. The main effects would suggest that broadcast applications of 28% were better than either injected or dribble and that maximum yield was obtained at the moderate N rate. The three way interaction would indicate that with no till at the moderate rate of N application the best method of application was injection followed by broadcast and dribble. With the chisel treatment at moderate N rate the best method was a dribble followed by injected and broadcast. Stover yields were significantly increased when the N rate was increased with increasing N rate up to the moderate rate and the broadcast applications were superior to dribble applications.

When the N concentrations and N uptake parameters are evaluated for the two tillage systems and three application methods across N rate, N rate appears to have the only significant effect. Concentrations in the leaf opposite and below the ear at silking were significantly increased up to the moderate N rate. Concentration of N in the grain and stover were significantly increased up through the highest rate of N application. Total N removal both in the grain, stover and total tended to follow similar pattern as was observed with the dry matter production.

GENERAL CONCLUSIONS

It becomes very obvious when interpreting the data that the method of 28% N application is very important as we evaluate different tillage systems. The large number of two-way and three-way interactions attest to this fact. These interactions although interesting, also prove to be difficult to interpret and explain. The crop stress induced by the type of growing season experienced in 1983 along with the interaction that the rainfall shortly after treatment application should be considered seriously before broad spectrum conclusion and/or recommendations should be made for the producer.

Table 2: Influence of nitrogen rates, tillage systems, and methods of 28% N application on grain yields and dry matter production on irrigated corn. Becker, MN - 1983

Treatments			Grain			Dry Matter Production			
N-Rate	Tillage System	Method Applied	Yields		DM	Grain	Cob	Stover	Total
Kg/ha			Bu/A	Mg/ha	%	----------Mg/ha----------			
Control	No Till	------	37.4	2.3	54.0	1.83	0.35	1.61	3.83
Control	Ridge Till	------	43.6	2.7	62.0	2.31	0.44	1.32	4.10
Control	Chisel	------	46.7	2.9	66.8	2.46	0.49	2.03	5.08
Control	Moldboard	------	46.7	2.9	68.2	2.46	0.42	1.79	4.70
84	No Till	Broadcast	38.1	2.4	54.5	2.01	0.42	1.88	4.34
84	No Till	Injected	65.6	4.1	57.2	3.47	0.60	3.11	7.21
84	No Till	Dribble	41.8	2.6	52.2	2.19	0.38	2.24	4.86
84	Ridge Till	Broadcast	42.7	2.7	62.8	2.26	0.47	1.79	4.54
84	Ridge Till	Injected	48.3	3.0	61.8	2.55	0.49	1.90	4.99
84	Ridge Till	Dribble	42.5	2.7	64.5	2.24	0.38	1.61	4.27
84	Chisel	Broadcast	54.3	3.4	72.8	2.86	0.49	2.26	5.64
84	Chisel	Injected	53.6	3.4	71.0	2.82	0.51	2.93	6.65
84	Chisel	Dribble	57.1	3.6	71.8	3.02	0.53	2.13	5.71
84	Moldboard	Broadcast	49.6	3.1	70.2	2.62	0.49	2.68	5.80
84	Moldboard	Injected	49.7	3.1	70.5	2.62	0.49	2.41	5.57
84	Moldboard	Dribble	47.3	3.0	70.8	2.50	0.47	2.17	5.17
168	No Till	Broadcast	42.6	2.7	54.2	2.24	0.53	2.21	5.04
168	No Till	Injected	57.7	3.6	53.5	3.04	0.56	3.36	6.85
168	No Till	Dribble	46.9	2.9	58.2	2.48	0.53	2.77	6.05
168	Chisel	Broadcast	65.0	4.1	65.5	3.42	0.47	2.77	6.72
168	Chisel	Injected	122.0	7.7	66.8	6.45	0.78	3.98	11.62
168	Chisel	Dribble	73.2	4.6	66.2	3.87	0.53	3.60	8.04
336	No Till	Broadcast	53.3	3.3	53.8	2.82	0.51	2.82	6.18
336	No Till	Injected	114.3	7.2	57.2	6.04	0.85	3.74	10.93
336	No Till	Dribble	114.7	7.2	57.8	6.07	0.91	4.05	11.06
336	Chisel	Broadcast	78.4	4.9	69.8	4.14	0.64	3.42	8.22
336	Chisel	Injected	147.1	9.2	67.8	7.79	1.03	4.59	13.44
336	Chisel	Dribble	139.7	8.8	69.2	7.39	0.91	4.61	12.94

Factorial Arrangement (Excludes Control, 168 and 336 Kg/ha N-Rate treatments)

Tillage							
No Till	48.5	3.1	54.7	2.55	0.47	2.42	5.46
Ridge Till	44.5	2.9	63.0	2.35	0.44	1.79	4.61
Chisel	55.0	3.5	71.8	2.91	0.51	2.44	6.00
Moldboard	48.9	3.1	70.5	2.57	0.47	2.42	5.51
P-Value (%)	89	89	99	89	86	99	99
BLSD (.05)							
Method Applied							
Broadcast	46.2	3.0	65.0	2.44	0.47	2.15	5.08
Injected	54.3	3.5	65.1	2.86	0.51	2.59	6.11
Dribble	47.2	3.0	64.8	2.48	0.44	2.03	4.99
P-Value (%)	98	98	6	98	94	99	99
BLSD (.05)							
Tillage X Method Applied							
P-Value (%)	98	98	87	98	75	98	99
BLSD (.05)							

Table 2: Continued

Treatments			Grain			Dry Matter Production			
N-Rate	Tillage System	Method Applied	Yields		DM	Grain	Cob	Stover	Total
Kg/ha			Bu/A	Mg/ha	%	----------Mg/ha----------			
Factorial Arrangement (Excludes Control, till plant and moldboard treatments)									
Tillage									
No Till			63.9	4.1	55.4	3.36	0.60	2.91	6.94
Chisel			87.8	5.6	69.0	4.63	0.67	3.36	8.74
P-Value (%)			97	97	99	97	91	99	99
BLSD (.05)									
Method Applied									
Broadcast			55.3	3.5	61.8	2.91	0.51	2.55	6.02
Injected			93.4	6.0	62.2	4.93	0.71	3.62	9.45
Dribble			78.9	5.1	62.6	4.17	0.63	3.22	8.11
P-Value (%)			99	99	39	99	99	99	99
BLSD (.05)									
N-Rate									
84			51.7	3.3	63.2	2.73	0.49	2.41	5.73
168			67.9	4.4	60.8	3.58	0.58	3.11	7.39
336			107.9	7.0	62.6	5.71	0.80	3.87	10.46
P-Value (%)			99	99	95	99	99	99	99
BLSD (.05)									
Tillage X Method Applied			46	46	75	46	36	7	56
Tillage X N-Rate			99	99	98	99	19	78	97
Method Applied X N-Rate			99	99	78	99	99	99	99
Tillage X Method X N-Rate			99	99	91	99	98	50	98

Table 3: Influence of nitrogen rates, tillage systems and methods of 28% N application, on leaf N, grain N and nitrogen removal by irrigated corn. Becker, MN - 1983

Treatments			N-Concentration			N-Removal		
N-Rate	Tillage System	Method Applied	Leaf	Grain	Stover	Grain	Stover[1]	Total
Kg/ha			----------%----------			----------Kg/ha----------		
Control	No Till	------	1.45	1.19	0.57	22.2	11.7	33.9
Control	Ridge Till	------	1.46	1.28	0.55	29.8	9.8	39.6
Control	Chisel	------	1.33	1.26	0.50	31.2	12.5	43.7
Control	Moldboard	------	1.16	1.18	0.46	29.2	10.4	39.6
84	No Till	Broadcast	1.41	1.11	0.57	22.7	13.2	36.0
84	No Till	Injected	1.85	1.16	0.50	40.6	18.7	59.3
84	No Till	Dribble	1.56	1.15	0.60	25.9	16.2	42.1
84	Ridge Till	Broadcast	1.29	1.33	0.54	30.0	12.5	42.5
84	Ridge Till	Injected	1.53	1.24	0.55	31.9	13.1	45.0
84	Ridge Till	Dribble	1.41	1.22	0.50	27.7	10.2	37.9
84	Chisel	Broadcast	1.30	1.26	0.46	36.3	12.8	49.1
84	Chisel	Injected	1.72	1.19	0.47	34.4	16.0	50.4
84	Chisel	Dribble	1.40	1.27	0.51	38.4	13.7	52.1
84	Moldboard	Broadcast	1.17	1.18	0.42	30.9	13.4	44.3
84	Moldboard	Injected	1.28	1.15	0.42	30.4	12.3	42.7
84	Moldboard	Dribble	1.13	1.20	0.44	30.3	11.8	42.1
168	No Till	Broadcast	1.50	1.34	0.55	29.9	15.3	45.2
168	No Till	Injected	2.55	1.20	0.59	36.7	23.3	60.0
168	No Till	Dribble	1.70	1.21	0.45	30.4	14.8	45.2
168	Chisel	Broadcast	1.67	1.26	0.49	43.8	16.1	59.9
168	Chisel	Injected	2.63	1.34	0.53	88.2	25.6	113.8
168	Chisel	Dribble	2.22	1.30	0.43	51.1	17.8	68.9
336	No Till	Broadcast	1.88	1.18	0.52	33.6	17.2	50.8
336	No Till	Injected	3.14	1.42	0.78	86.0	36.7	122.7
336	No Till	Dribble	3.02	1.47	0.72	90.3	35.8	126.1
336	Chisel	Broadcast	1.99	1.28	0.50	53.8	20.4	74.2
336	Chisel	Injected	3.14	1.59	0.66	124.6	37.6	162.2
336	Chisel	Broadcast	2.86	1.42	0.59	105.6	32.7	138.3
Factorial Arrangement (Excludes control, 168 and 336 Kg/ha N-rate treatments)								
Tillage								
No Till			1.61	1.14	0.56	29.8	16.0	45.8
Ridge Till			1.41	1.26	0.53	29.8	11.8	41.6
Chisel			1.47	1.24	0.48	36.3	14.1	50.5
Moldboard			1.19	1.18	0.43	30.5	12.4	43.1
P-Value (%)			99	97	99	89	99	92
BLSD (.05)			0.12	0.12	0.05		1.7	
Method Applied								
Broadcast			1.29	1.22	0.50	30.0	13.0	43.0
Injected			1.59	1.19	0.48	34.4	15.8	49.4
Dribble			1.37	1.21	0.51	30.5	13.6	43.5
P-Value (%)			99	76	51	93	97	98
BLSD (.05)			0.10				1.8	
Tillage X Method Applied								
P-Value (%)			67	92	50	98	86	98

Table 3: continued on next page.

Table 3: Continued

Treatments			N-Concentration			N-Removal		
N-Rate	Tillage System	Method Applied	Leaf	Grain	Stover	Grain	Stover[1]	Total
Kg/ha			----------%----------			----------Kg/ha----------		
Factorial Arrangement (Excludes control, till plant and moldboard treatments)								
Tillage								
No Till			2.07	1.25	0.58	44.0	21.2	65.2
Chisel			2.10	1.32	0.51	64.0	21.4	85.4
P-Value (%)			33	88	99	98	10	99
Method Applied								
Broadcast			1.62	1.24	0.51	36.7	15.8	52.7
Injected			2.50	1.32	0.59	68.4	26.3	94.7
Dribble			2.12	1.30	0.55	57.0	21.8	78.8
P-Value (%)			99	90	98	99	99	99
BLSD (.05)								
N-Rate								
84			1.54	1.19	0.52	33.4	15.1	48.5
168			2.04	1.27	0.50	46.7	18.8	65.7
336			2.67	1.39	0.63	82.3	30.1	112.4
P-Value (%)			99	99	99	99	99	99
BLSD (.05)								
Tillage X Method Applied			19	99	99	88	22	78
Tillage X N-Rate			95	31	49	95	60	96
Method Applied X N-Rate			99	98	99	99	99	99
Tillage X Method X N-Rate			63	77	45	99	17	97

1 = Stover includes cob + Stover N-Removal

Table 4: Influence of nitrogen rates, tillage systems and methods of 28% N application on grain yield and dry matter production on corn. Goodhue Co. MN - 1983

Treatments			Grain			Dry Matter Production			
N-Rate	Tillage System	Method Applied	Yields		DM	Grain	Cob	Stover	Total
Kg/ha			Bu/A	Mg/ha	%	----------Mg/ha----------			
Control	No Till	-	77.5	4.87	64.8	4.09	0.67	4.43	9.23
Control	Ridge Till	-	69.8	4.38	67.0	3.69	0.60	3.69	7.99
Control	Chisel	-	77.2	4.85	65.2	4.07	0.58	3.47	8.18
84	No Till	Broadcast	121.4	7.63	67.1	6.42	0.94	4.70	12.10
84	No Till	Injected	112.2	7.05	65.8	5.94	0.92	4.77	11.64
84	No Till	Dribble	116.7	7.34	65.6	6.18	0.94	4.52	11.64
84	Ridge Till	Broadcast	123.2	7.75	69.5	6.54	0.92	4.64	12.10
84	Ridge Till	Injected	138.6	8.71	68.6	7.35	0.98	5.24	13.57
84	Ridge Till	Dribble	108.2	6.80	68.0	5.73	0.85	4.55	11.15
84	Chisel	Broadcast	124.2	7.81	69.9	6.58	0.94	4.99	12.54
84	Chisel	Injected	114.2	7.18	70.0	6.05	0.92	4.95	11.94
84	Chisel	Dribble	109.6	6.89	66.2	5.80	0.89	5.13	11.82
168	No Till	Broadcast	136.2	8.56	66.2	7.21	1.12	5.73	14.09
168	No Till	Injected	145.7	9.16	66.8	7.73	1.20	5.31	14.38
168	No Till	Dribble	125.6	7.90	64.8	6.65	1.09	5.33	13.10
168	Chisel	Broadcast	139.0	8.74	67.6	7.35	1.12	6.11	14.63
168	Chisel	Injected	139.7	8.78	66.9	7.39	1.12	5.46	14.02
168	Chisel	Dribble	145.5	9.15	67.0	7.71	1.21	5.67	14.78
336	No Till	Broadcast	138.0	8.68	65.8	7.32	1.14	5.82	14.27
336	No Till	Injected	125.9	7.92	65.7	6.67	1.12	5.58	13.78
336	No Till	Dribble	133.2	8.37	65.5	7.06	1.14	5.31	13.53
336	Chisel	Broadcast	138.2	8.69	68.0	7.32	1.16	5.60	14.09
336	Chisel	Injected	131.7	8.28	68.1	6.97	1.09	5.24	13.30
336	Chisel	Dribble	127.9	8.04	67.8	6.76	1.07	5.23	13.08

Factorial Arrangement (Excludes control, 168 and 336 Kg/ha N-rate treatments)

Tillage							
No Till	116.8	7.34	66.1	6.18	0.94	4.66	11.80
Ridge Till	123.3	7.75	68.7	6.54	0.92	4.82	12.27
Chisel	116.0	7.29	67.7	6.14	0.92	5.02	12.09
P-Values (%)	61	61	46	61	4	71	39
BLSD (.05)							
Method Applied							
Broadcast	122.9	7.72	68.8	6.52	0.94	4.77	12.23
Injected	121.7	7.65	67.1	6.45	0.94	4.97	12.38
Dribble	111.5	7.23	66.6	5.89	0.89	4.72	11.53
P-Values (%)	98	98	94	98	64	61	97
BLSD (.05)							
Tillage X Method Applied							
P-Values (%)	98	98	17	98	34	57	97

Table 4 continued on next page.

Table 4: Continued

Treatments			Grain			Dry Matter Production			
N-Rate	Tillage System	Method Applied	Yields		DM	Grain	Cob	Stover	Total
Kg/ha			Bu/A	Mg/ha	%	----------Mg/ha----------			
Factorial Arrangement (Excludes control and till plant treatments)									
Tillage									
No Till			128.3	8.07	65.9	6.78	1.05	5.22	13.00
Chisel			130.0	8.17	67.6	6.87	1.05	5.34	13.26
P-Values (%)			45	45	67	45	7	38	32
BLSD (.05)									
Method Applied									
Broadcast			132.8	8.35	67.4	7.03	1.07	5.48	13.62
Injected			128.2	8.06	66.7	6.78	1.05	5.22	13.19
Dribble			126.4	7.95	66.1	6.69	1.05	5.19	13.00
P-Values (%)			96	96	93	96	14	93	97
BLSD (.05)									0.47
N-Rate									
84			116.4	7.32	66.9	6.16	0.94	4.84	11.94
168			138.6	8.72	66.6	7.34	1.14	5.60	14.15
336			132.5	8.33	66.8	7.01	1.12	5.44	13.66
P-Values (%)			99	99	10	99	99	99	99
BLSD (.05)							0.08	0.40	0.74
Tillage X Method Applied			7	7	25	7	34	38	64
Tillage X N-Rate			29	29	19	29	9	70	59
Method Applied X N-Rate			88	88	65	88	46	49	11
Tillage X Method X N-Rate			97	97	27	97	43	1	67

Table 5: Influence of nitrogen rates, tillage systems and methods of 28% N application, on leaf N content, grain N content and nitrogen removal by corn. Goodhue Co., MN - 1983

Treatments			N-Concentration			N-Removal		
N-Rate	Tillage System	Method Applied	Leaf	Grain	Stover	Grain	Stover[1]	Total
Kg/ha			----------%----------			----------Kg/ha----------		
Control	No Till	------	1.95	1.48	0.59	61.1	30.7	91.8
Control	Ridge Till	------	1.87	1.40	0.55	52.0	23.7	75.7
Control	Chisel	------	1.77	1.33	0.57	54.8	23.5	78.3
84	No Till	Broadcast	2.62	1.39	0.67	89.8	37.7	127.6
84	No Till	Injected	2.70	1.47	0.65	87.4	37.4	124.8
84	No Till	Dribble	2.67	1.46	0.69	90.6	38.0	128.6
84	Ridge Till	Broadcast	2.74	1.29	0.57	84.3	31.9	116.2
84	Ridge Till	Injected	2.73	1.51	0.65	111.3	40.9	152.2
84	Ridge Till	Dribble	2.44	1.37	0.65	78.8	35.0	113.9
84	Chisel	Broadcast	2.55	1.50	0.63	99.4	38.1	137.5
84	Chisel	Injected	2.84	1.58	0.63	96.0	37.2	133.2
84	Chisel	Dribble	2.70	1.40	0.62	81.8	37.4	119.2
168	No Till	Broadcast	2.96	1.57	0.88	113.7	60.9	174.6
168	No Till	Injected	3.02	1.62	0.85	125.7	55.4	181.1
168	No Till	Dribble	2.89	1.59	0.83	106.1	53.6	159.7
168	Chisel	Broadcast	3.06	1.65	0.82	121.7	59.9	181.8
168	Chisel	Injected	3.01	1.60	0.81	118.7	53.6	172.4
168	Chisel	Dribble	3.13	1.72	0.81	132.6	55.5	188.0
336	No Till	Broadcast	3.14	1.64	0.92	120.4	64.7	185.1
336	No Till	Injected	3.09	1.69	0.92	112.6	61.7	174.2
336	No Till	Dribble	2.88	1.67	0.83	117.8	54.1	171.7
336	Chisel	Broadcast	3.19	1.64	0.93	120.7	63.4	184.1
336	Chisel	Injected	2.98	1.64	0.95	114.7	60.1	174.9
336	Chisel	Dribble	2.98	1.69	0.85	115.4	54.1	169.4

Factorial Arrangement (Excludes Control, 168 and 336 Kg/ha N-rate treatments)

Tillage						
No Till	2.66	1.44	0.67	8.92	37.7	127.0
Ridge Till	2.63	1.39	0.62	91.5	35.9	127.4
Chisel	2.69	1.49	0.63	92.4	37.5	129.9
P-Values (%)	36	92	31	16	10	8
BLSD (.05)						
Method Applied						
Broadcast	2.63	1.39	0.62	91.1	35.8	127.1
Injected	2.75	1.52	0.64	98.2	38.5	136.7
Dribble	2.60	1.41	0.65	83.8	36.8	120.6
P-Value (%)	83	98	37	98	50	96
BLSD (.05)		0.08				
Tillage X Method Applied						
P-Values (%)	77	84	49	98	62	98

Table 5 continued on next page.

Table 5: Continued

Treatments			N-Concentration			N-Removal		
N-Rate	Tillage System	Method Applied	Leaf	Grain	Stover	Grain	Stover[1]	Total
Kg/ha			----------%----------			----------Kg/ha----------		
Factorial Arrangement (Excludes control and till plant treatments)								
Tillage								
No Till			2.88	1.56	0.80	107.0	51.5	158.6
Chisel			2.94	1.60	0.78	111.2	51.1	162.3
P-Values (%)			53	84	25	78	5	30
BLSD (.05)								
Method Applied								
Broadcast			2.92	1.56	0.81	110.9	54.1	165.0
Injected			2.94	1.60	0.80	109.0	50.8	160.0
Dribble			2.87	1.58	0.77	107.4	48.6	156.0
P-Values (%)			39	54	67	49	91	84
BLSD (.05)								
N-Rate								
84			2.68	1.46	0.65	90.8	37.6	128.4
168			3.01	1.62	0.83	119.7	56.4	176.2
336			3.04	1.66	0.90	116.9	59.7	176.6
P-Values (%)			99	99	99	99	99	99
BLSD (.05)			0.12	0.03	0.06		4.9	8.5
Tillage X Method Applied			34	44	9	28	6	20
Tillage X N-Rate			30	88	44	51	1	47
Method Applied X N-Rate			76	67	65	46	55	45
Tillage X Method X N-Rate			25	86	1	98	1	8

1 = Stover includes cob + stover N-Removal

CORN TILLAGE RESIDUE MANAGEMENT, LANCASTER, 1983

J. B. Swan, A. E. Peterson, W. H. Paulson, R. Higgs, D. Linden, G. Randall, C. Sheaffer

The driftless soils area has the greatest county average estimated soil losses from cropland in Minnesota, ranging from 4.0 to 6.6 t/ac/yr in the six counties involved. Typical soils of the region such as Fayette-Dubuque, Seaton, and associated soils, are highly erodible, form dense crusts if unprotected from raindrop impact, and consequently, have low final infiltration rates and high runoff from the intense storm events common to the region. New and improved tillage practices are increasingly being relied upon to meet environmental goals under more intense cropping systems. These systems modify the soil and water losses as well as the kind and concentration of materials in the runoff. A more complete understanding of these tillage systems will allow a more accurate prediction of their effect on the environment; will permit the maximization of the crop production benefits of the tillage systems; and will permit them to be more effectively incorporated into the overall farming system of the region.

EXPERIMENTAL PROCEDURES

The experimental site is located on the Lancaster Experimental Farm. Five tillage treatments are replicated four times (table 1) the first replication is located on Palsgrove silt loam; the other three replications are located on Rozetta silt loam. Each treatment is split into normal and mulched subtreatments. On the no-till (slot plant) and ridge-plant plots an additional subtreatment (bare) is established by removing all residue prior to planting; the residue is then placed on the adjacent mulched plots of the same tillage treatment. On mulched subtreatments, corn residue additions are made after tillage but before planting to obtain approximately 60 percent surface cover. Plots are approximately 90 to 100 feet in width and 80 feet in length. Row width is 36 inches in 1983. In 1983 corn (Pioneer 3747) was planted (at 29,800 seeds/acre) on May 9. The moldboard treatments (conventional and wheeltrack plant) were plowed May 5 and secondary tillage with a disk was also done on May 5 for the conventional and chisel treatments. The chisel plots were chiseled in the fall of 1982. On the ridge-plant plots a 2-row Buffalo-till cultivator, with lister shovels mounted on the front rank replacing disks, was used to remove the ridge top prior to planting on May 9. All plots were planted with a 4-row John Deere 7000 Max-Emerge planter equipped with fluted coulters. A Ford 6610 tractor was used to make wheel tracks prior to planting on the wheeltrack treatment.

Nitrogen (270 lbs/A as anhydrous ammonia) was injected on April 26, 1983. The starter fertilizer at planting was 200 lbs. of 6-24-24. The insecticide was Counter at 10 lb/A. Chemical weed control used was 1 qt. Dual and 2 lbs/A Atrazine applied preemerge. One pound Atrazine and 1 quart oil were applied post-emergence.

Percent cover was determined from slides made soon after planting. Planting depth, rate of emergence, plant height, silking date, and early growth measurements were made on designated portions of each plot. Random roughness measurements were made on all tillage treatments in Rep. 3 on May 10 and 11 and again on June 9.

Nine plot frames (45-3/4 x 45-3/4 inches) were emplaced on May 9 and covered to protect the surfaces. Infiltration measurements were made on the wheeltrack mulch, wheeltrack bare, no-till mulch, conventional mulch and conventional bare treatments on June 6-9. Random roughness measurements were made before and after each run. Residue amounts were measured for the mulch treatments.

Neutron probe measurements were made weekly on each plot starting June 13 through August 22. Bulk density of the surface layer was measured periodically. Hourly spring soil temperatures were measured on chisel, conventional and no-till treatments in Rep. 3 for both mulch added and bare treatments (chisel normal) at depths of 1, 5, 10, 15, 50, 100 cm. Runoff measurement subplots were installed on June 30 on Rep. 3 on conventional and no-till bare and mulch plots and on the chisel normal plot. Yields were determined by hand harvesting 60 foot samples (two 30-ft. subsamples) from each plot on September 29 and 30, 1983.

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

RESULTS

In 1983, corn yields were reduced on all treatments by water stress due to a severe drought during pollination and grain filling; only 1.13 inches of rain fell between July 3 and August 25; while air temperatures were well above normal (Table 5). Corn yields were not significantly different between treatments; however, the effect of replicates (reps) was highly significant. Average corn yields for each rep were closely related to average depth of rooting (depth to chert (Table 9); rep average corn yields increased nearly 40 bu/a as average depth to chert increased from 24 to 57 inches. In 1981 and 1982 with greater July and August precipitation, average yields in Rep 1 (24 inches to chert) equalled or exceeded yields in Rep. 4 (57 inches to chert); i.e., in years when water was adequate there was no relationship between depth to chert and average yield for a rep. The effect of rooting depth on yield thus depends greatly on the climatic conditions in the individual year as well as on the crop grown. Under water stress conditions such as 1983 at Lancaster, yield decreased consistently as rooting depth decreased.

SEEDBED CONDITIONS

Significant differences in planting depth were measured (Table 2). Even though all treatments were planted with the same planter (with fluted coulter attached) planting depth on the wheeltrack plant treatment was significantly shallower than the chisel normal treatment. No other treatments were significantly different with respect to planting depth. The standard error associated with planting depth was greater in all treatments where mulch was present in the row at planting except for the conventional treatment which had the greatest range in planting depth of any treatment. Following plowing on May 5, the soil dried sufficiently to produce a hard cloddy condition on the bare plot while the mulched plot remained at a higher water content which improved penetration of the planter unit.

Rate of emergence (Table 3) initially showed more rapid emergence on bare plots, however, severe crust formation on bare or low residue plots slowed emergence allowing the emergence rates on mulched plots to generally equal or surpass the bare plots. The crust also appeared to affect early growth and treatments were not significantly different with respect to early growth (Table 1). However, for average plant height and date of silking, significant differences were measured. The no-till mulch treatment had the shortest height and silked latest, while chisel normal was tallest and no-till bare silked first. The no-till bare and mulch treatments were significantly different with respect to date of silking and plant height; however, the individual mulch treatments for ridge plant were not significantly different from each other with respect to plant height or silking date. For the conventional treatment, mulch significantly delayed silking date.

Average population at harvest was significantly higher on the mulch ridge plant and mulch conventional tillage treatments than on the respective bare treatments. Plant population was approximately 21,000 plants/A where 20 percent or more surface residue was present on no-till, conventional and chisel normal treatments. Population was lower on both wheeltrack treatments, bare conventional and bare ridge plant treatments. As discussed earlier, soil movement and crusting appeared to selectively affect treatments without residue cover and may have reduced population. When subplots with population less than 18,000 plants/A in Reps II, III and IV were omitted, average populations ranged from 19,400 to 21,900 plants/A and yields were not significantly different between treatments.

Relative early growth (REG) and relative yield (RY) results are given in Table 4 and are in general agreement with the past two years. The ridge plant treatment differed from the general relationship with virtually no difference in Ry even though REG ranged between 0.76 to 1.06.

Large differences in final (55-minute) infiltration rates were measured between treatments (Tables 6 and 8). On both the wheeltrack and conventional tillage treatments, when mulch was present the final infiltration rates were consistently greater. The final infiltration rate for the no-till mulch treatment in 1983 exceeded all other treatments by at least 1.0 inch/hour. Table 8 contains a 3-year summary of infiltration measurements at Lancaster. The effect of mulch in maintaining a greater infiltration rate can be seen for both plowed treatments (conventional and wheeltrack plant). For the bare plowed treatments, the final infiltration rate on the rougher wheeltrack plant treatment averaged about 1.5 times that for the smooth conventionally tilled treatment. The rough surface provided some temporary benefit, but was much less effective than the mulch in maintaining a

high infiltration rate and preventing surface sealing. In 1983, two passes with the anhydrous injector knives produced 9-10 inch deep slots about 18 inches apart. When protected by mulch these deep injection marks and their fracture planes were highly effective in increasing the infiltration rate. In contrast, in 1981 and '82 the dense no-till surface was broken only in the narrow planter slot and the infiltration rate averaged about the same as the bare conventional treatments's infiltration rate. Thus when the no-till surface is sealed, mulch cover is of little benefit in increasing the infiltration rate compared to conventional tillage, however, when the no-till surface has channels through which water can move readily, the heavy mulch cover is very effective in maintaining a high infiltration rate. These results illustrate the dual requirement of 1) a porous surface with high saturated hydraulic conductivity and, 2) a protective mulch cover which are necessary in order to have rapid sustained infiltration. Residue cover by itself is not sufficient to produce a high infiltration rate.

SUMMARY

Five year results with continuous corn at Lancaster show nearly equal average yields from conventional, chisel, and ridge plant treatments with no-till (slot plant) slightly lower in some years (Table 7).

Thus farmers in the driftless soil area can choose between a variety of tillage options which have yields comparable with conventional tillage, but which are superior in soil and water conservation and also offer savings in time, labor, and fuel compared to conventional moldboard plow tillage methods.

Table 1. Effect of tillage and mulch treatments on percent cover, planting depth, corn early growth, plant height, silking date, population and yield

Treatments		Percent Cover		Avg. Planting Depth Inches	Avg. Early Growth gms DM/ 10 Plants	Avg. Height July 5 Inches	Date 50% Plants Silked July	All Subplots		Selected Subplots *(No.)	
Tillage	Residue	Row	Entire Area					Avg. Population at Harvest	Avg. Yield Bu/A	Avg. Population at Harvest	Avg. Yield Bu/A
Ridge Plant	Bare (0)	2	3	1.6 ab	31.8	33.5 ab	24 ef	18,500 c	91.7	19,500 *	94.6 *(2)
	Normal (1X)	0	10	1.4 ab	24.3	33.8 ab	24.5 cdef	20,100 abc	99.9		99.9
	Mulch (2X)	22	23	1.5 ab	33.8	31.8 abc	24.8 bcdef	21,000 a	93.1		93.1
No Till (slot plant)	Bare (0)	12	15	1.6 ab	45.0	35.8 a	23.8 f	20,700 ab	92.4	21,400 *	94.5 *(1)
	Normal (1X)	34	68	1.5 ab	29.8	34.0 ab	24.5 cdef	21,900 a	85.2		85.2
	Mulch (2X)	95	92	1.4 ab	21.0	28.5 c	26.8 a	20,800 ab	77.1	20,900 *	79.2 *(1)
Conventional	Normal (0)	1	2	1.6 ab	18.3	31.8 abc	24.5 cdef	18,600 c	88.3	19,421 *	88.8 *(1)
	Mulch (1X)	85	92	1.3 ab	23.3	30.25 bc	26 ab	21,100 a	95.9		95.9
Fall Chisel	Normal (N)	18	20	1.8 a	29.5	36.0 a	24.3 def	21,500 a	95.0		95.0
	Mulch (1X+N)	73	86	1.6 ab	21.8	32.8 abc	25.5 abcd	21,200 a	90.7		90.7
Wheeltrack Plant	Normal (N)	0	2	1.3 b	25.0	32.3 abc	25.8 abc	18,900 bc	91.4	19,500 *	92.3 *(1)
	Mulch (1X)	70	76	1.2 b	25.0	30.5 bc	25.3 bcde	18,500 c	86.6	19,500 *	87.8 *(3)
Significance Level				0.01	NS	0.05	0.01	0.01			NS

*(No.) In Reps II, III, IV omit single subplot population less than 18,000 PPA

Table 2. Planting depth measurements, Lancaster 1983.

Treatment		Planting Depth			2/3 of Seeds Between
		----------mm----------			
Tillage	Residue	Avg.	Sx	Range	Depths (mm) of:
Ridge Plant	Bare	40 ab*	8.2	20-60	32-48
	Normal	36 ab	12.4	20-60	24-48
	Mulch	39 ab	8.0	30-60	31-47
No Till (slot plant)	Bare	41 ab	6.2	30-60	35-47
	Normal	38 ab	7.6	30-60	30-46
	Mulch	37 ab	9.4	15-60	28-46
Conventional	Normal	40 ab	11.0	10-60	29-51
	Mulch	34 ab	8.8	15-50	25-43
Fall Chisel	Normal	45 a	5.4	35-50	40-50
	Mulch	40 ab	7.3	30-60	33-47
Wheeltrack Plant	Normal	33 b	9.7	15-50	23-43
	Mulch	30 b	12.9	10-60	17-43

*5 Percent level of significance Duncans new multiple range test.

Table 3. Influence of tillage method and mulch rate on percent emergence.

Treatment		Days After Planting Date of May 9					
		---------- Percent Emerged ----------					
Tillage	Residue	15	17	20	22	26	30
Ridge Plant	Bare	27	47	76	81	95	100
	Normal	21	45	74	78	97	100
	Mulch	16	44	76	91	99	100
No Till	Bare	11	40	79	85	95	100
	Normal	8	39	85	88	100	100
	Mulch	2	24	62	75	100	100
Conventional	Normal	7	31	79	79	99	100
	Mulch	5	26	74	86	99	100
Fall Chisel	Normal	12	33	74	78	98	100
	Mulch	4	35	71	80	92	100
Wheeltrack Plant	Normal	10	49	71	83	97	100
	Mulch	5	28	77	85	97	100

Day 15 = May 25

Table 4. Effect of mulch on relative early growth (Reg.) and relative yield (Ry)[1/].

Tillage	Mulch Level	Percent Cover in Row	Reg[2/]	Ry[3/]
Ridge	1X	10	0.764	1.060
	2X	23	1.063	0.971
No Till (slot plant)	1X	68	0.661	0.897
	2X	92	0.467	0.846
Conventional	1X	92	1.274	1.009
Chisel	1X + N	86	0.737	0.957
Wheeltrack Plant	1X	76	1.00	0.964

[1/] Yield adjusted to equal population for each Ry comparison in Reps II, III, IV.

[2/] $Reg = \frac{\text{Early growth with mulch}}{\text{Early growth without multh}}$

[3/] $Ry = \frac{\text{Yield with mulch}}{\text{Yield without mulch}}$

Table 5. 1983 Weather summary, Lancaster Experiment Station.

Month	Precipitation Inches Total	Precipitation Inches Departure	Growing Degree Days 1983	Growing Degree Days Departure	Temperature Avg. Max.	Temperature Avg. Min.	Temperature Avg.	Temperature Departure
					----------of----------			
April	2.34	-0.83	(59)	--	52.2	33.2	42.7	-3.8
May	5.18	1.73	186	-114	64.8	44.0	54.4	-3.4
June	3.28	-1.27	570	+55	80.6	57.4	69.0	2.0
July	3.34	-0.95	748	+88	86.5	63.8	75.2	3.8
August	3.12	-1.50	751	+156	88.3	63.2	75.7	6.8
September	3.81	0.37	414	+62	74.4	51.0	62.7	1.8

NOTE: 1.13 inches of rain between July 3 and August 25 - a period of 53 days

Table 6. 1983 Lancaster infiltration rate measurements

Tillage	Residue	Application Rate In/Hr.	Water Applied Before Runoff Inches	Infiltration Rate X Minutes After Runoff Commences In/Hr.							
				2.5	7.5	12.5	17.5	25	35	45	55
Wheeltrack	Bare (E)	4.64	1.19	2.24	1.52	1.04	1.16	1.58	0.74	0.86	0.80
	(W)	4.32	1.35	2.88	2.52	1.80	1.68	1.56	1.08	1.08	1.32
	Mulch	5.12	1.58	3.80	3.32	3.20	2.36	2.66	2.72	2.36	2.24
Conventional	Bare (E)	4.32	1.12	2.88	2.52	2.04	1.68	1.62	1.14	0.48	0.36
	(W)	4.56	1.06	2.04	1.56	1.44	0.96	0.78	0.66	0.72	0.72
	Mulch (E)	4.88	1.28	2.96	2.36	1.64	2.24	2.06	2.06	1.64	1.88
	(W)	4.93	1.15	2.05	1.09	1.33	1.21	1.27	0.79	1.39	1.09
No Till (slot plant)	Mulch (E)	4.80	1.24	3.96	3.60	2.88	2.76	3.00	2.88	3.00	3.24
	(W)	4.48	1.81	4.24	4.24	3.92	3.80	3.68	3.34	3.70	3.82

Table 7. Continuous corn tillage yield results at Lancaster, Wisconsin 1979-1983.

Tillage	1979	1980	1981	1982	1983	Average
	Bu/Ac					
Ridge plant*	162	157	157	147	100	145
Slot plant	163	146	151	141	85	137
Chisel	160	150	167	154	95	145
Conventional	169	159	168	151	89	147

*Planted flat in 1979 and 1981 - corn not cultivated to form ridges in 1980 and 1983.

Table 8. Infiltration rate* 55 minutes after runnoff begins.

Treatment		1981	1982	1983	Avg.
Tillage	Residue	Inches/Hour			
No Till	Mulch	1.46	1.10	3.53*	
	(No till mulch) / (Conv. Bare)	(1.51)	(0.72)	(6.53)	
Conventional	Bare	0.97	1.52	0.54	1.01
	Mulch	2.72	2.34	1.49	2.18
	(Bare/mulch)	(0.36)	(0.65)	(0.36)	(0.46)
Wheeltrack Plant	Bare	0.97	2.44	1.06	1.49 (81+83 only 1.02)
	Mulch	1.44		2.24	1.84
	(Bare/mulch)	(0.67)		(0.47)	(0.55)

*Soil disturbed prior to planting by anhydrous ammonia injection.

Table 9. Average yields by replicate and precipitation for 1981, 1982 and 1983 and depth to chert Lancaster, Wisconsin.

Year	Number 1	2	3	4	Monthly Precipitation May	June	July	August
	Bu/Ac				Inches			
1981	146.8	146.7	142.1	147.1	0.85	4.28	2.91	11.35
1982	150.0	143.4	142.8	147.3	5.46	3.45	5.29	4.06
1983	72.8	85.2	96.4	111.2	5.18	3.28	3.34*	3.12*
Avg. depth to chert in inches	24	29	37	57				

* 1983 - 1.13 inches precipitation from July 3 to Aug. 25 (53 days).

1981 - Subplots with population < 17,000 omitted.
1983 - Subplots with population < 18,000 omitted Rep II, III, IV.
1982 - Missing values estimated for 8 plots out of a total of 48 plots.

The Effect of Tillage and Potassium Placement on the Availability of Potassium to Corn

James Swan, John Moncrief, Pat Burford, and Brian Schrieber

With conservation tillage practices now becoming more popular it is important to know if different fertilizer management techniques are necessary. Placement of fertilizers may be more important. Changes in soil physical properties associated with extreme reduction in tillage can effect the spacial distribution of both roots and applied K, as well as root metabolism. These as well as other changes in soil and plant properties can affect the availability of soil K.

The main objectives of this study are:

1. To determine the effects of tillage on K availability to corn.
2. To determine the effect of row applied K and tillage on availability and growth of corn over a range of soil test K levels resulting from broadcast treatments.
3. And to characterize the effect of tillage on the spacial distribution of broadcast K, and determine how this relates to soil test interpretation.

Although,this study was initiated in 1982 only the 1983 results will be discussed.

Methods and Materials:

Cropping History and Residue Management:

The following table shows the cropping history at the experimental site.

Year	Crop Grown
1978	oats
1979	alfalfa
1980	alflafa
1981	corn as silage
1982	corn as grain
1983	corn as grain

Hybrid Corn Used:

1982-105 day single cross hybrid(Pioneer 3732) planted 5/20/82.
1983-95 day single cross hybrid(Pioneer 3906) planted 5/23/83.
Both hybrids were planted at a rate of 7.26 seeds/m^2, at a row spacing of 96 cm.

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

Pesticide Application:

1982:
- -Terbufos(Counter) was used at a rate of 7.8 kg/ha.
- -Fall application of Glyphosate(Roundup) to control quack grass at a rate of 4.6 l/ha.
- -Atrazine/Alachlor(Atrazine/Lasso) mixture applied at 4-5 leaf stage at the rate of 2.2 kg/ha atrazine and 2.2 kg/ha alachlor.

1983:

- -Atrazine/Alachlor(Atrazine/Lasso) mixture applied pre-emergence at a rate of 2.2 kg/ha atrazine and 2.2 kg/ha alachlor.
- -Fonofos(Dyphonate) for root worm control at a rate of 11.2 kg/ha.

Equipment:

- -Chisel plow(Glencoe Soil Saver) chisels 9 cm wide and spaced 33.3 cm apart with twisted shovels
- -Field Cultivator(Bushog)
- -Planters:1982 John Deere maxemerge, 1983 Hinicker, both equipped with 5 cm fluted coulters

Experimental Design:

This study was designed as a randomized complete block with six replications. Tillage treatments used were, spring chisel plowing(20-23 cm deep) followed by a field cultivator (10-13 cm deep)and no-till. Broadcast K applications were made in the spring prior to tillage. Because of preexisting variability in soil K, regression was used to characterize treatment differences.

Row applied potassium was applied as 0-0-7 to every other row and nitrogen-phosphorus starter as 7-21-0 to all the rows.

Statistical Analysis:

The analysis was done using the Statistical Package for the Social Sciences.

Treatment Summary:

Tillage:
- -No Till
- -Spring chisel plowing followed by a field cultivation

Potassium Application:

- -Broadcast application rate of 0, 225, and 450 kg/ha K_2O.
- -Row application rate of 190 l/ha 7-21-0 and 190 l/ha 7-21-0 plus 95 l/ha of 0-0-7.

Fertilizer Application Schedule:

Type	Date Applied	Method	Rate Applied
KCl	4/26/83	Broadcast	0,225 and 450 kg/ha
ammonium polyphosphate+ urea (7-21-0)	5/23/83	Row	190 l/ha
ammonium polyphosphate+ urea (7-21-0)+ KCl (0-0-7)	5/23/83	Row	190 l/ha +95 l/ha
Ammonium Nitrate	5/18/83	Broadcast	335 kg/ha
Calcium sulfate	6/8/83	Braodcast	225 kg/h
Zinc Chelate (Na_2 Zn EDTA)	7/12/83	Broadcast	1.0 kg/ha (actual Zn)

Because of borderline soil test levels, sulfur as calcium sulfate and zinc as zinc chelate were applied to eliminate the effect of these nutrients.

Soil Sampling Techniques:

Ten samples per plot were composited for 0-5, 5-10, 10-15, and 15-30 cm depths. A seperate 0-15 cm sample was taken at each of the ten sampling spots to compare with the incremented 0-15 cm sample average. Soil samples were taken on two dates: before fertilizer application(4/26/83), and after fertilizer application(6/16/83).

The samples were dried at 50 degrees centigrade, and ground to pass a 2 mm sieve.

Deep samples were taken (6/12/83) to a depth of 2 meters. The first 15 cm were discarded and the 15 to 30 cm depth retained. Then samples were incremented every 30 cm to the 2 m depth. The samples were placed in plastic bags to retain moisture, for moist soil K analysis, and bulk density determinations. After these moist samples were taken the remaining sample was dried at 50 degrees centigrade, and ground to pass a 2 mm sieve.

Plant Samples:

Whole plant samples were taken at approximately the 6 leaf stage of development(7/5/83). Plants were cut at ground level(10 plants/plot). These samples were dried at 60 degrees centigrade and ground to pass a 1 mm sieve.

At harvest grain and stover samples were taken. Grain was dried at 60 degrees centigrade, and stover at 60 degrees centigrade, both to constant weight. Both samples were ground for tissue analysis.

Soil Analysis:

The K levels in the soil tested were determined using ammonium acetate extraction. Phosphorus levels were determined by the Bray-1 method.

Residue Measurements:

Residue was measured by the line intersect method.

Results and Discussion

Site Characterization:

The effect of tillage, and distribution of residue on rate of emergence of corn and final stand count.*

Tillage	1983 Soil Cover In Row	between Row	Emergence 6/8/83	Final Stand 6/24/83
	----------percent----------			plants/m^2
No-till	50.8 (15.2)	72.3 (11.1)	66(22)	6.68(.73)
Chisel	16.7 (5.5)	21.0 (5.5)	82(11)	6.40(.40)

*Numbers in parenthesis are the standard deviations, n=12 and 6 for cover and emergence respectively. In and between the row are defined as the 20 cm area centered over the row, and the remainder respectively.

There was approximately three times the level of cover without tillage than with chisel plowing reguardless of position relative to the row. The cover without tillage was more variable due to poor distribution by the combine. Although there is a considerable difference in residue distribution and emergence due to tillage, there was no effect on final stand.

Characterization of pH, Potassium and Phosphorus

The effect of tillage and nitrogen application(ammonium nitrate applied 5/18) on soil pH, N=18, value in parenthesis is standard deviation.

depth (cm)	No-till 4/26	6/16	Chisel 4/26	6/16
	----------pH----------			
0-5	6.6 (0.3)	5.4 (0.3)	6.7 (0.2)	5.9 (0.2)
5-10	6.8 (0.2)	6.3 (0.2)	6.8 (0.2)	6.4 (0.2)
10-15	6.9 (0.2)	6.6 (0.2)	6.8 (0.1)	6.6 (0.2)
0-15	6.7 (0.2)	6.0 (0.3)	6.8 (0.1)	6.3 (0.2)
15-30	6.7 (0.2)	6.5 (0.2)	6.8 (0.1)	6.6 (0.2)

The effects of tillage on the spatial distribution and soil buffering of broadcast K(applied 6/16), N=6, standard deviation is the value in parenthesis.

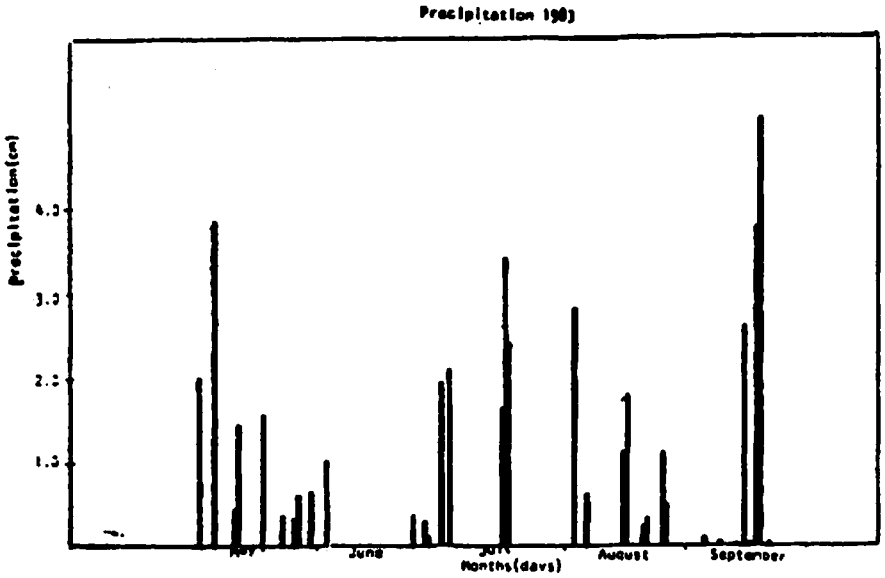
Rate of K kg K_2O/ha	Depth (cm)	No-till 4/26	No-till 6/16	Chisel 4/26	Chisel 6/16
		K(ppm)			
0	0-5	87.3 (15.2)	90.2 (21.0) 40	90.8 (15.5)	96.5 (32.6)
	5-10	65.8 (11.0)	69.4 (10.6) 40	70.5 (12.1)	76.8 (20.1)
	10-15	63.5 (14.4)	62.4 (11.6) 42	75.3 (25.0)	69.0 (19.4)
	0-15	70.5 (12.7)	69.8 (8.9)	68.5 (15.3)	72.0 (18.0)
	15-30	54.0 (19.6)	56.8 (24.5)	55.8 (10.0)	54.8 (12.4)
225	0-5	112.2 (34.3)	272.8 (55.4)	108.4 (21.9)	167.2 (39.8)
	5-10	71.0 (23.2)	91.5 (31.5)	77.5 (21.0)	123.2 (35.9)
	10-15	59.5 (13.5)	63.0 (16.0)	62.8 (18.3)	70.2 (16.8)
	0-15	79.8 (20.4)	128.8 (33.6)	75.8 (18.8)	111.5 (30.9)
	15-30	57.2 (27.1)	54.3 (17.2)	47.6 (6.9)	55.3 (15.3)
450	0-5	164.5 (17.8)	424.6 (60.0)	160.2 (71.1)	249.0 (51.5)
	5-10	70.8 (25.1)	126.6 (21.6)	112.2 (41.5)	179.2 (30.0)
	10-15	61.2 (7.1)	79.8 (10.4)	74.0 (19.9)	102.3 (32.1)
	0-15	101.7 (11.0)	172.4 (32.4)	108.3 (34.7)	152.7 (36.3)
	15-30	55.8 (17.6)	57.2 (6.5)	56.7 (24.9)	59.5 (24.8)

It is interesting to note the interaction of tillage with change in soil test. The change is 30-60 percent higher with the no-till treatment in the 0-15 cm depth. This may partially account for the higher soil K levels necessary with this system.

The spacial distribution of phosphorus. The values in parenthesis are the standard deviations, N=18.

Depth (cm)	No-till	Chisel
	P (ppm)	
0-5	25.9 (8.1)	28.2 (7.8)
5-10	23.1 (9.1)	25.9 (8.6)
10-15	21.4 (7.8)	21.5 (4.4)
0-15	25.9 (8.1)	24.6 (7.1)
15-30	13.7 (2.3)	12.7 (2.6)

Phosphorus distribution is a result of the previous tillage history at this site. The cooperator had been using chisel plow tillage prior to the establishment of the tillage treatments of this study. This is reflected in the preexisting vertical gradient in P.



Subsoil potassium, pH, bulk density, and volumetric moisture percentage, as effected by tillage(6/2/83). The value in parenthesis is the standard deviation, N=9.

Variable Type	Depth (cm)	No-till	Chisel
Moist soil K (ppm)	15-30	31.6(8.3)	42.4(14.5)
	30-60	23.0(4.4)	25.6(7.7)
	60-90	22.5(6.9)	20.5(5.0)
	90-120	28.8(7.5)	23.9(4.4)
	120-150	30.0(6.5)	26.4(4.0)
Dry soil K (ppm)	15-30	52.0(20.3)	53.2(10.9)
	30-60	76.1(16.5)	58.6(17.8)
	60-90	69.3(11.9)	59.3(17.5)
	90-120	72.9(13.8)	60.0(24.0)
	120-150	62.8(23.9)	67.8(24.1)
pH	15-30	6.8(.5)	6.9(.3)
	30-60	6.4(.4)	6.5(.4)
	60-90	6.2(.6)	6.4(.7)
	90-120	6.3(.5)	6.1(.8)
	120-150	7.0(.6)	6.6(1.1)
Bulk Density (g/cm^3)	15-30	1.41(.06)	1.46(.09)
	30-60	1.43(.07)	1.41(.05)
	60-90	1.38(.04)	1.38(.09)
	90-120	1.33(.07)	1.36(.13)
	120-150	1.30(.08)	1.27(.11)
Moisture (% by vol.)	15-30	23.7(0.89)	23.3(1.18)
	30-60	25.0(1.12)	23.5(0.92)
	60-90	25.4(0.90)	23.0(1.25)
	90-120	28.1(1.39)	26.9(3.93)
	120-150	26.5(4.48)	25.1(4.37)

There is a low level of subsoil K. Soil samples run moist had about one fourth the soil test as those allowed to dry. Subsoil moisture was higher in the no-till treatment going into the season.

The effect of tillage, broadcast K, and row applied K on early dry matter production(7/5/83). The values in parenthesis are standard deviations, N=6.

K Applied (kg K O/ha)	Row Fertilizer	Tillage No-till	Chisel
0	N-P-K	9.3(1.1)	10.7(1.4)
	N-P	6.4(3.5)	8.3(1.0)
225	N-P-K	8.1(0.9)	10.6(1.9)
	N-P	8.1(0.6)	9.3(0.9)
450	N-P-K	8.5(0.4)	9.7(2.8)
	N-P	7.6(0.9)	9.0(1.6)

Early growth is increased with the use of row applied potassium. This is expected since the plant takes up large quantities of K in its early stages of development. Chisel plow treatments had greater early whole plant growth than no-till treatments. This is most likely the result of more favorable soil temperatures, allowing earlier emergence. The effect of row applied K is greatest at the 0 kg/ha rate of broadcast K, especially in the no-till treatment.