THE EFFECTS OF FERTILIZER RATES ON CUCUMBERS

A.C. Caldwell, F.G. Bergsrud, M.J. Wiens and D.S. Fairchild

A field experiment was established at the Staples Irrigation Farm in June of 1972 and 1973 to study the effects of fertilizer on yield and chemical composition of cucumbers. A randomized complete block design was used with eight treatments replicated five times. The following fertilizer treatments were applied to the same plot site in 1972 and 1973.

Treatment Code	Treatments	$N+P_2O_5+K_2O+S+B$
A	$N_1+P_1+K_1+S_1+B$	100+75+200+20+3
B	$N_2+P_1+K_1+S_1+B$	200+75+200+20+3
C	$N_3+P_1+K_1+S_1+B$	100+75+200+20+3
D	$N_4+P_1+K_1+S_1+B$	150+75+200+20+3
E	$N_1+P_2+K_1+S_1+B$	100+150+200+20+3
F	$N_1+P_1+K_2+S_1+B$	100+75+400+20+3
G	$N_1+P_1+K_1+S_2+B$	100+75+200+40+3
H	Check	0+0+0+0+0

All fertilizer treatments, except the nitrogen rates, were top-dressed and tilled in on June 8, 1973. Nitrogen rates were split into the following amounts and times of application:

1. N_1 - 50 lbs/acre at planting + 50 lbs/acre two weeks after plant appearance,
2. N_2 - 50 lbs/acre at planting + 50 lbs/acre two, four and six weeks after plant appearance,
3. N_3 - 100 lbs/acre at planting, and
4. N_4 - 50 lbs/acre at planting + 50 lbs/acre two and four weeks after plant appearance.

Cucumbers were planted in 11 inch rows in late June, at approximately 200,000 plants/acre.

Cucumbers were harvested once on August 22nd to simulate machine harvesting. Table 1 shows yield increases of up to 11,700 lbs/acre with fertilizer treatments versus unfertilized cucumbers. No significant differences are noted in yields with varying fertilizer treatments. Highest saleable cucumber yields were recorded with 50 lbs N/acre at planting plus 50 lbs N/acre 2 weeks after plant appearance, 75 lbs P_2O_5/acre, 400 lbs K_2O/acre, 20 lbs S/acre and 3 lbs B/acre.

Table 1. 1973 cucumber yields with varying fertilizer rates under irrigation at Staples.

Fertilizer Treatment Code	Yields	
	Total	Saleable
	----------lbs/acre----------	
A	17,077b*	15,077b
B	18,420b	13,871b
C	12,474b	11,099b
D	18,652b	13,765b
E	15,384b	14,389b
F	17,896b	15,648b
G	15,309b	13,839b
H	4,328a	3,904a
Significance	**	**

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

Plant tissue samples were collected from the fully developed upper leaves at the early bloom stage in growth. Significant changes were noted in the concentrations of N, K, Al, and Fe with varying fertilizer treatments (Table 2). Greatest utilization of nitrogen was noted with split applications. One hundred pounds of nitrogen applied entirely at planting resulted in lower concentrations of N in the plant than unfertilized cucumbers. Significant accumulations of Al and Fe were noted in the unfertilized cucumbers.

CONCLUSIONS

1. Nitrogen applied in split applications of 50 lbs/acre at planting plus 50 lbs/acre two weeks after planting appears adequate for normal growth.
2. Cucumber yields with higher fertilizer rates of phosphorus, potassium and sulfur were inconsistent from year to year. Fertilizer rates of 75 lbs P_2O_5/acre, 200 lbs K_2O/acre, 20 lbs S/acre and 3 lbs B/acre appear adequate on this soil type.

3. Yields were doubled from 1972 to 1973 by narrowing the row width and increasing the plant population to 200,000 plants/acre. Narrower rows, higher plant populations and a balanced fertilizer program appear to be the key to excellent cucumber yields.

Table 2. Plant analyses of upper leaves from cucumbers with varying fertilizer rates under irrigation at Staples in 1973.

Fertilizer Treatment Code	%					ppm				
	N	P	K	Ca	Mg	Al	Fe	Zn	Mn	B
A	4.13bc*	0.61	3.49bc	2.55	0.64	257a	358a	58.8	127	61.3
B	4.68c	0.66	3.65bc	2.51	0.58	216a	293a	65.3	127	50.6
C	2.77a	0.77	3.28b	1.75	0.50	249a	326a	55.9	109	45.8
D	4.78c	0.61	3.46bc	2.67	0.62	248a	330a	62.8	145	55.2
E	4.43bc	0.71	3.45bc	2.40	0.61	239a	349a	61.5	123	56.3
F	4.36bc	0.62	3.89c	2.17	0.54	206a	325a	59.2	137	55.8
G	4.15bc	0.66	3.43bc	2.36	0.64	253a	332a	61.5	121	50.6
H	2.84a	0.67	2.58a	2.31	0.70	619b	629b	55.2	82	29.2
Significance	**	N.S.	**	N.S.	N.S.	**	N.S.	N.S.	N.S.	N.S.

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

NITROGEN TRIALS ON CHRIS AND ERA WHEAT UNDER IRRIGATION AT STAPLES IN 1973

A.C. Caldwell, F.G. Bergsrud, M.J. Wiens and D.S. Fairchild

In 1972, a rate of nitrogen fertilizer experiment on wheat varieties (Chris and Era) was initiated at Staples on a Hubbard sandy loam. This same flat area was used again for a similar experiment in 1973. Five rates of N (0, 25, 50, 75, and 100 lbs/A) were broadcast. The entire amounts of 25 and 50 lbs N/A were applied before seeding, while the 75 lbs of N/A was split into 50 lbs/A at seeding and 25 lbs/A at boot stage, and the 100 pound rate into 50 lbs/A at seeding and 50 lbs/A at boot stage. A basic fertilizer of 200 lbs/A of 8-16-32 + 2-1/2 S was broadcast before seeding.

Soil nitrate nitrogen levels in the 0-24 inch zone were low at 12 lbs/A before nitrogen fertilizer was applied in 1972. Soil samples taken in the spring of 1973 from areas receiving 100 lbs N/A in 1972 indicated from 6-7 lbs/A nitrate nitrogen. These nitrate nitrogen concentrations are very low and would indicate there was no nitrogen fertilizer carry-over from the previous year. Soil test levels of P and K were very high and medium, respectively.

With greater emphasis on weed control and irrigation frequency in 1973, wheat yields ranged from 26-59 bushels per acre (table 1). The variety Chris yielded from 26-49 bushels per acre with the highest yield recorded from 100 lbs N/A. Era yields ranged from 35-59 bushels per acre with 75 lbs N/A effecting the highest yield. No lodging was noted in the semi-dwarf Era or the taller Chris with up to 100 lbs N/A.

Table 1. Yields of Era and Chris wheat as affected by nitrogen fertilizer rates under irrigation at Staples in 1973.

Fertilizer treatments	Variety	
	Era	Chris
lbs N/A*	---------Bu/A----------	
0	35a**	26a
25	48b	36ab
50	54bc	43bc
75	59c	44bc
100	56c	49c
Significance	**	**

* N applied as ammonium nitrate.

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

Forage square yard samples were collected at the early dough stage of growth. From these samples total dry matter produced, percent total nitrogen in the forage and pounds of nitrogen in the forage was calculated. These observations are reported in tables 2 and 3.

The present nitrogen in the whole plant tissue from the variety Chris ranged from 1.12-1.40 % N. Generally, wheat receiving higher rates of nitrogen fertilizer had greater concentrations of nitrogen in the plant tissue. Era wheat was generally higher in total nitrogen than the variety Chris with the highest concentration of 1.64% resulting from 100 lbs N/A.

Total dry matter produced ranged from 3.0 to 4.5 tons per acre with varying nitrogen treatments. Higher yields of dry matter were produced with 50, 75 and 100 lbs of N/A. Both varieties of wheat produced similar quantities of dry matter per acre.

Pounds of nitrogen in the forage are high ranging from 68 pounds N/A in Chris forage with 0 N/A to 136 pounds N/A in Era forage treated with 100 lbs N/A. This data would indicate that wheat receiving no nitrogen fertilizer obtained up to 69 pounds per acre of nitrogen from the soil. This observation can be substantiated from other experiments at the Staples farm. Soils testing low in NO_3-N in early April have tested approximately 55 lbs/A NO_3-N in June. This rapid mineralization of organic matter to available forms of nitrogen occurs when the soil temperatures increase.

Table 2. The nitrogen concentration, dry matter production and pounds of nitrogen in Era plant tissue as affected by nitrogen fertilizer rates at Staples in 1973.

Fertilizer treatment	N	Forage Yields	N removed in forage
lbs N/A	%	Tons/A	lbs/A
0	1.07a*	3.2a	69a
25	1.16a	3.1a	73a
50	1.24ab	4.1b	101b
75	1.40b	4.4b	124c
100	1.64c	4.2b	136c
Significance	**	**	**

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

Table 3. The nitrogen concentration, dry matter production and pounds of nitrogen in Chris plant tissue as affected by nitrogen fertilizer rates at Staples in 1973.

Fertilizer treatment	N	Forage yields	N removed in forage
lbs N/A	%	Tons/A	lbs/A
0	1.12a*	3.0a	68a
25	1.06a	3.8ab	81ab
50	1.13a	3.9b	87ab
75	1.38b	3.6ab	99b
100	1.40b	4.5b	124c
Significance	**	*	**

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

CONCLUSIONS

1. Two years of fertilizer research indicated no significant wheat yield increase with more than 50 lbs N/A.

2. In 1973 with high wheat and fertilizer prices, the greatest economic returns were obtained with 75 lbs N/A on Era and 100 lbs N/A on Chris.

3. No nitrogen fertilizer carry-over was noted from 1972 to 1973.

4. The plant disease Take-All was diagnosed in the 1973 wheat crop. To overcome this disease the 1974 wheat will be planted on a new location at Staples that was not in wheat production in 1973.

FERTILIZER TRIALS ON IRRIGATED ALFALFA AND RED CLOVER

Staples, Minnesota - 1973

C. J. Overdahl, Dean Fairchild and Melvin Wiens

PHOSPHATE TRIAL (ALFALFA)

In the phosphorus trial, no response was obtained for the second consecutive year. Treatments of 0, 30, 60, 90 and 120 pounds per acre of P_2O_5 were applied with 4 replications. The plot yield average was 4.35 tons per acre. Soil test phosphorus was 84 pounds per acre (very high) in 1972. In 1973, the phosphorus test average was 72, still very high.

POTASH TRIAL (RED CLOVER AND ALFALFA)

	Annual treatments of K_2O in lbs/A and time of application						
	None	June 240	Oct. 240	June 120	Oct. 120	June 120 Oct. 120	Significance
	Yields Tons/Acre at 15% Moisture						
Alfalfa							
1972	3.4	3.6	3.8	3.5	3.4	3.6	N.S.
1973	4.0a	4.8bc	4.6bc	4.6bc	4.3ab	4.8c	5%
Red Clover							
1972	4.2	5.0	4.5	4.7	4.7	4.7	N.S.
1973	3.3	3.6	3.3	3.4	3.6	3.7	N.S.
	Soil Test K lbs/A						
Alfalfa							
1972	92	258	322	160	165	185	
Red Clover							
1972	107	262	230	182	167	162	
Alfalfa							
1973	85	290	210	150	140	195	
Red Clover							
1973	90	290	240	160	190	310	

	Plant Analysis %K						
	None	June 240	Oct. 240	June 120	Oct. 120	June 120 Oct. 120	Sig.
Alfalfa							
1972							
1st cut	2.05	2.76	2.89	2.20	2.74	2.65	
2nd cut	2.00	2.50	2.46	2.27	1.92	2.34	
3rd cut	2.52	3.44	3.08	2.94	2.85	3.18	
	2.18%	2.90				2.72	
1973							
1st cut	1.74a	2.74b	2.88b	2.40b	2.45b	2.47b	5%
2nd cut	1.58a	2.76b	2.76b	2.48b	2.39b	2.65b	1%
3rd cut	1.64a	2.60b	2.57b	2.45b	2.17b	2.56b	5%
	1.65	2.70				2.56	
Red Clover							
1972							
1st cut	2.14	3.05	2.83	3.02	2.61	3.04	
2nd cut	2.20	2.86	2.60	2.51	2.21	2.44	
3rd cut	2.65	3.54	2.98	3.32	2.87	2.98	
1973							
1st cut	1.76a	2.63b	2.65b	2.56b	2.42b	2.66b	5%
2nd cut	2.03a	2.84c	2.97c	2.65bc	2.48b	2.92c	1%
3rd cut	1.81a	3.00d	2.53c	2.40c	2.10b	2.66c	1%

LIME PLOTS (ALFALFA)

	Rates of lime T/A applied July 1971			
	0	2 1/2	5	Sig.
	Yield T/A, 15% Moisture			
1972	3.8	3.6	3.8	N.S.
1973	4.1	4.3	4.2	N.S.
	Soil pH			
1972				
Depth				
0-6"	6.4			
0-1'	6.2			
1-2'	6.5			
2-3'	6.9			
1973	6.5	6.5	6.6	

The 0-6" sample in July 1971 for plots are averaged 5.6.

SULFUR (ALFALFA)

	Lbs/acre of sulfur applied spring 1972 as gypsum			
	0	50	100	Sig.
	Yield T/A, 15% Moisture			
1972	4.3	4.0	3.7	N.S.
1973	4.2	4.3	4.2	N.S.

Sulfur soil test, 8 ppm 1970.

COPPER (ALFALFA)

	Lbs/acre of copper applied as copper sulfate		
	0	10	
	Tons/Acre		
1972	0.52	0.60	3rd cutting only
1973	5.3	5.4	N.S.

Tissue analysis of alfalfa indicates 7 samples out of 12 too low to be recorded by spectrograph. The other 5 samples averaged 1.3 ppm copper at first cutting, while 17 samples averaged 2.5 ppm in red clover (1973). In 1972 (2nd cut), alfalfa averaged 1.6 ppm, while red clover averaged 3.6 ppm.

PHOSPHATE TRIAL (ALFALFA)

	Lbs/acre of P_2O_5 applied annually					
	0	30	60	90	120	
1972	3.9	4.2	3.9	4.0	4.0	N.S.
1973	4.3	4.4	4.4	4.3	4.3	N.S.

GENERAL SUMMARY

In 1973, there was a significant response to both 120 and 240 pounds per acre K_2O. There was no K response on red clover. In 1972, red clover outyielded alfalfa by about a ton per acre, but in 1973, alfalfa outyielded red clover by more than a ton per acre on the treated plots.

Soil tests for K are in the low or medium-low range on the untreated plots and only medium where 120 pounds was applied. The 240 pound treatment generally brings soil tests to very high.

There was no response to phosphorus, sulfur, lime, or copper.

CORN TILLAGE STUDY

Waseca, 1973

G. W. Randall, W. E. Lueschen and J. B. Swan

A field experiment was initiated in 1969 to evaluate tillage systems for continuous corn production in south-central Minnesota. Eleven tillage treatments were established in a randomized complete-block design with four replications. Each treatment has been super-imposed on the same plot since establishment. The experiment is located on a LeSueur clay loam soil with a 2-5% south-facing slope. Tile lines spaced 75' apart lie perpendicular to the rows within all plots.

A broadcast application of fertilizer (0+50+50 lbs. $N+P_2O_5+K_2O$/A) was applied on October 16 and was followed immediately by the fall primary tillage operations. Nitrogen (175 lbs. N/A as ammonium nitrate) was broadcast on the surface on April 27. The spring primary tillage treatments were performed on May 10 and the secondary treatments on May 14.

Corn (Minhybrid 4201) was planted at a rate of 26,800 ppA on May 15. A John Deere plateless planter modified with Allis Chalmers 2" fluted coulters was used to plant the plots which did not receive primary tillage. For those plots which did receive primary tillage, the fluted coulters were removed. Starter fertilizer (13+35+45 lbs. $N+P_2O_5+K_2O$/A) and an insecticide (1 lb. active Furadan/A) were applied at planting time. Chemical weed control consisted of 2.5 lbs. alachlor/A (A.I.) and 2½ lbs. atrazine/A (A.I.) applied preemergence. With the exception of the fall chisel-none and no-tillage treatments where too much surface residue prevented cultivation, each treatment was cultivated once.

Results

Results from previous years can be found in Soil Series 87, 88, and 89, "A Report on Field Research in Soils".

In 1973, emergence, early plant growth, tassel date, grain moisture at harvest and yield were affected significantly by the tillage treatments (Table 1). Primary tillage in the fall with the moldboard plow resulted in earliest emergence, fastest small plant growth, earliest tasseling and driest corn at harvest. Plant growth and maturity, in general, were delayed by the spring primary and no tillage treatments. Differences were not apparent among the secondary treatments.

Fall chiseling with some form of secondary tillage resulted in highest yields. These were closely followed by the fall moldboard plow treatments. Lowest yields were obtained with spring

Table 1. Influence of tillage treatments on continuous corn prodcution at Waseca in 1973.

Tillage Treatments Primary	Secondary	Emergence date	Small plant weight	Tassel date	Final population	Moisture at harvest	Yield (@15.5%)
		May	g/dry plant	July	x 1000	%	bu/A
Fall Plow	None	26	8.7	23	19.1	27.1	141.2
" "	Conventional[1/]	26	8.6	23	18.8	27.0	144.9
" "	Field Cult.	26	8.5	23	19.0	27.2	144.1
Spring Plow	Conventional	28	6.6	26	18.7	28.2	140.5
Fall Chisel	"	27	7.2	24	19.3	27.3	155.1
" "	Field Cult.	27	6.4	24	18.7	27.5	145.7
" "	None	27	6.1	25	18.7	27.3	134.3
Spring Chisel	Conventional	29	5.9	25	18.4	28.2	138.4
" "	Disk	29	5.6	25	19.5	28.0	131.5
None	None	29	3.3	26	17.2	29.1	133.4
None	Disk	29	6.3	26	18.9	28.5	145.8
	Significance:[2/]	**	**	**	ns	**	**
	CV (%):	4.1	13.0	3.0	4.5	1.4	4.4
	BLSD						
	.05:	.7	1.2	1.0		0.5	9.0
	.01:	.9	1.6	1.3		0.7	12.3

1/ Conventional = Disk and field cultivate
2/ ** = significant at the 99% level; ns = not significant at 95% level.

chiseling and no tillage. The single spring disking appeared to be a good alternative to spring chiseling or no tillage if fall primary tillage was not completed. Yield differences among the secondary treatments were not significant when used with moldboard primary tillage but were when chisel tillage was used. This was the first year that a significant correlation was found between early plant growth and grain yield (.359*).

Due primarily to poor seed germination, the plant population was only 70% of the planted rate; however, tillage had no effect on population. Observations on weed growth at harvest showed excellent control with the exception of the no tillage treatment where very consistent infestations of fall panicum were present. Lodging notes were not taken because of high winds on July 23 which caused lodging and subsequent goosenecking of all plants.

Other physical and chemical measurements as affected by certain primary tillage treatments were obtained during the growing season. Surface residue accumulation (mulch from the preceding corn crops) was shown to increase markedly with the chisel and no tillage treatments (Table 2).

Table 2. Effect of primary tillage treatments on the surface residue accumulation after four years of continuous corn at Waseca.

Tillage treatment		
Primary	Secondary	Surface residue
		T/A (Dry Matter)
Fall Plow	None	Trace
Fall Chisel	None	1.82
None	None	3.83

The effect of this mulch on the soil temperature is shown in Fig. 1. These measurements were obtained by using thermocouples installed at a depth of 4" directly under the corn row. The minimum and maximum daily temperatures were averaged each day for approximately one month. Over this 30-day period the fall plow treatment showed a 1.4 and 2.7°F advantage over the fall chisel and no tillage treatments, respectively. Daily differences between the fall plow and no tillage were as high as 4.8°F.

May was cold with air temperatures averaging 5.3° less than normal. This resulted in soil temperatures never rising above 63° in any treatment. Consequently, emergence, early plant growth and maturity of the corn throughout the season was enhanced by those tillage treatments which incorporated the majority of the corn residue and allowed the dark soil to absorb the sun's energy thereby warming more quickly.

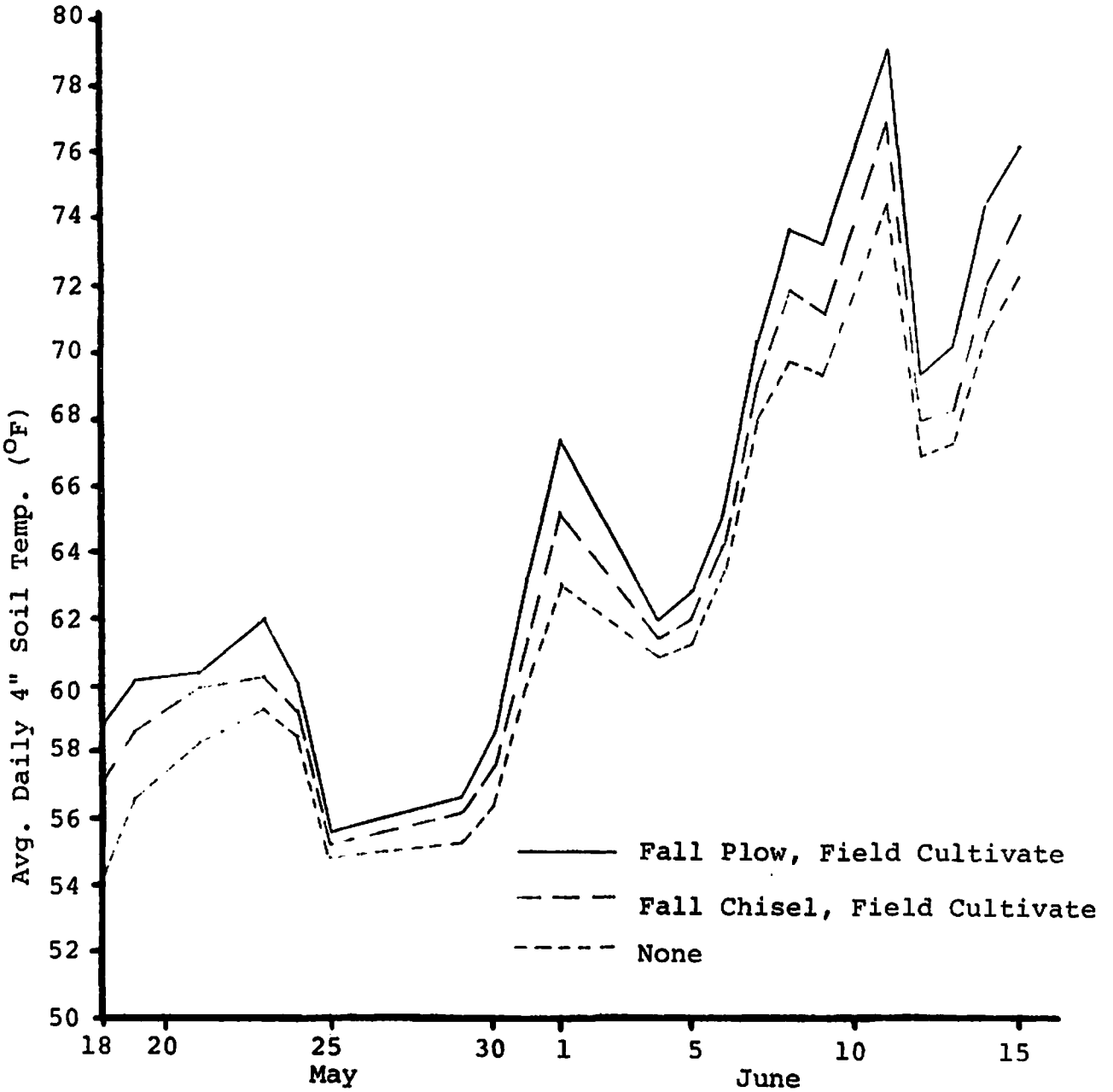

Fig. 1. Influence of three tillage treatments on the 4" soil temperature during the spring of 1973 at Waseca.

Depth to the perched water table was monitored in two tillage treatments (fall plow-field cultivate and no tillage) from mid-June thru August with open-end, 2" plastic pipes. Appreciable differences between the water table levels of the two treatments were not apparent throughout the season (Table 3).

Table 3. Depth to perched water table under two tillage systems at Waseca in 1973.

	Date								
Treatment	6/14	6/23	6/29	7/6	7/13	7/23	7/30	8/4	8/20
Fall plow-field cult.	41*	35	36	42	43	52	48	58	56
No tillage	38	31	35	38	43	54	49	59	59

* each value is an average of 6 pipes.

Soil moisture data from the fall plow-field cultivate and the no tillage treatments were taken via neutron probe. Four stoppered Al tubes were placed in each of the two treatments from two replications. A complete set of measurements was taken in both July and August (Table 4).

Table 4. Soil moisture of the profile under two tillage systems at Waseca in 1973.

	July 10		August 4	
Depth	Fall plow field cult.	No tillage	Fall plow field cult.	No tillage
inches	- - - - - - - - - - - - -%H_2O by volume- - - - - - - -			
8	18.2*	23.0	29.6	32.0
12	26.2	31.2	35.2	36.3
18	31.0	33.5	34.6	34.8
24	36.6	35.2	34.8	33.8
30	37.5	36.7	32.6	33.2
36	37.2	37.0	32.4	33.6
42	38.0	37.0	34.6	35.6

* each value is an average from 8 tubes.

At both dates soil moisture in the top 12" of the fall plow treatment was slightly less than the no tillage treatment. However, no marked difference existed between the treatments at depths greater than 12". With the water table varying from 31" to 59" and the soil moisture content averaging greater than 30% at depths below 12", it is doubtful that available soil moisture was limiting during the 1973 growing season.

Plant samples from four treatments (a. fall plow-field cultivate, b. fall chisel-field cultivate, c. disk only and d. no tillage) were taken at both the small plant (18" tall) and earleaf at tasselling stages. The small plant data shown in Table 5 indicate (1) sufficient elemental concentrations with all tillage

treatments and (2) slight differences in concentrations among the four treatments. The high concentration of iron may have been due to some contamination with soil splash into the whorls of the small plants; especially the tilled treatments.

Table 5. Nutrient concentrations in the small plant as influenced by tillage methods at Waseca in 1973.

Tillage Method	N	P	K	Ca	Mg	Fe	Mn	Zn	Cu	B
	%					ppm				
Fall plow-field cult.	3.86	.53	4.08	.58	.37	950	76	37	7.5	12.3
Fall chisel-field cult.	3.92	.56	3.80	.60	.38	875	70	35	8.8	13.2
Disk only	3.96	.55	3.82	.57	.42	835	70	42	9.3	14.4
No tillage	4.01	.53	3.74	.56	.38	565	63	39	9.6	15.4
Signif:[1/]	ns	ns	ns	ns	*	**	ns	*	*	*
CV(%):	3.1	3.6	5.6	3.9	5.9	15.3	8.8	6.7	8.5	9.2
BLSD(.05)					.04	205		4	1.2	2.2

[1/] ** and * = significant at the 99 and 95% levels; ns = not significant at the 95% level.

In the ear leaves, differences in nutrient concentrations were not noticed among the tillage treatments (Table 6). Concentrations were in the sufficient zone; although both K and Zn approached the critical level.

Table 6. Nutrient concentrations in the ear leaf as influenced by tillage methods at Waseca in 1973.

Tillage Method	N	P	K	Ca	Mg	Fe	Mn	Zn	Cu	B
	%					ppm				
Fall plow-field cult.	2.60	.28	2.33	.79	.50	230	32	20	9.0	7.0
Fall chisel-field cult.	2.64	.28	1.84	.86	.62	220	36	18	9.3	7.1
Disk only	2.54	.29	2.05	.82	.64	215	36	19	9.1	6.5
No tillage	2.68	.30	1.99	.80	.59	210	30	22	10.1	6.3
Signif:[1/]	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
CV(%):	8.9	4.6	12.8	7.5	11.0	11.8	18.6	13.4	6.4	10.5

[1/] ns = not significant at the 95% level.

Soil samples were taken from the same treatments as the tissue samples described above. All cores were divided into 0-2", 2-4", 4-6", 6-9" and 9-12" increments and were analyzed for pH, P, K

and NO_3-N. Results show all four parameters to be affected by the tillage treatments (Table 7). The pH of the 0-2" layer was slightly more acid with the disk and no tillage treatments while pH differences among the treatments were not found at the lower depths. P and K were found to accumulate near the surface with the fall chisel, disk and no tillage treatments. The similarity of the results between chisel and no tillage was surprising because one would think that the chisel would mix the soil more completely and thus incorporate the P and K. Only the moldboard plow treatment resulted in a somewhat uniform incorporation and distribution of P and K throughout the upper 12 inches. Nitrate-nitrogen within the profile was consistently lower under no tillage. Nitrate concentrations were highest near the surface with the chisel treatment and were most uniformly distributed throughout the profile with the moldboard plow.

Table 7. Influence of primary tillage methods on pH, P, K and NO_3 of the soil profile at Waseca in 1973.

Sample depth	Primary tillage treatment			
	Moldboard plow	Chisel plow	Disk	No tillage
inches		pH		
0-2	6.8	6.9	6.6	6.5
2-4	6.9	7.0	6.9	6.8
4-6	6.9	7.1	7.0	7.0
6-9	6.9	7.0	7.0	7.1
9-12	6.8	7.0	6.9	7.0
		P (lbs./A)		
0-2	68	98	108	108
2-4	68	73	55	48
4-6	66	38	29	32
6-9	47	18	16	23
9-12	24	8	8	8
		K (lbs./A)		
0-2	320	520	580	540
2-4	270	300	300	260
4-6	250	230	190	200
6-9	240	200	170	180
9-12	200	190	170	170
		NO_3-N (ppm)		
0-2	12.1	19.2	17.1	11.4
2-4	14.9	17.9	16.5	10.5
4-6	16.0	14.8	16.2	10.1
6-9	15.2	14.1	14.2	10.5
9-12	12.8	9.4	10.0	5.1

On November 1, three-inch diameter soil cores were taken from the moldboard plow and no tillage treatments to obtain various

physical measurements. To eliminate the effects of surface residues and cultivation, samples were taken from the 3-6" and 1-4" layers, respectively. No mechanical traffic had occurred over the sampled areas. Saturated conductivity (K), bulk density (D_B) and air filled pore space (AFPS) at 50 cm suction were determined.

Results shown in Table 8 indicate significant differences among the treatments in K, D_B and AFPS. At this late sampling, saturated conductivity of the between-row area under no tillage was approximately 20 times the rate of that under moldboard plowing. This was probably due to some channeling in the no tillage samples, which was not found in the plowed samples. Within the corn row of the plow treatment, K was intermediate. Bulk densities from the two tillage methods were not different. Air filled pore space was greatest within the row of the plow treatment, intermediate between rows in no tillage and least between rows in the plow treatment. These results indicate that soil physical properties have been affected and that similar samples should be taken throughout 1974 to determine if seasonal patterns are prevalent.

Table 8. Soil physical properties as influenced by two tillage methods at Waseca in 1973.

Tillage treatment	Saturated conductivity	Bulk density	Air filled pore space
	cm/hr	g/cm^3	cm^3/cm^3
None (between row)	26.2c	1.33b	.098b
Fall plow (between row)	1.4a	1.32b	.059a
Fall plow (in row)	7.5b	1.24a	.127b
Signif:	*	**	**
CV(%):	83.6	1.0	20.7

1970-1973 YIELD SUMMARY

In three of the four years significant yield differences have been found. However, the highest yields have not always been associated with the same treatments. Climatological differences among growing seasons have largely been responsible for this year to year inconsistency. For instance, 1971 was extremely dry and highest yields were obtained from the fall plow and chisel tillage treatments without any secondary tillage. In other years, secondary tillage generally increased yields. Four year averages show highest yields to result from fall moldboard plowing or fall chiseling with secondary tillage. Perhaps in fields that are more poorly drained or are level to north facing the fall moldboard plow would be advantageous because of warmer spring soil temperature and hastened early plant development. Spring chiseling and no tillage generally produced the lowest yields.

Table 9. Yields from continuous corn tillage experiment at Waseca from 1970-1973.

Tillage Treatment Primary	Secondary	Year 1970	1971	1972	1973	4-Yr. Avg.
		bu/A				
Fall plow	None	164.7	114.8	135.3	141.2	139.0
" "	Conventional[1/]	166.8	104.7	131.8	144.9	137.1
" "	Field cult.	163.7	102.8	136.2	144.1	136.7
Spring plow	Conventional	161.5	100.6	134.9	140.5	134.4
Fall chisel	"	164.2	106.6	130.8	155.1	139.2
" "	Field cult.	156.7	110.5	133.1	145.7	136.5
" "	None	161.1	116.2	126.2	134.3	134.4
Spring "	Conventional	150.2	100.1	139.9	138.4	132.2
Spring "	Disk	159.5	110.2	133.6	131.5	133.7
Zero	None	155.9	96.2	130.1	133.4	128.9
Zero	Disk	157.9	104.1	130.8	145.8	134.7
Signif:[2/]		*	+	ns	**	
CV(%):		3.6	5.9	5.1	4.4	
BLSD(.10):		8.3	9.7		7.7	
(.05):		9.9			9.0	

1/ Conventional = Disk and field cultivate
2/ **,*, + = significant at the 99, 95 and 90% levels; ns = not significant at the 90% level.

ENERGY RELATIONSHIPS

Over the last few months and during the coming years it has been and will be even more apparent that conservation of our fuel and energy supplies is paramount. This is even true for the farmer who converts fuel energy (calories) into food energy (calories). Farmers may be asked or required to limit their fuel usage in the production of their crops. An answer to the question "How can this reduction of fuel usage be achieved without limiting food output?" is complex. In many cases it would depend on each farmer's individual operation. However, from a generalized tillage standpoint in southern Minnesota, a few recommendations based on our tillage research can be given.

(1) On a number of our better drained and sloping soils, where continuous corn is grown, the substitution of chisel plowing for moldboard plowing at least every other year could save up to 18%[1/] of the fuel needed for primary tillage. This savings could be increased with annual chiseling, however, incorporation of residues and fertility, diseases and the total effect on yield may govern the frequency.

(2) For primary tillage after soybeans, the use of a chisel or a field cultivator instead of a moldboard plow would be encouraged. Principle reasons are (a) reduced erosion, (b) less time required and (c) increased fuel savings

(from 30 to 60%). Under wet soil conditions the field cultivator may be preferred over the chisel.

(3) The number of secondary tillage operations may be reduced without sacrificing yields. Changing from a fall plow, disk, field cultivate system to a fall plow, field cultivate system may result in a 20% fuel saving. Eliminating both spring disk operations from a fall plow, disk, disk, field cultivate system may save over 30%. Data from our experiments would indicate that the elimination of all secondary tillage may not result in much yield loss but could not be recommended as a general farm practice. The rough soil conditions which exist after primary tillage could cause numerous equipment breakdowns, loss of efficiency and result in poor plant populations.

The secondary tillage problem is made more complex when we consider the incorporation of herbicides for weed control. Many of our better performing herbicides for grass weed control need to be incorporated -- preferrably twice. If certain soil conditions or weed species prevail that necessitate use of these herbicides, then dual secondary tillage operations may be needed to prevent yield loss. This emphasizes the complex "systems approach" to agricultural production.

(4) The substitution of herbicides for cultivation to control weeds has been a widely accepted practice and saves on-farm usage of fuel. One herbicide application as compared to three cultivations would result in approximately an 85% reduction in on-farm fuel usage for weed control. The addition of a cultivation to the herbicide application would still result in a 50% reduction and perhaps the best weed control and yields.

The above suggestions are somewhat general but do point out areas where fuel efficiency could be improved. For example, if a farmer had a fall plow, disk, field cultivate, herbicide and two cultivation program and he decided to eliminate the disk secondary tillage and one cultivation, he could save up to 25% of his fuel for these crop production operations. Some farm operations may be able to incorporate these suggestions into their program quite easily but others may not.

1/ Fuel usage data based on Machinery Management Data, ASAE D230.2, American Society of Agricultural Engineers Yearbook, May 1973 modified to meet average Minnesota conditions and personal communication with Dr. Jack True, Department of Ag. Engineering.

CORN - SOYBEAN TILLAGE

Waseca, 1973

G. W. Randall, W. E. Lueschen and J. B. Swan

A field experiment was initiated this past year to evaluate tillage systems under a corn-soybean rotation in southcentral Minnesota. Twelve tillage treatments were established in a randomized complete-block design with four replications for corn and four for soybeans each year. The two crops simply rotate from one area to the other each year. The experiment is located on a Webster clay loam with a 0-2% slope. Tile lines spaced 75' apart lie perpendicular to the rows.

Broadcast fertilizer (0+50+50 lbs. $N+P_2O_5+K_2O$/A) was applied to both crop areas on October 16. Fall primary tillage operations were conducted November 9, 1972. Nitrogen (175 lbs. N/A as ammonium nitrate) was broadcast on April 27 to the corn area. The spring primary tillage treatments were performed on May 10 and the secondary treatments on May 14.

Corn (Minhybrid 4201) was planted at a rate of 26,800 ppA May 15. A John Deere plateless planter modified with Allis Chalmers 2" fluted coulters was used to plant the plots which did not receive primary tillage. For those plots which did receive primary tillage, the fluted coulters were removed. Starter fertilizer (13+35+45 lbs. $N+P_2O_5+K_2O$/A) and an insecticide (1 lb. active Furadan/A) were applied at planting time. Chemical weed control consisted of 2.5 lbs. alachlor/A and 3 lbs. cyanazine/A applied preemergence. With the exception of the no-tillage treatment where too much surface residue prevented cultivation, each treatment was cultivated once.

Soybeans (Corsoy) were planted at a rate of 8.3 beans/foot of row on May 16. The planter, procedures used and starter fertilizer rates were the same as those described above for corn. Weeds were controlled with 3 lbs. alachlor/A and 2½ lbs. chloroamben/A. All treatments, except the no tillage treatment, received one cultivation.

EXPERIMENTAL TREATMENTS

The 12 tillage treatments are listed in Table 1. Seven of the treatments (No. 1, 2, 6, 7, 9, 10 and 11) are conducted continuously; regardless of crop. The other five treatments take on a "systems" approach to tillage whereby the tillage method varies with the crop in the rotation. The disk-plow may also be called a plowing disk or a heavy disk but not a one-way disk.

Table 1. Tillage treatments in the corn-soybean rotation tillage study at Waseca.

Treatment No.	for SOYBEANS following CORN		for CORN following SOYBEANS	
	Primary	Secondary	Primary	Secondary
1	NONE	NONE	NONE	NONE
2	Fall Plow	f. cult.	Fall Plow	f. cult.
3	" "	" "	Fall Chisel	f. cult.
4	" "	" "	Spring "	" "
5	" "	" "	Zero	Zero
6	Spring Plow	f. cult and/or disk	Spring Plow	f. cult. or disk
7	Fall Chisel	disk	Fall Chisel	zero or f. cult.
8	" "	"	Zero	Zero
9	Spring Chisel	disk	Spring Chisel	zero or disk
10	Spring Disk	disk	Spring Disk	disk
11	Fall Disk-Plow	disk or f. cult.	Fall Disk-Plow	disk or f. cult.
12	Fall Disk	disk	Fall Plow	f. cult.

Table 2. Influence of tillage methods on second year corn at Waseca in 1973.

No.	Treatment Primary	Treatment Secondary	Emergence Date May	Tassel Date July	Final Population X 1000	Moisture at Harvest %	Yield bu/A
1	None	None	30	27	15.8	24.8	120.6
2	Fall plow	Field cult.	27	24	18.8	22.7	132.3
3	" "	Disk	27	24	18.1	22.4	135.4
4	Spr. chisel	Field cult.	30	27	17.3	23.5	129.6
5	Fall disk	None	31	27	17.5	24.6	130.1
6	Spr. plow	Disk	30	26	17.9	23.6	133.8
7	Fall chisel	Field cult.	28	25	18.0	23.3	124.0
8	" "	None	29	26	16.6	23.4	124.6
9	Spr. "	Disk	30	26	17.8	23.8	125.5
10	Spr. disk	Disk	29	26	17.8	23.8	126.6
11	Fall disk-plow	Field cult.	28	25	18.5	22.3	140.2
12	Spr. plow	Disk and field cult.	30	26	18.5	23.1	126.8
		Signif:[1/]	**	**	ns	**	*
		BLSD (.05):	1.0	0.7		1.4	13.7
		CV(%)	2.6	2.1	7.7	3.7	5.8

[1/] ** and * = significant at the 99% and 95% levels, respectively; ns = not significant at the 95% level.

RESULTS: CORN

This experiment was established in a very homogeneous area which had been planted to corn in 1972. Consequently, in 1973 the corn series of the rotation did not follow soybeans but rather corn. For this reason, some of the treatments listed for 1973 in Table 2 were different than those for corn following soybeans (Table 1).

Emergence and tassel dates, grain moisture at harvest and yield were influenced significantly by the tillage methods for this second year corn. In general, plant maturity was hastened and yields were highest from the fall plow and fall disk-plow primary treatments. Yield levels were primarily by severe wind damage on July 23. Although the final population ranged from 15,800 to 18,800, this difference was not significant. Poor seed germination was responsible for the overall low plant population.

RESULTS: SOYBEANS

Emergence date and plant population were affected by the tillage treatments (Table 3). The fall moldboard plow treatments resulted in the earliest emergence and the spring moldboard the latest. Spring moldboard plow showed the lowest populations; however, all stands were sufficient for optimum yields. Yields were high but were not affected by the treatments.

Table 3. Influence of tillage methods on soybean production at Waseca in 1973.

No.	Treatment[1/] Primary	Secondary	Emergence Date	Plant Population	Yield
			May	plants/10'row	bu/A
1	None	None	27	78	50.8
2	Fall plow	Field cult.	26	77	51.4
3	" "	" "	26	75	53.1
4	Spr. "	" "	30	72	50.7
5	" "	" "	29	74	48.0
6	Spr. "	Disk and field cult.	29	74	50.8
7	Fall chisel	Disk	27	76	49.2
8	" "	"	27	78	51.8
9	Spr. "	"	28	76	50.0
10	Spr. disk	"	28	72	50.4
11	Fall disk-plow	Disk and field cult.	28	80	52.4
12	Fall disk	Disk	28	77	51.1
		Signif:	**	*	ns
		BLSD (.05):	1.0	6	
		CV (%):	2.6	4.5	4.3

[1/] Treatments 4 and 5 differ from those given in Table 1 because during the winter it was decided that more valuable, long-term information would be obtained if they were changed from spring plow to fall plow.

Mulch rates and consequently soil temperatures were affected by the three primary tillage treatments. Approximately 60% of the corn residue from the previous year was incorporated by the chisel plow. Soil temperatures were obtained by installing thermocouples at a depth of 4" directly under the soybean row. Maximum and minimum temperatures were averaged for each day. During this late-May thru mid-June period, the temperatures from the fall moldboard plow treatment averaged about 1°F above the chiseled treatments and about 2°F over the no tillage treatments. These temperature differences, although not as great as from our continuous corn tillage study, did not appear to affect early soybean growth.

Table 4. Influence of tillage method on mulch rate and soil temperature after one year of corn at Waseca.

Treatment			Soil Temperature[1/]		
Primary	Secondary	Mulch Rate	5/30-6/1	6/4-6/9	6/11-6/16
		T DM/A	- - - - - - - -	°F	- - - - - - -
Zero	None	2.37	61.0	66.0	71.4
Fall plow	Field cult.	Trace	63.3	67.7	73.2
Fall chisel	Disk	0.99	62.0	66.8	72.3

[1/] Average 4" soil temperature of the 3 to 6 day periods in late May and early June.

Tissue samples consisting of the upper-most, mature trifoliate were taken from four treatments of varying primary tillage. These samples were gathered on July 27 at the mid-bloom stage. Differences in nutrient concentrations were not found among the primary tillage treatments. All concentrations were in the sufficient zone (Table 5).

Table 5. Effect of tillage method on the nutrient concentration in soybean leaves at Waseca in 1973[1/]

Treatment										
Primary	Secondary	P	K	Ca	Mg	Fe	Mn	Zn	Cu	B
		- - - - - - - % - - - - - - -				- - - - - - - - ppm - - - - -				
Zero	None	.35	1.62	1.35	.46	149	44	38	6.4	37
Fall plow	Field cult.	.35	1.66	1.34	.47	150	48	34	6.1	37
Fall chisel	Disk	.38	1.75	1.25	.48	163	43	33	6.0	38
Spr. disk	Disk	.35	1.61	1.29	.47	167	43	36	5.4	37
	Signif:	ns	ns	ns	ns	ns	ns	ns	ns	ns
	CV(%):	7.3	13.3	9.1	10.7	16.0	13.6	11.1	11.0	6.6

1/ Upper-most, mature trifoliate.

Nitrogen fixation data were obtained by acetylene reduction techniques performed by Dr. Ham and co-workers on August 10. Nodule weight per plant was affected significantly by the primary tillage treatments (Table 6). Spring plowing resulted in the lowest and spring chiseling the highest nodule weight. Nitrogen fixation as shown by total activity and specific activity was not affected by the tillage treatments. The inconsistencies in the nodule weights between the spring primary tillage treatments and high degree of variability in the other parameters emphasizes the need to investigate this relationship again next year. Sincere appreciation is extended to Dr. Ham for providing the labor and technology in obtaining this data.

Table 6. Nitrogen fixation by soybean as influenced by tillage methods at Waseca in 1973.

Treatment		Nodule Wt.	Nodule No.	Total[1/]	Specific[2/]
Primary	Secondary	/plant	/plant	Activity	Activity
		g		ul/ethylene	
Zero	None	1.999	101	71.24	37.51
Fall plow	Field cult.	1.816	120	94.78	52.00
Spr. plow	" "	0.750	52	26.38	34.31
Fall chisel	Disk	1.406	74	56.26	40.78
Spr. "	"	2.222	70	87.24	37.26
Fall disk	Disk	1.823	78	67.62	36.35
	Signif:	**	ns	ns	ns
	BLSD(.05):	0.720			
	CV(%):	27.4	41.7	50.2	39.8

1/ Ethylene produced per plant.
2/ Ethylene produced per gram of nodule tissue.

IRON CHLOROSIS IN SOYBEANS

Waseca, 1973

Gyles W. Randall

For a number of years symptoms of iron (Fe) deficiency have been observed on soybeans grown on calcareous soils in southern and western Minnesota. The severity of this Fe chlorosis has varied with weather conditions, soil conditions, the variety of soybeans grown, and possibly other unknown factors. The chlorosis commonly affects only small portions of a given field and while total yield losses may be small the loss within the affected area is often significant. The chlorotic symptoms normally appear very early in the growing season. If the symptoms are mild, the plants tend to recover as growing conditions become more favorable and the plants develop a more extensive root system. More severe deficiencies result in persistance of the symptoms, the death of many plants and reduced productiveness of others.

In recent years soybean growers have reported that Fe deficiences are occurring more frequently and the affected areas in fields are becoming larger. Much of this increase in severity of the Fe problem can be associated with the recent introduction of several new high yielding varieties which are not very tolerant of the conditions favoring Fe chlorosis. It is possible that higher rates of fertilization and changes in other management practices may also be contributing factors.

A number of contributing factors to Fe chlorosis in soybeans have been studied. Some of these involve: genetic factors within the soybean plant, soil environmental factors such as moisture, temperature, pH and organic matter and nutritional factors such as phosphorus, calcium, manganese, zinc and bicarbonate ions. Tillage practices, row fertilization and perhaps herbicide interactions with Fe chlorotic soybeans remain to be investigated.

Foliar application of $FeSO_4$ has been the traditional method of treating Fe chlorosis on soybeans. This material is relatively inexpensive but limited research work and experience by farmers have shown considerable variation in the effectiveness of $FeSO_4$ treatments. A number of Fe chelates have been introduced in recent years and are used for correcting Fe problems on fruit trees and other crops. These materials have been used less extensively on field crops but have some advantages for foliar applications and may have economic potential for use in soil applications. The cost of a unit of Fe in chelates is greater than in $FeSO_4$ but the rates required are smaller.

Within the last three to four years, field research with various Fe compounds applied to soybeans has been conducted in Iowa. In general, the Iowa research has shown that foliar Fe treatments are more effective and economical than soil treatments.

PROCEDURES AND RESULTS

In view of this, two experiments involving the foliar application of Fe materials to iron-deficient soybeans were established on five farms in Waseca and Faribault counties in 1973. One experiment evaluated four materials applied at three rates (Table 1). The other experiment involved two materials applied in single or multiple applications at two growth stages (Table 2). All trials were established on farmer-planted Corsoy beans which had been showing definite Fe chlorosis symptoms for 5 to 7 days. Each treatment was applied to two rows 25' long and was replicated from 4 to 10 times. All applications were made in a 15" band directly over the row by using a stainless steel 3-gallon hand sprayer. A spray volume of 50 gal/A and a surfactant (0.5% v/v) was used for all treatments. This insured complete wetting of the foilage.

Table 1. Corsoy soybean yields as influenced by the foliar application of four Fe materials at three rates of application in south-central Minnesota (1973).

Treatment		County		
Material	Rate	Waseca (Baer)	Waseca (Meyer)	Faribault (Sendelbach)
	lbs.Fe/A	- - - - - - - - -	bu/A	- - - - - - - - - -
Check		21.5	2.2	34.7
Fe-138	0.10	25.0	23.2	38.0
"	0.125	25.2	23.6	35.5
"	0.15	22.2	33.9	38.6
Exp. A	0.10	19.4	6.7	28.2
"	0.125	20.4	4.1	31.2
"	0.15	20.8	8.5	35.6
Exp. B	0.10	16.4	3.3	35.4
"	0.125	20.8	3.9	33.4
"	0.15	19.1	4.6	31.6
Exp. C	0.10	24.0	4.0	36.2
"	0.125	18.2	9.3	36.2
"	0.15	19.2	12.7	28.5
	Significance:	ns	**	ns
	BLSD: (.05)		12.0	
	CV: (%)	23.1	97.2	20.4

Results in Table 1 show that yield response to foliar-applied Fe occurred at only one of the three locations (Meyer). Greater than a 10-fold yield increase was noted with the Fe-138 material. Although the high rate resulted in an additional 10 bushel yield, this was not statistically significant due to the high variability. No phytotoxic symptoms were noted at the high rate; consequently one would feel safe applying this material at rates between 0.10 and 0.15 lbs. Fe/A. Yields were not increased significantly over

the check by the three experimental compounds. The soybeans at the Baer farm did not respond to any of the treatments and remained somewhat yellow and stunted throughout the growing season. This may have been due to a concomitant K deficiency which was noticed thru tissue analysis. At the Sendelbach farm, all beans naturally recovered; consequently, the Fe treatments could not be evaluated.

The growth stage of the plant at Fe application appeared to be quite important (Table 2). Results obtained on the Coy farm show that Fe applied at only the early stages of iron chlorosis (2nd. trifoliate) proved beneficial. Yield increases were not obtained when waiting until the beans were in the 4th. trifoliate; probably because the plants had begun to lose leaves and root rot was becoming prevalent. A multiple application at both the 2nd. and 4th. trifoliate stages was not superior to the single early application. Results obtained at the Lohberger farm were inconclusive because no yield was significantly higher than the check.

Table 2. Corsoy yields as influenced by single and double applications of Fe materials at two growth stages of iron-deficient soybeans in south-central Minnesota (1973).

Treatment			County	
Material	Stage	No. of Applications	Waseca (Coy)	Waseca (Lohberger)
	trifoliate		- - - - -bu/A- - - - -	
Check		0	27.9	31.6
Fe-138	2nd.	1	42.0	34.5
"	4th.	1	29.7	29.7
"	2 & 4th.	2	40.6	35.0
Exp. A	2nd.	1	35.6	31.6
"	4th.	1	30.2	21.4
"	2 & 4th.	2	33.9	34.4
	Significance:		**	**
	BLSD: (.05)		8.8	7.9
	CV: (%)		26.6	14.5

Concentrations of Fe in the uppermost, mature trifoliates were significantly reduced by the Fe treatments (Table 3). This is contrary to most other plant-nutrient relationships but has been reported by other workers. With this phenomenon present, it is apparent that plant analysis at this time cannot be used to determine if Fe deficiency in soybeans exists.

Table 3. Fe concentration in leaf tissue as influenced by the foliar application of Fe materials to iron-chlorotic soybeans in south-central Minnesota (1973).

Treatment		County	
Material	Rate	Waseca (Meyer)	Waseca (Coy)
		- - - - - - ppm	- - - - - -
Check		186	180
Fe-138	0.10	137	145
"	0.125	130	
"	0.15	127	
Exp. A	0.10	146	154
"	0.125	151	
"	0.15	148	
	Significance:	**	**
	BLSD: (.05)	20	16
	CV: (%)	9.5	6.8

CONCLUSIONS:

1) Fe-138 applied to the foliage at rates from 0.10 to 0.15 lbs. Fe/A appears to be a satisfactory treatment but not always 100 percent effective.

2) Applications within one week after chlorosis symptoms appear is recommended. This is usually about the 2nd. trifoliate stage.

3) Band the material over the row. Fe falling on the inter-row area (soil) does absolutely no good.

4) Be patient. Response to the Fe (new leaves become dark green and interveinal chlorosis is absent) may take from 7 to 20 days.

SOYBEAN-NITROGEN FERTILIZER RATE AND PLANTING DATE STUDY

G.E. Ham and G.W. Randall

Ammonium nitrate at the rate of 50 and 100 pounds nitrogen per acre was plowed down the preceding fall with the corn residues. In addition 100 pounds of nitrogen was broadcast on the surface before planting and incorporated. Soybean varieties, planting dates and seed yields are shown in Table 1. The seed yields of Corsoy and II-63-217 were increased significantly with nitrogen fertilizer. Nodule number, nodule weight and N_2 (C_2H_2) fixation were all reduced when nitrogen fertilizer was added.

Table 1. Effect of nitrogen rates, planting date and soybean genotype on soybean seed yield at Waseca (1972).

Date planted	Soybean genotype	Nitrogen applied (lb/acre) 0	50	100 Fall	100 Spring
		bu/acre			
May 11	Corsoy	49.6	53.1	55.5*	51.7
	II-63-217	54.7	59.0*	55.6	56.6
	Steele	50.9	51.2	52.0	53.6
	Teweles 505	50.5	47.6	46.0	48.6
	Wells	51.7	51.7	50.9	52.5
May 31	Corsoy	47.8	49.5	50.0	53.5*
	II-63-217	55.3	50.9	52.1	53.5
	Steele	47.5	47.0	43.9	45.9
	Teweles 505	40.7	40.6	37.3	38.3
	Wells	47.0	44.8	43.1	46.9

* Yield significantly greater than the check of the same variety.

SOYBEAN GENOTYPE - NITROGEN FERTILIZER STUDY

G.E. Ham and G.W. Randall

Ammonium nitrate at the rate of 200 pounds nitrogen per acre was placed down the preceding fall. Based on performance in the 1972 study, 10 genotypes were selected for 1973 (genotypes that showed the largest yield decreases and those showing the largest increases). In addition, 28 genotypes of indeterminate and determinate plant types of Hark and Corsoy background were grown in the study. Some of the genotypes were grown in other experiments on the Waseca station and the yields were about 10 bushels per acre greater than those obtained in this study. The reasons for the lower yields are not known. Four of the 10 genotypes from the 1972 study showed the same response in 1973 (either positively or negatively to nitrogen in both years); the other six genotypes did not respond similarly in both years. The seed yield of six genotypes was increased significantly (Table 1). The highest yield with nitrogen was 46.8 bushels per acre. The largest yield increase in a genotype was 7.2 bushels per acre (18.4%).

Table 1. Effect of nitrogen fertilizer on the yield response of various soybean genotypes at Waseca (1973).

Soybean* genotype	Nitrogen rate (lb/acre) 0	200	Nitrogen effect on yield bu/acre	%
	-------bu/acre-------			
59-120	39.2	39.2	0	0
61-96	33.3	35.4	2.1	6.3
68-27	39.0	41.1	2.1	5.4
68-35	36.5	36.2	-0.3	-0.8
68-36	40.1	38.2	-1.9	-4.7
68-48	41.4	41.5	0.1	0.2
68-49	39.8	38.3	-1.5	-3.8
68-57	42.2	41.2	-1.0	-2.4
68-58	39.7	41.7	2.0	5.0
68-60	36.9	36.5	-0.4	-1.1
12-407	40.4	41.1	0.7	1.7
12-410	38.6	39.6	1.0	2.6
12-415	37.6	42.4**	4.8	12.8
12-418	39.8	42.3	2.5	6.3
12-434	39.8	43.3**	3.5	8.8
12-435	39.6	40.4	0.8	2.0
12-462	34.3	36.8	2.5	7.3
13-1011	38.4	37.7	-0.7	-1.8
13-1018	42.0	42.2	0.2	0.5
13-1030	42.0	44.4	2.4	5.7

Table 1 (continued).

Soybean* genotype	Nitrogen rate (lb/acre) 0	200	Nitrogen effect on yield bu/acre	%
	--------bu/acre---------			
13-1031	44.1	44.7	0.6	1.4
13-1035	42.7	39.5	-3.2	-7.5
13-1042	40.9	40.7	-0.2	-0.5
13-1069	41.6	39.2	-2.4	-5.8
12-055	41.7	40.6	-1.1	-2.6
12-131	41.2	40.0	-1.2	-2.9
12-136	43.1	41.8	-1.3	-3.0
12-139	43.3	41.9	-1.4	-3.2
12-149	42.7	41.3	-1.4	-3.3
12-182	40.1	45.6**	5.5	13.7
12-286	41.5	46.8**	5.3	12.8
13-653	43.9	45.1	1.2	2.7
13-702	42.8	40.0	-2.8	-6.5
13-720	43.3	45.7	2.4	5.5
13-789	40.3	40.1	-0.2	0.5
13-803	42.3	39.3	-3.0	-7.1
13-821	39.9	43.6**	3.7	9.3
13-825	39.1	46.3**	7.2	18.4
Average	40.4	41.1	0.7	1.7

* Genotype 59-120 through 68-60 obtained from J.W. Lambert, Department of Agronomy and Plant Genetics, Univ. of Minn., 12-407 through 13-825 obtained from D.E. Green, Department of Agronomy, Iowa State University.

** Yield significantly greater than check yield at .05 level.

NITROGEN FERTILIZATION OF CORN

Waseca, 1973

G. W. Randall and W. E. Lueschen

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

Experiment I

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

Soil test P and K values were high. Broadcast rates of 26# P/A and 75# K/A were applied before fall-plowing on 11-9-72. Ammonium nitrate and urea were fall-applied on 10-27-72 and anhydrous and aqua ammonia on 11-13-72. Soil conditions for the ammonia application were quite rough and wet; consequently, some 82% was lost to the atmosphere. Spring application of N was conducted on 4-27-73 with very good soil conditions.

Corn (Minhybrid 4201) was planted at 26,800 ppA in 30" rows on May 18. Row fertilizer (9+10+25 lbs. N+P+K/A) and an insecticide (1 lb. active Furadan/A) were applied at planting time. Weeds were controlled with a preemergence band application of 5 lbs. Ramrod (A.I.)/A and one cultivation. The leaf opposite and below the ear was sampled on July 27 and was submitted for analysis by Kjeldahl methods. Yields were obtained on October 23 by combine harvesting the center two rows from each plot.

Results

Nitrogen concentrations in the earleaf and grain (protein), yield and moisture at harvest were affected significantly by the nitrogen sources and rates of application (Table 1). Anhydrous ammonia generally was the most efficient and ammonium nitrate the least efficient N source under 1973 conditions. April and May rainfall averaged 2.81 and 2.40" above normal, respectively, and resulted in temporarily saturated soil conditions. As a result denitrification reactions and subsequent losses of NO_3 may have occurred. The 150 lb. rate, averaged over all sources, was superior to the 75 lb. rate.

Table 1. Effect of source, rate and time of application of nitrogen on the leaf N concentration and yield of corn at Waseca 1973. (Experiment I).

Treatment				Grain		
Source	Rate	Time	Leaf N	N	Yield	H_2O
	lbs.N/A		%	%	bu/A	%
Anhydrous Am.	75	Fall	2.47	1.33	145.4	23.9
"	75	Spring	2.69	1.41	143.2	24.2
"	150	Fall	2.65	1.33	145.8	24.3
"	150	Spring	2.75	1.38	146.8	23.9
Urea	75	Fall	2.11	1.20	136.8	25.6
"	75	Spring	2.23	1.22	126.8	25.6
"	150	Fall	2.29	1.26	145.3	24.1
"	150	Spring	2.52	1.38	144.3	24.0
Am. Nitrate	75	Fall	2.18	1.22	122.7	25.3
"	75	Spring	2.33	1.22	128.7	25.6
"	150	Fall	2.31	1.22	137.3	25.0
"	150	Spring	2.43	1.36	146.0	24.4
Aqua Am.	75	Fall	2.32	1.22	134.9	25.4
"	75	Spring	2.33	1.23	133.5	25.3
"	150	Fall	2.52	1.33	144.8	24.4
"	150	Spring	2.50	1.33	140.7	25.0
Significance:			**	**	*	**
CV (%):			6.8	5.3	7.3	3.0
BLSD (.05):			0.24	0.10	17.1	1.2

Individual Factors:

Source

Anhydrous Am.	2.64	1.36	145.3	24.1
Urea	2.28	1.27	138.3	25.0
Am. Nitrate	2.31	1.26	133.7	25.0
Aqua Am.	2.42	1.28	138.5	24.8
Significance:	**	**	*	**
BLSD (.05):	.11	.05	7.6	0.5

Rate

75# N	2.33	1.26	134.0	25.1
150# N	2.49	1.32	143.8	24.4
Significance:	**	**	**	**

Time

Fall	2.36	1.27	139.1	24.7
Spring	2.47	1.32	138.7	24.7
Significance:	**	**	ns	ns