SOIL SERIES 115

A REPORT ON FIELD RESEARCH IN SOIL SCIENCE

The 1985 edition of the "Bluebook" is a compilation of data collected and analyzed throughout Minnesota. Information was contributed by personnel of the Department of Soil Science including Extension Soil Specialists, Soil Scientists at the branch stations of Crookston, Lamberton, Morris, and Waseca; Becker and Staples experimental sites; and Soil and Crop area agents. Associated personnel from the Soil Conservation Service, and the Soil and Water Research group of the ARS-USDA, The Tennessee Valley Authority, The Departments of Agriculture and Natural Resources also contributed information.

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The investigators also greatly appreciate the cooperation of many county agents, farmers, technical assitants, secretaries and the representatives of the various firms and businesses who contributed time, land, machinery and materials and without whose support many of the results reported here would not have been possible.

Some of the results are from 1984 experiments only and should be regarded on this basis. Since most data are from only 1984 studies, conclusions may not be conclusive and thus are not for further publication without the written consent of the individual researchers involved.

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LONG-TERM PRECIPITATION RECORDS

D.G. Baker and D.L. Fusch

Two precipitation records, among many others, can be cited to show that we are currently in a "wet" regime. The records we have chosen to show are those of Minneapolis-St. Paul (1837-1983) and Fairmont (1887-1983), Fig. 1 and 2, respectively. In each illustration the asterisks represent the total precipitation each year and the long straight line is the average for the total record. The next longest straight line, (it is at the right hand side) represents the average or normal for the 1951-1980 period. For Minneapolis-St. Paul this 30-year average is slightly less than the long-term average, while for Fairmont it is slightly higher. The next straight line above is the average for the most recent 10 years, 1974-1983. And above this 10 year line at each station is another and shorter line that represents the average for the last 5 years, 1979-1983. Table 1 summarizes what these two records show about the recent annual precipitation averages.

Table 1. Precipitation averages at Minneapolis-St. Paul and at Fairmont.

Period	Minneapolis-St. Paul	Fairmont
1837-1983	26.83 in.	--
1887-1983	--	28.80 in.
1951-1980	26.42 in.	29.14 in.
1974-1983	28.60 in.	31.59 in.
1979-1983	30.02 in.	36.37 in.

These results, which show a marked recent increase in the annual total precipitation at the two stations, are not unique to either of these two stations, or even to the state of Minnesota. The rise in Devil's Lake (North Dakota) and Salt Lake (Utah) and the resulting problems have been in the news for some time. It is quite apparent that much if not all of the problems encountered by property owners on some local lakes are due to the recent precipitation increase.

The two records shown in Fig. 1 and 2 make it obvious that the current high precipitation is not the first time such an event has occurred. Indeed the two records show that wetter periods of even greater duration have occurred at least three or four times previously within the record period.

A second point of value to learn from the two records is that each wet period has been followed by a dry one. A third point to be gleaned is that while at first glance the rise and fall appear to have some regularity while the wet and dry periods are variable enough that a prediction as to their future occurrence cannot be made with any degree of confidence.

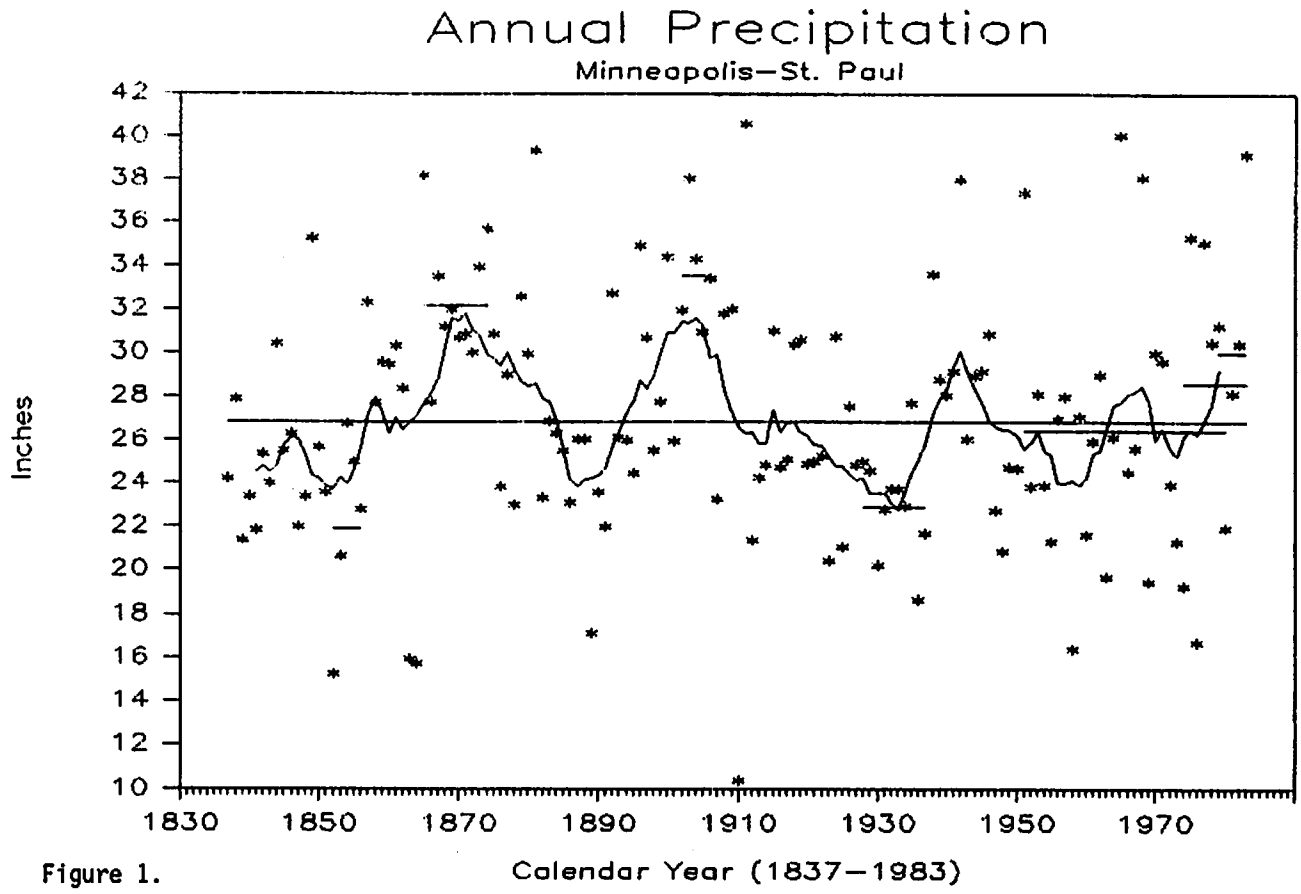


Figure 1.

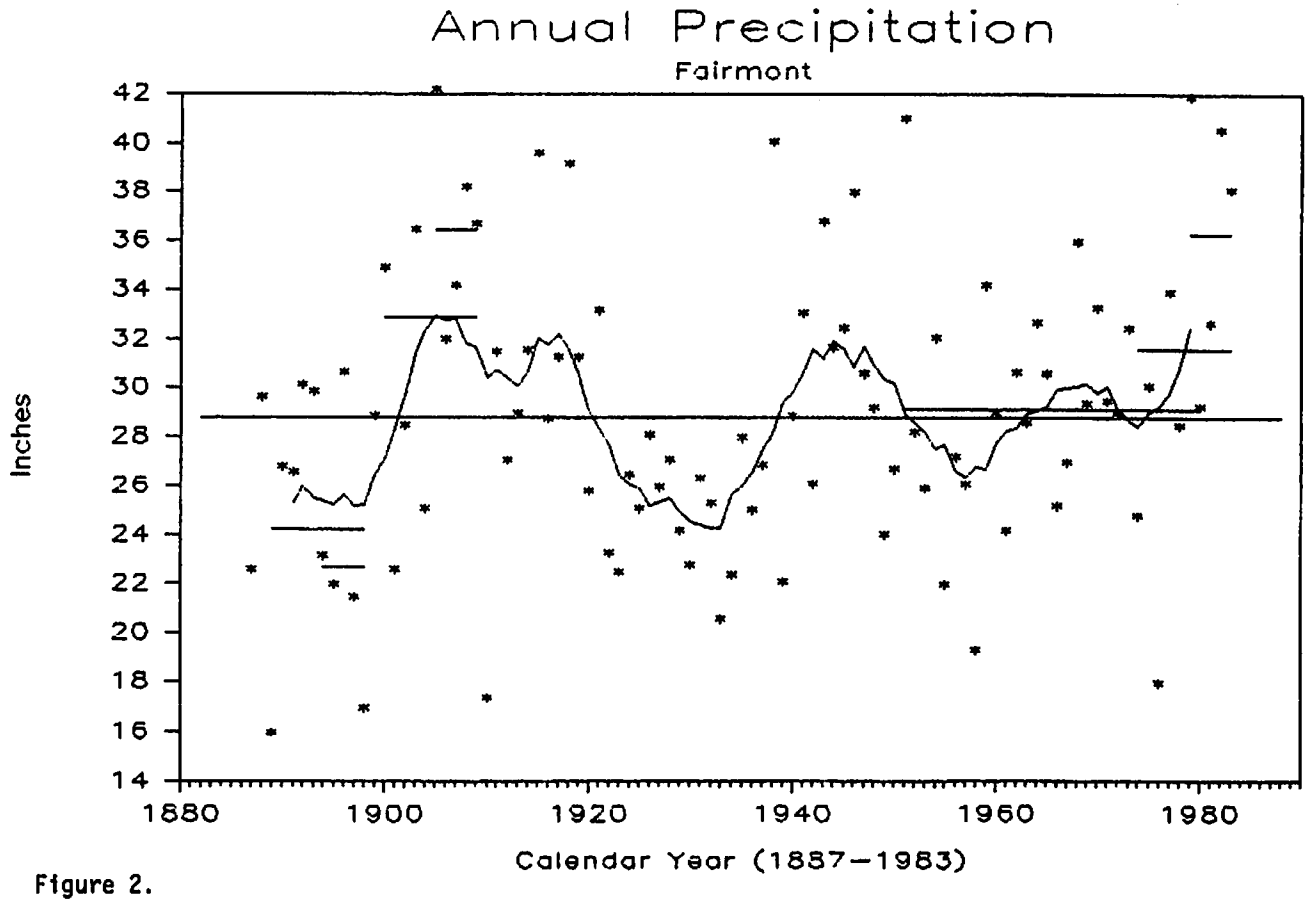


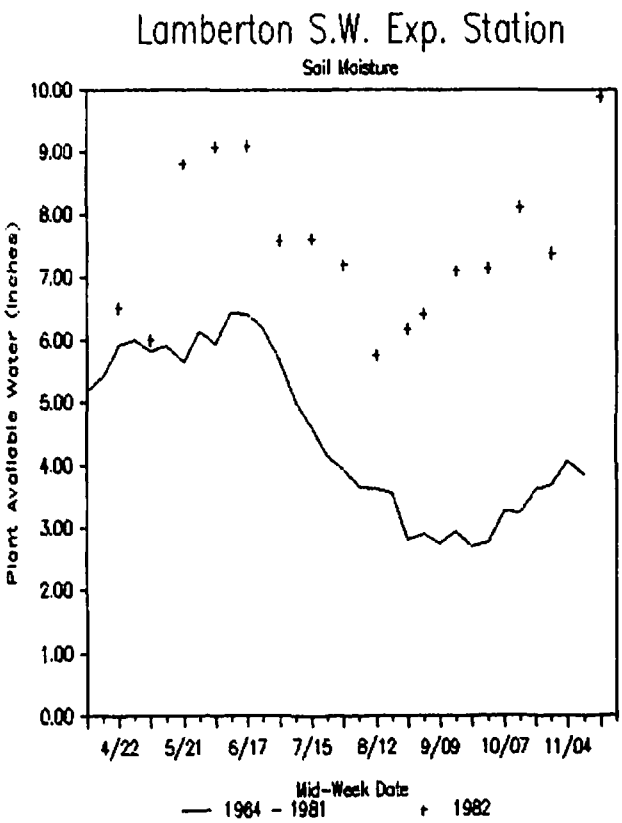
Figure 2.

SOIL MOISTURE

D.C. Baker, W.W. Nelson, G. Bardell and D.L. Ruschy

The recent precipitation increase is also evident in the soil moisture record at Lamberton, Southwest Agricultural Experiment Station. In the last three seasons, 1982-1984, Fig. 3, 4, and 5, respectively, the soil moisture has greatly exceeded the long-term average that began in 1964. The effect that these three years have had upon the long-term average is considerable: compare the 1964-1981 average with that of 1964-1984 shown in Fig. 6.

At Waseca the 1984 season did not show up as an especially wet season in terms of the soil moisture measurements as shown in Fig. 7. However, in comparing an average season at Waseca to one at Lamberton it is evident that Waseca has a wetter growing season. Not only is the total water content greater at Waseca but the Waseca soil water profile does not show the large midseason decrease in moisture supplies typical of Lamberton and western Minnesota. This very important difference between the two stations must be reflected in crop yields, since Waseca's water supplies generally remain much higher during the critical silking-tasseling and grain filling periods.



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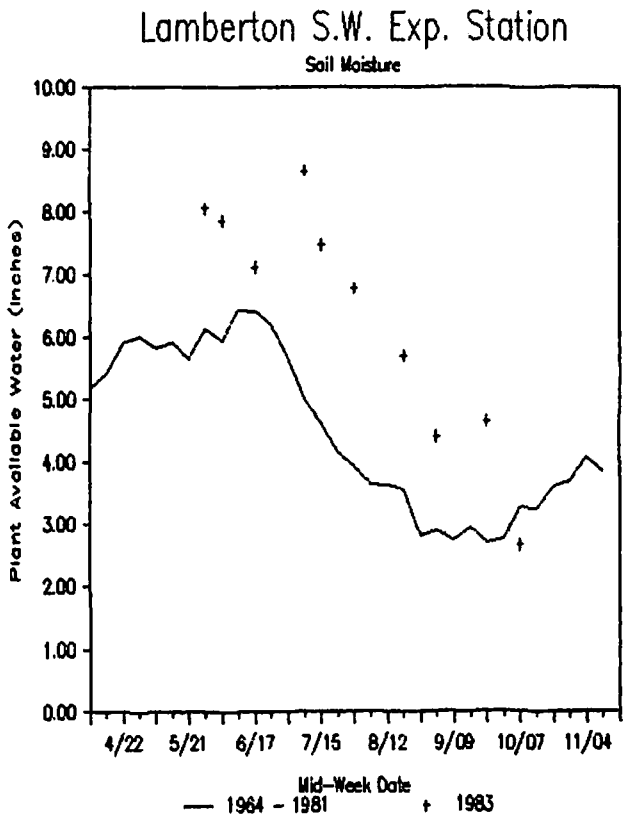

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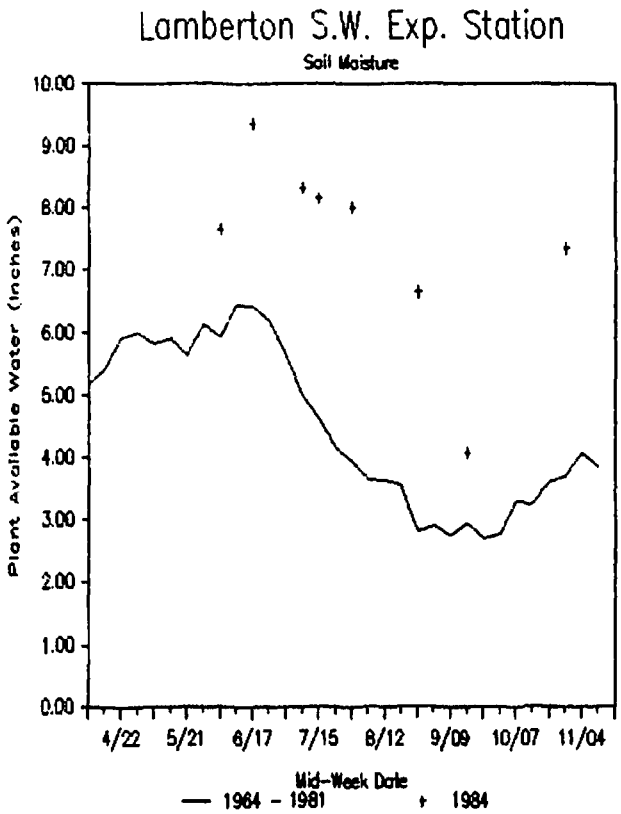

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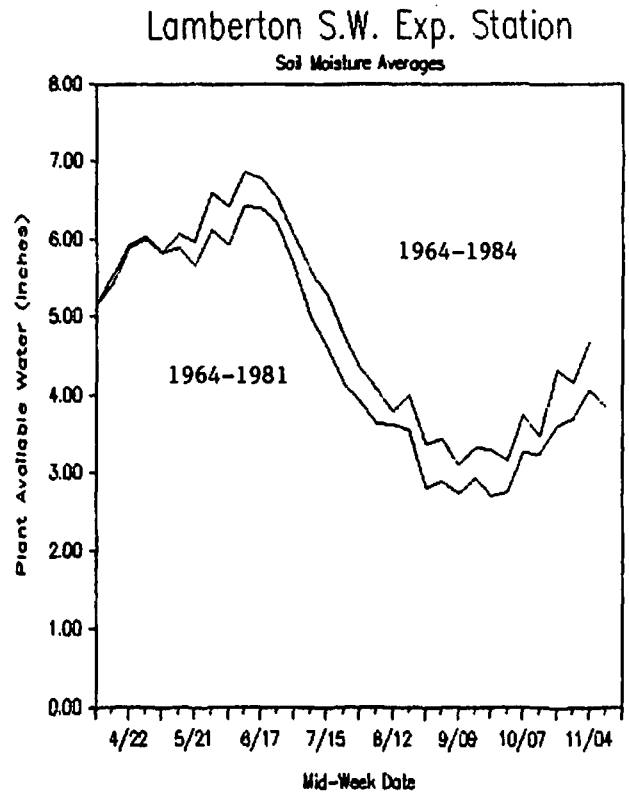

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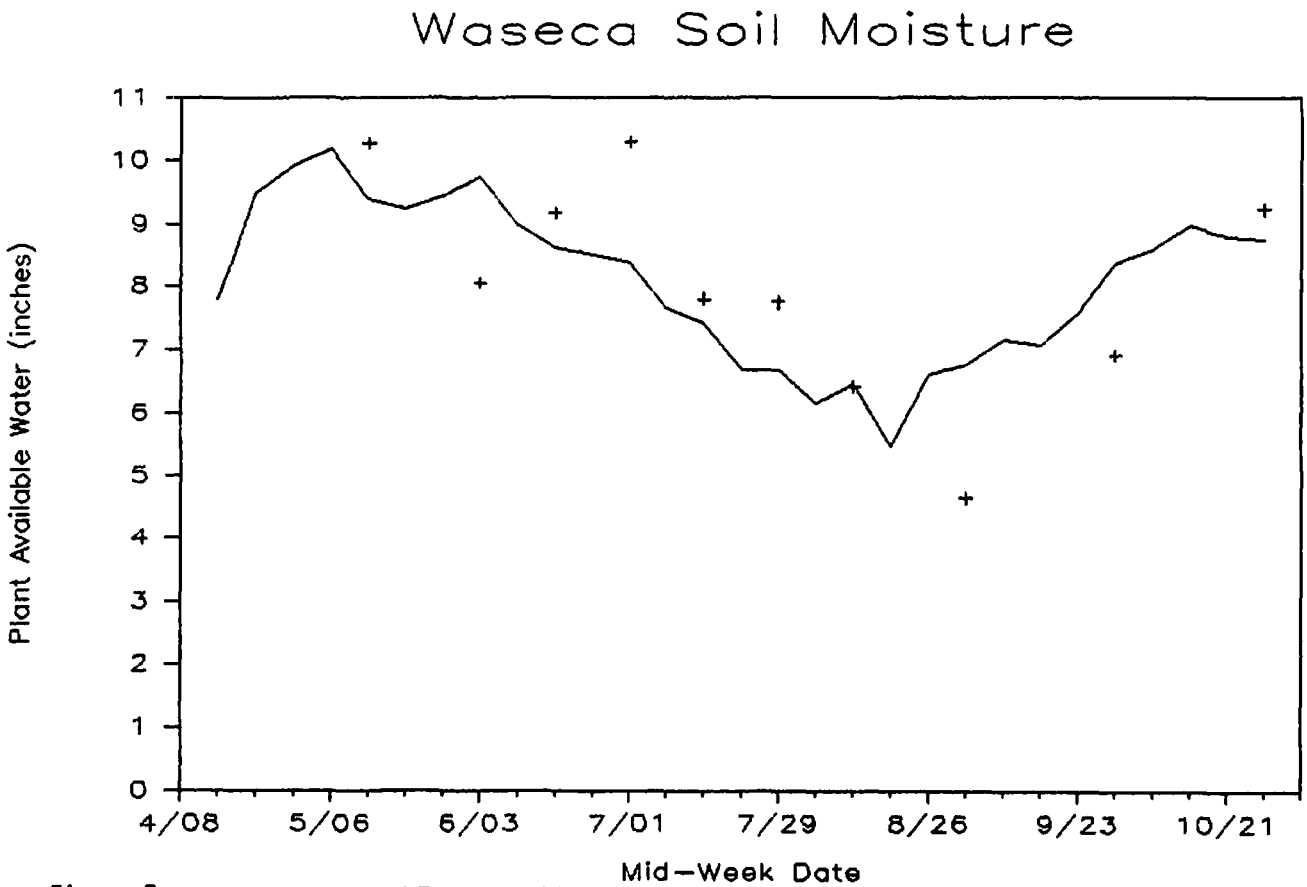


Figure 7.

The average total plant available soil water in 5 feet of soil under corn at Lamberton for the 1964-1984 period is to be seen in Fig. 8. This is similar to the generalized picture of the soil moisture profile that has been shown in previous years. It shows that on the average in the week of June 10 the maximum amount is reached and the minimum occurs on or about Sept. 9. The drawdown in soil water between these two dates (what we have termed the "grand consumption" period) amounts to about 3.90 inches. Fig. 8 also illustrates the two soil moisture recharge periods: (1) late summer and fall recharge from about Sept. 9 to soil freeze-up, which usually occurs in the first week of December, and (2) the spring recharge from soil thaw (about the first week in April) until about June 10. The fall recharge period is ordinarily greater than that of spring on agricultural soils.

Fig. 9-15 permit a more detailed examination of the soil moisture seasonal changes to be made. The seven depths represented by Fig. 9-15 are the intervals in which the 60-inch column of soil is sampled.

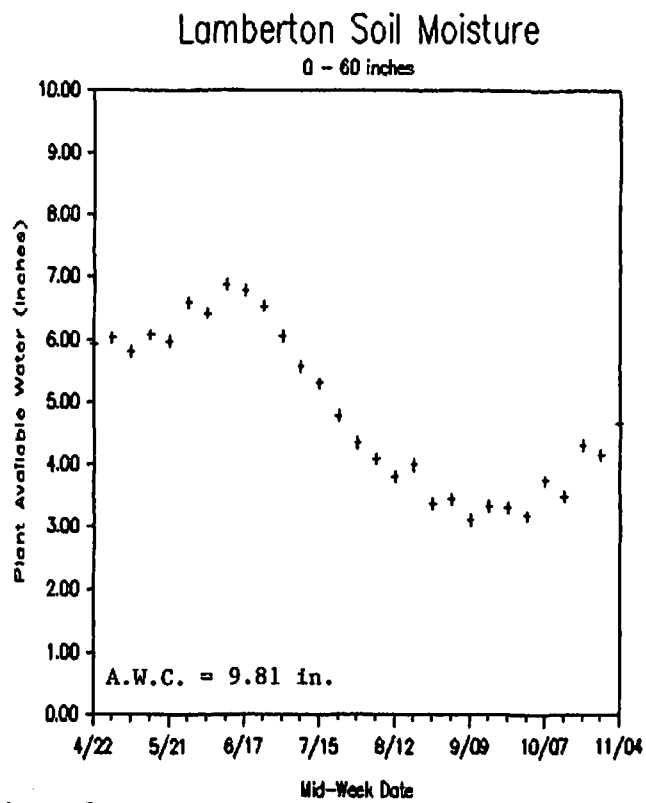
There is some indication of a lag with depth of the spring recharge. More evident, however, is the lag with depth of the time when the minimum soil moisture content is reached. The approximate dates when the maximum and minimum amount of water is reached on the average at each depth are shown in Table 2.

Table 2. Approximate dates of the maximum and minimum water content at different depths under corn at Lamberton, 1964-1984.

Depth	Date of Maximum	Date of Minimum	Interval, Days
0-6 in.	June 10	July 22	42
6-12	June 10	Aug. 26	77
12-18	June 10	Sept. 9	91
18-24	June 10	Sept. 9	91
24-36	June 17	Sept. 23	98
36-48	June 17	Oct. 7	112
48-60	June 24	Oct. 14	112

The maximum water content at each depth interval shows little variation because it is simply a matter of the rate at which the water can percolate through the soil. On the other hand, the time at which the minimum is reached is essentially a function of when the roots are able to reach a given depth as well as the movement of water (both upward and downward) to regions of lower soil water content.

A.W.C. in Figures 8 - 15 represents the plant Available Water holding Capacity.



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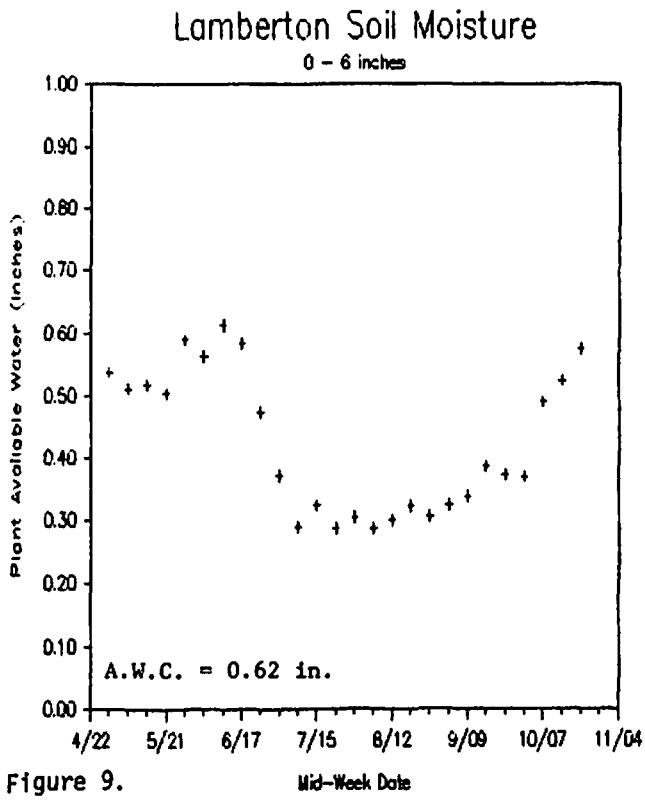

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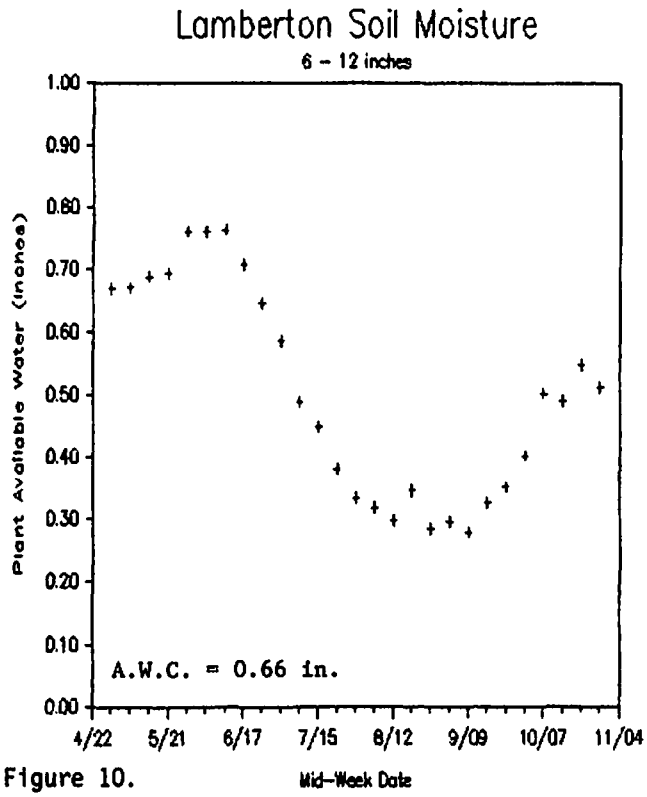

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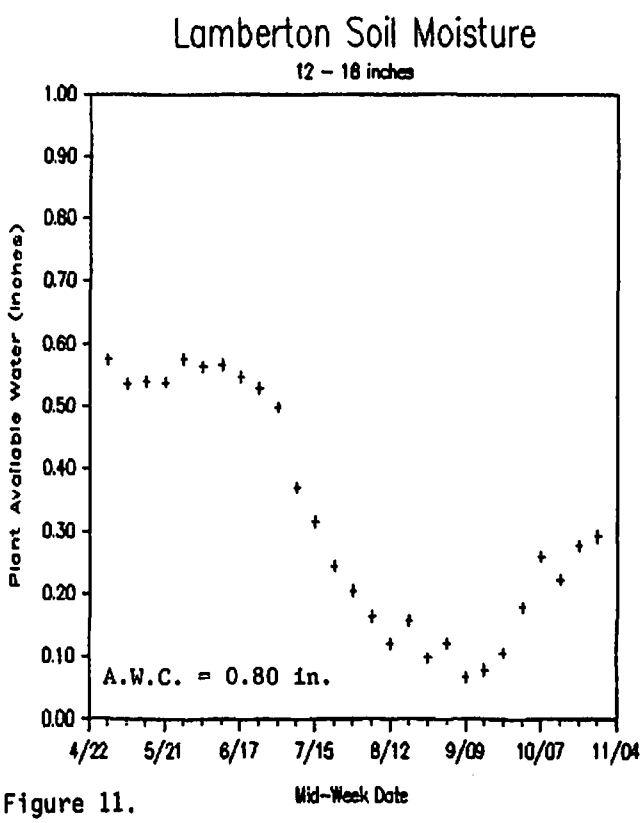

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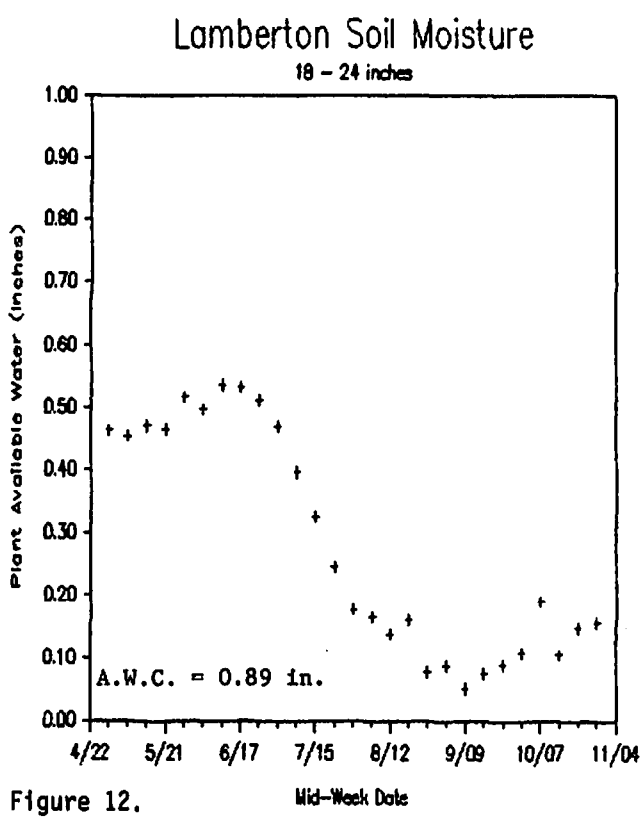

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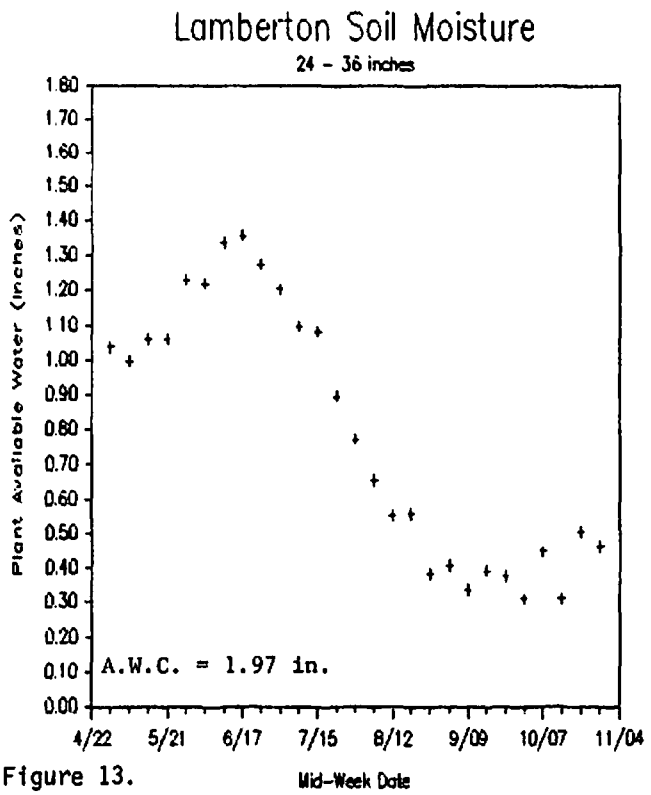

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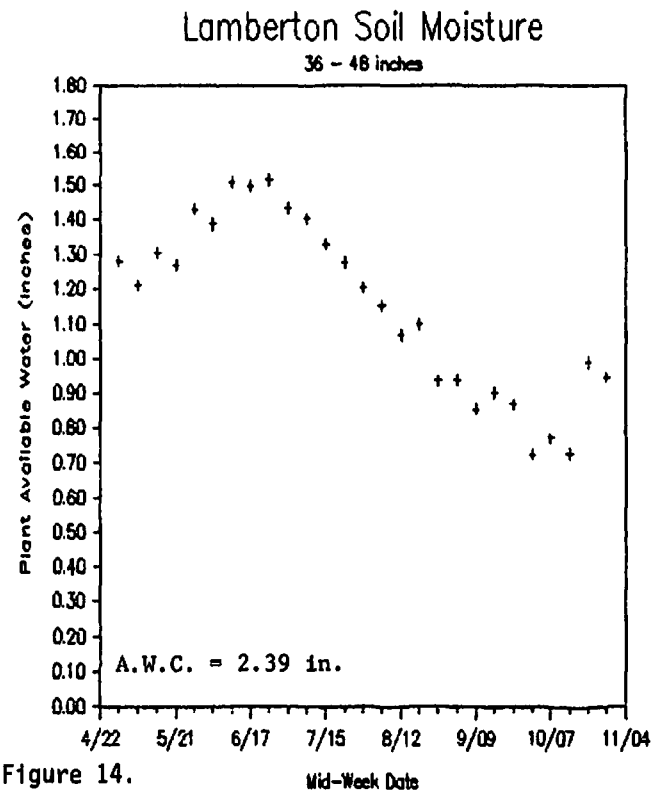

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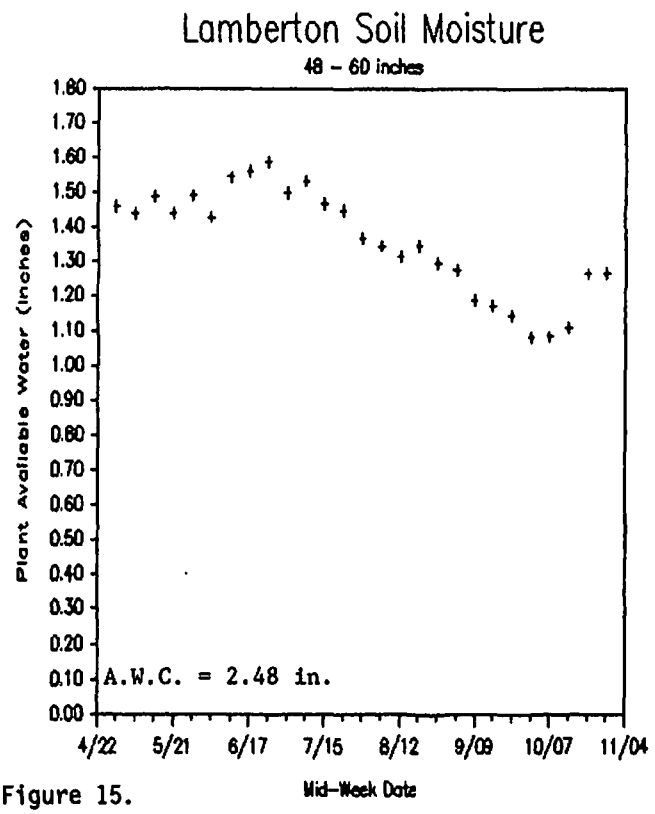
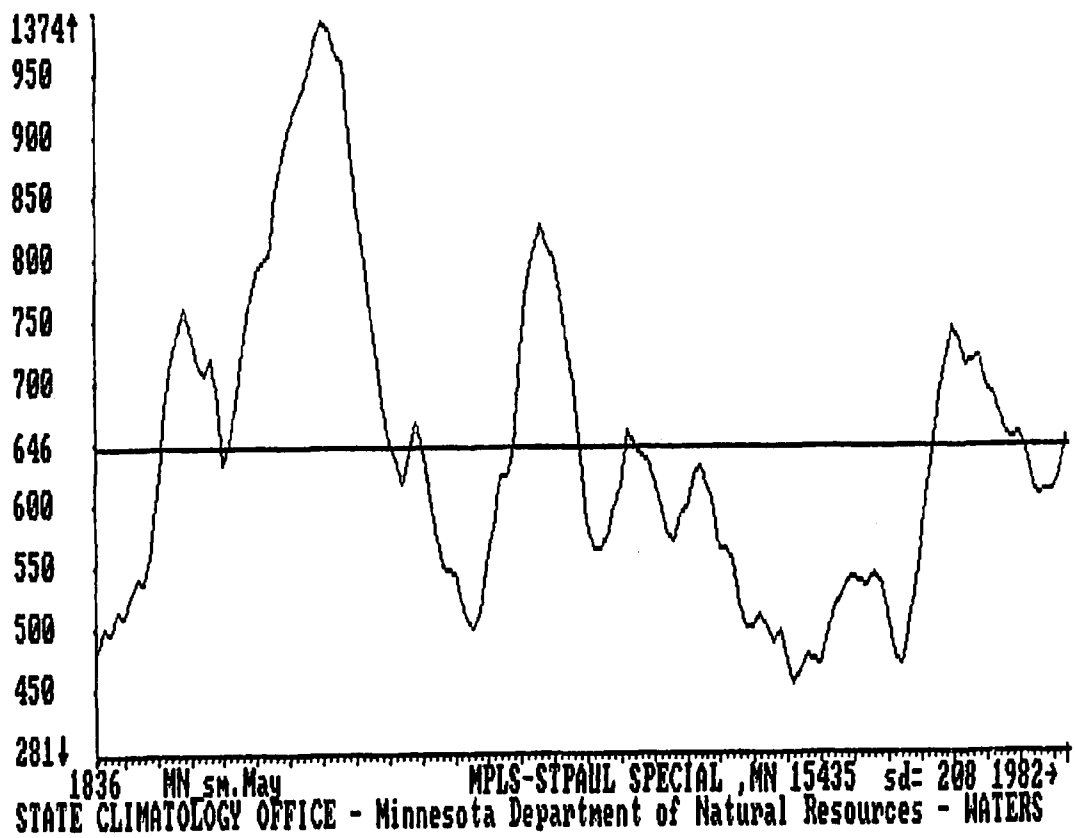


Figure 15.

SOIL MOISTURE MODELING

J.A. Zandlo, F.L. Kuehnast, D.I. Rusby, and D.G. Baker

Soil moisture is measured at only a few sites across the state. One reason for the lack of more measurements is that it is a difficult and time consuming task. As a result, there has been an attempt to develop mathematical models based on variables important to soil moisture such as precipitation and temperature. A model was developed here which permits an estimate to be made of the long-term variation in soil moisture. The results based on the long-term Minneapolis-St. Paul weather records is illustrated in Fig. 16, 17, and 18. The first two show the year by year variation in the calculated soil moisture for September 1 and November 1 of each year. The third, Fig. 18, is for the soil moisture content as of May 1 but the data have been smoothed. The smoothing permits the trends to be shown and obscures the usually distracting annual variations. The computer program which was used to prepare Fig. 16-18 was developed by Mr. James Zandlo of the State Climatology Office. Students and staff may be interested in the computer program and may contact Mr. Zandlo for the program.



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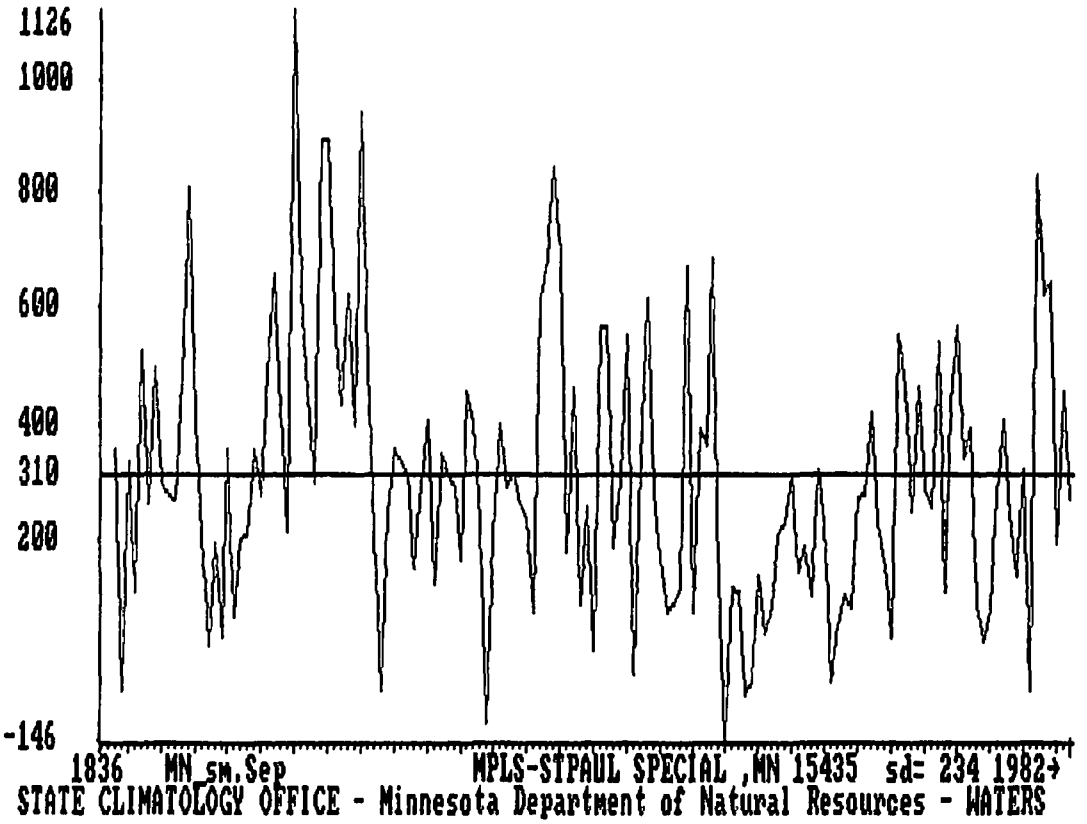

Figure 17.

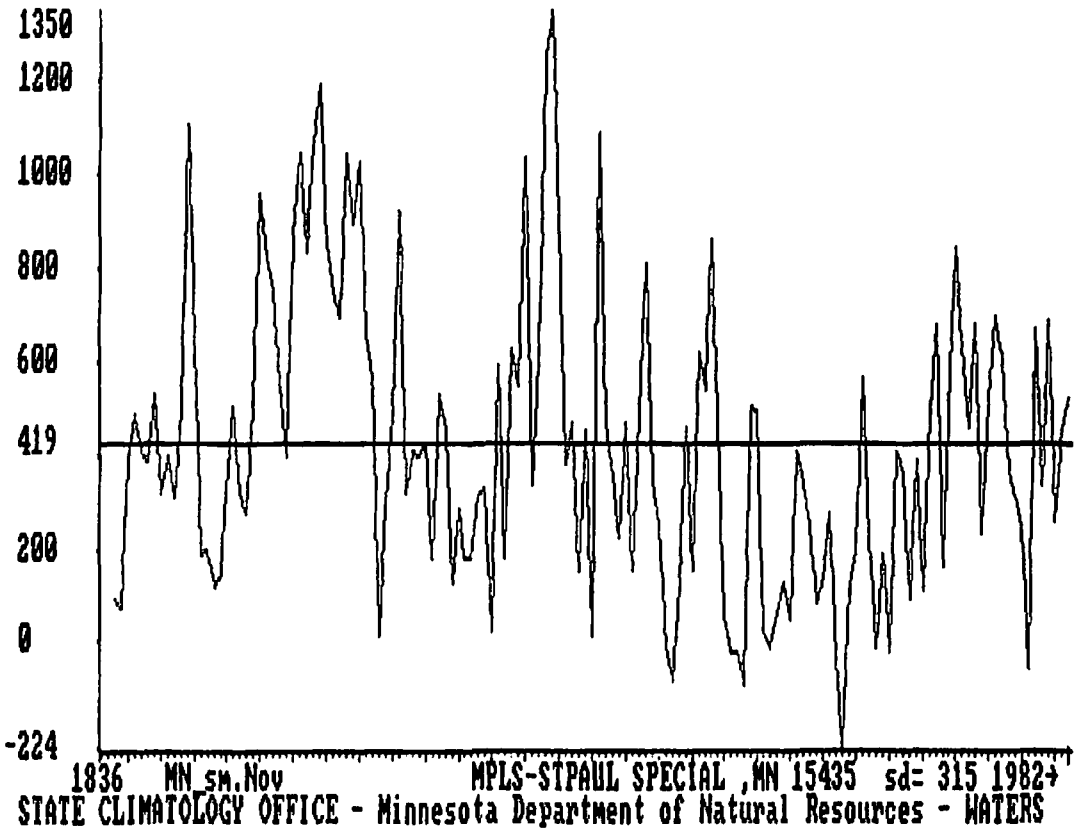

Figure 18.

THE TWIN CITY TEMPERATURE RECORD AND CLIMATIC STABILITY

L.G. Baker and D.L. Buschy

That climate is constantly changing is sometimes forgotten, and thus it is assumed to be approximately or absolutely constant. Even those of us who accept the dynamic aspect of climate sometimes forget the degree of change that has occurred in the recent past. The variation in precipitation at Minneapolis-St. Paul has already been shown in Fig. 1. In that figure the long curved line represents the general trend line with the annual variations suppressed. The temperature variation based upon the long-term Twin City record, 1820-1983, also shows marked variations, Fig. 19. A 30-year running average is shown. Two quite dramatic changes in direction of the temperature curve are shown. The temperature was declining until about 1890 when another change took place. This was an upward trend that reached a maximum in about 1960, which was succeeded by a decrease that has brought the mean down to about what it was in the 1930's.

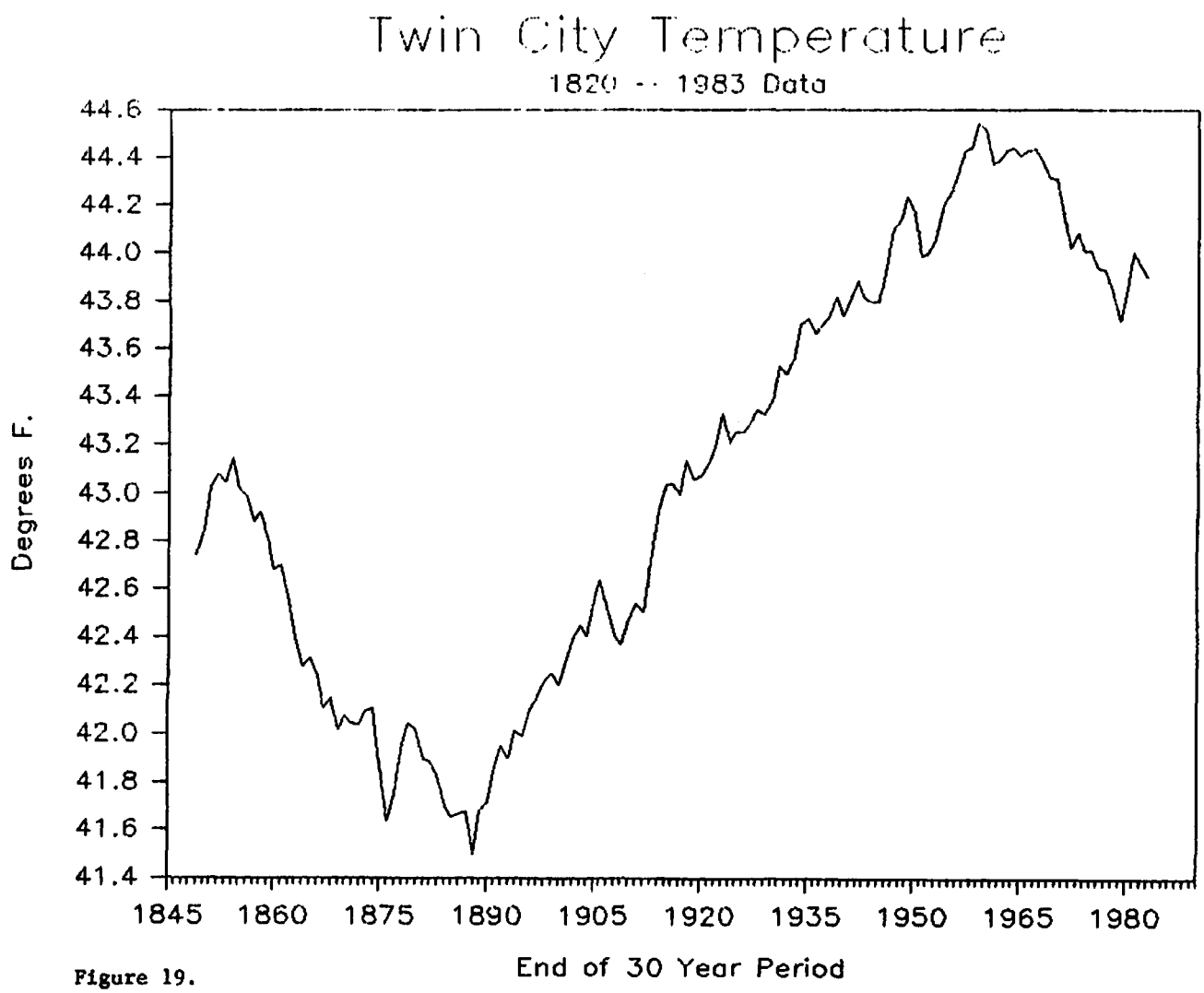

Figure 19.

Climatic anomalies (variations that appear to be out of the ordinary, an unusual event) are often difficult to pin down and verify. Some seem to be more or less legendary and might be termed "old wives' tales". Others are truly unusual events - or at least events that seem to be out of order. One is Indian summer, which is a real event that does elude a precise and quantitative definition. It does not occur every year and, of course, its duration varies from year to year. Nevertheless its occurrence is frequent enough that it is a recognized feature. Another event that has been difficult to prove but remains as something that we all seem to have heard of is the so-called January thaw. However, to be certain as to its occurrence (do we all agree on its time of occurrence: early, middle, or late January?) we must be able to define it before we can look for it in our records.

We did not have the "January thaw" in mind when we were calculating the mean daily temperature at the St. Paul campus weather station. When analyzing the 1963-1983 temperature record a marked temperature increase of about 7°F was noted centered on January 21. This is shown in Fig. 20. The same very noticeable feature was found in the Minneapolis-St. Paul airport record for the same period. In order to determine the confidence that could be placed in our finding we analyzed the Minneapolis-St. Paul record decade by decade for the 1891-1980 period. The "January thaw" could be observed in four of the nine decades. So it would appear that the "January thaw" remains an ephemeral feature in terms of its predictability. Upon occasion it apparently can be a strong and noticeable feature, but it remains inconstant and unpredictable in its appearance.

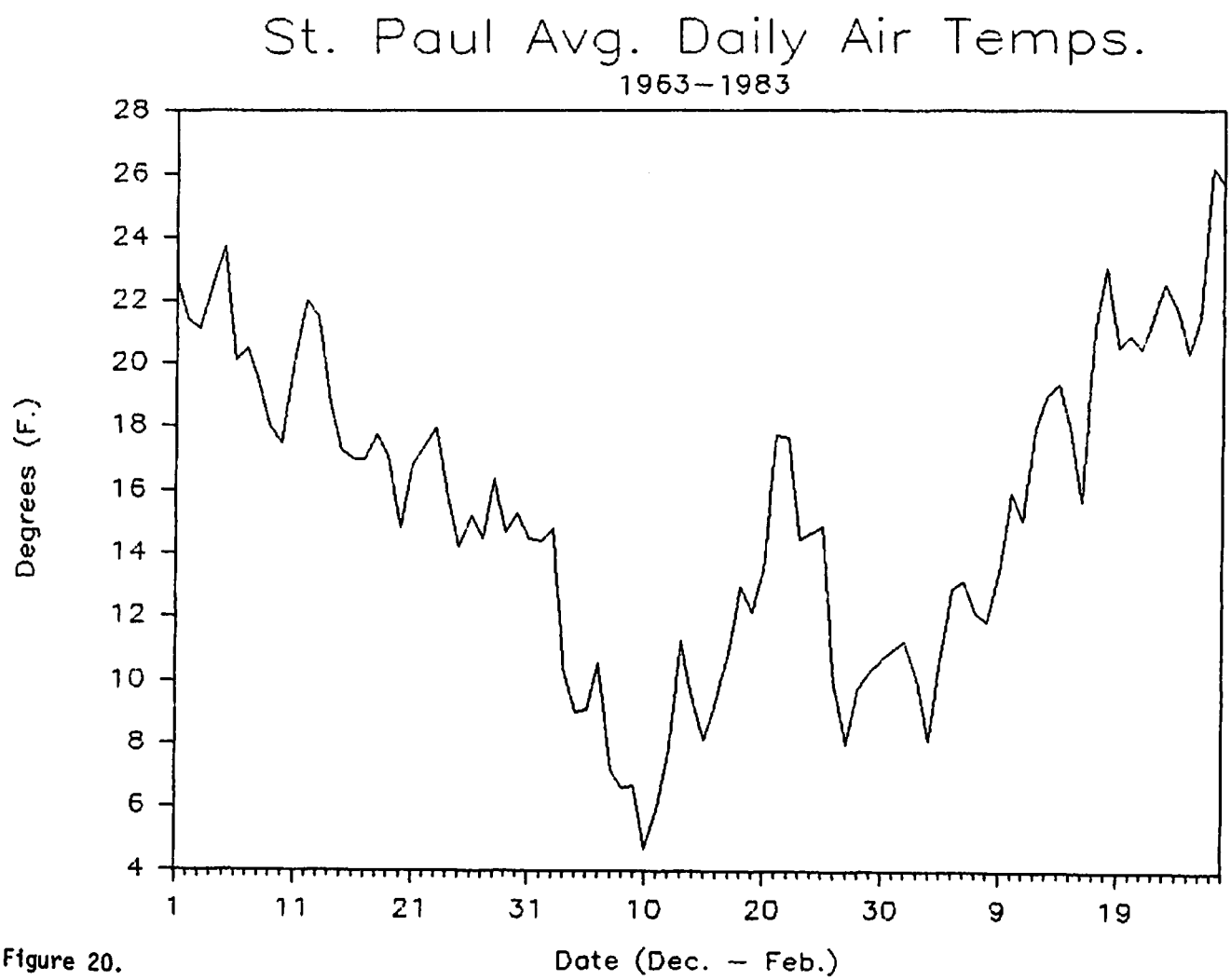

Figure 20.

AGRICULTURAL YEAR PRECIPITATION, SEPT. 1983 - AUG. 1984
E.L. Kuehnast and D.G. Baker

Based upon the long-term Lamberton soil moisture study it has become evident that the 12-month precipitation period of interest to Minnesota agriculture is not January-December, but it is September-August. This is because the soil moisture reached its minimum in late August but beginning in September the soil moisture reservoir begins to be recharged. This surplus then is not used until the next crop season. Thus the precipitation of importance to the 1984 crop was the precipitation which fell between September 1983 and August 1984.

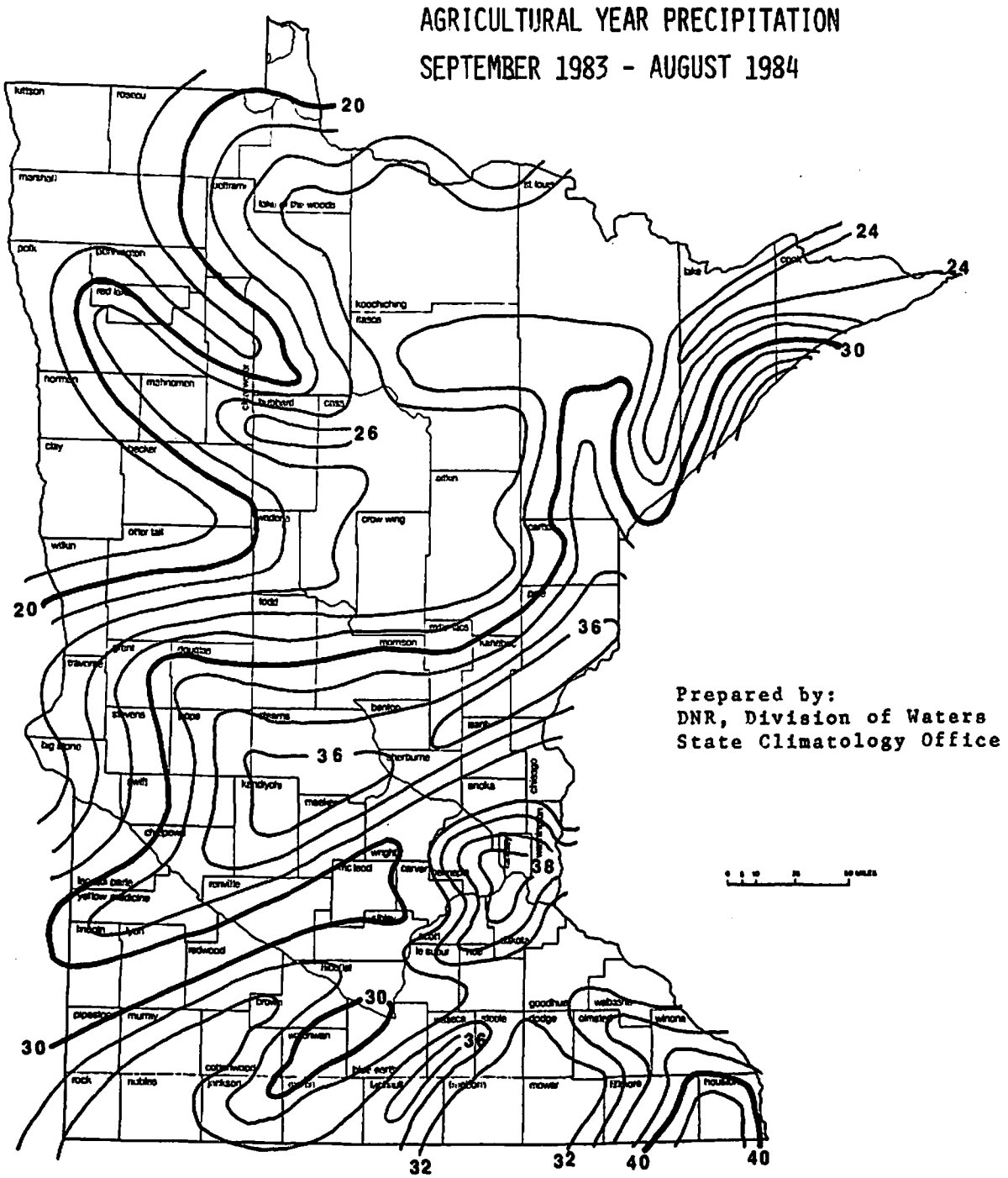

Figure 21.

It is evident from Figs. 21 and 22, which show the total annual precipitation and the departure from normal, respectively, that the southern half of the state was well supplied. Except for a small area over Waterman County in south-central Minnesota the departures from normal ranged all the way up to 8 to 10 inches in three different areas: one in the extreme southeast corner, another centered over the Twin City metropolitan area, and a third running in a narrow band from Kandiyohi County northeast to southern Pine County.

Below precipitation occurred in a large part of the northern half of the state. The driest was a small area in Pennington, Clearwater, and Beltrami counties in the northwest where the departure was at least 4 inches.

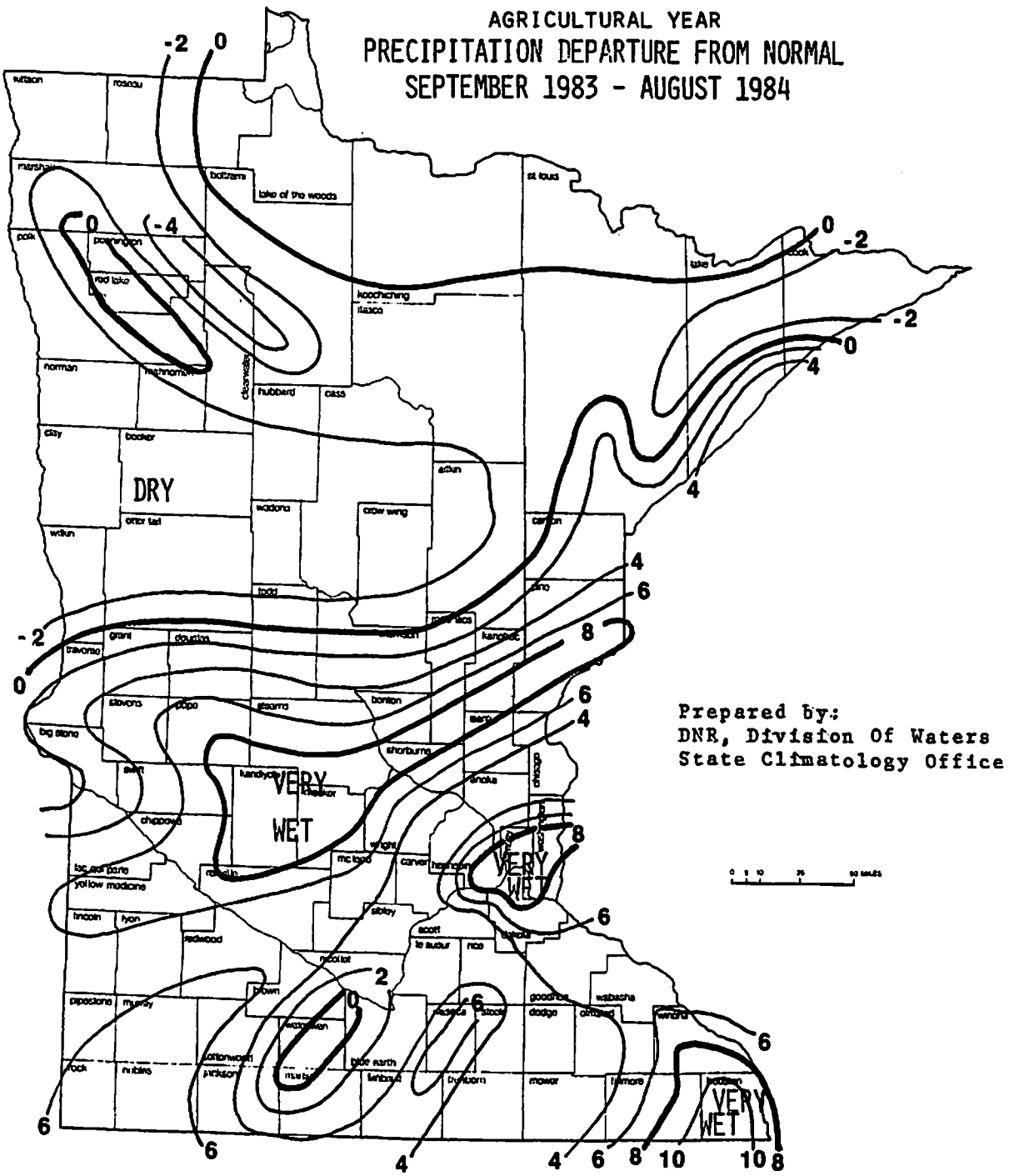

Figure 22.

SOIL MOISTURE SITUATION, SPRING 1985

E.L. Kuehnast and D.G. Baker

This report is from a mathematically modeled soil moisture analysis that is based on precipitation data. The model estimates the amount of plant available water that is contained within a 5 foot column of medium to fine textured soil. The indicated results should be adjusted according to whether the actual soil within a given area can hold more (a heavy or clay soil) or less (a light or sandy soil) than the basic 10 inches.

Areas with 10 inches or more of soil moisture in Fig. 23 are considered to be at or near their maximum water holding capcity. Soils in the 8 to 10 inch areas will be near maximum capacity with normal spring rains. Thus, all of Minnesota except the northwest is expected to have soils at their maximum capacity this spring. The areas with normal to slightly above normal soil moisture conditions are Kittson, Marshall, Pennington and Clay and parts of Roseau, Red Lake, Polk, Norman and Wilken counties.

The difference between the spring of 1984 versus 1985 is that last year the soils did not freeze because of the exceptionally heavy early snow cover. Thus the soil water from the upper layers percolated into the sub-soils all winter (W.W. Nelson, University of Minnesota, Southwest Experiment Station, stated that the "drainage tiles ran all winter"). This year is almost the reverse with little to no snow cover through December and minimum snow cover into February. This has resulted with deep frost depths of more thatn 24 inches across the state by February 1, 1985. Within the wet frozen soils there can be no percolation and most of the snow melt water and even the rains that may occur during snow melt will be lost as runoff. As a result there will be little change in the soil moisture conditions between the time of soil freeze-up and this spring's thaw period.

This is the fourth spring in a row, as a whole, across Minnesota there will be high soil moisture conditions. The question is, what affect does this have on spring planting? The mean date in Minnesota when 50% of the corn was planted in the last 10 years was the 13th of May. The five wet springs of the last 10 years were 1978, 1979, 1982, 1983 and 1984 and the 50% corn plant dates for Minnesota were May 16, May 23, May 13, May 18, May 17, respectively. (All planting dates - Federal Crop Reporting Service). Interpretation of these data show an average of about 5 days delay in planting, which also extended the maturity date about 5 days from 20th September to about the 25th of September. By extending the maturity 5 days it approximated 2 to 3% additional corn moisture at harvesting.

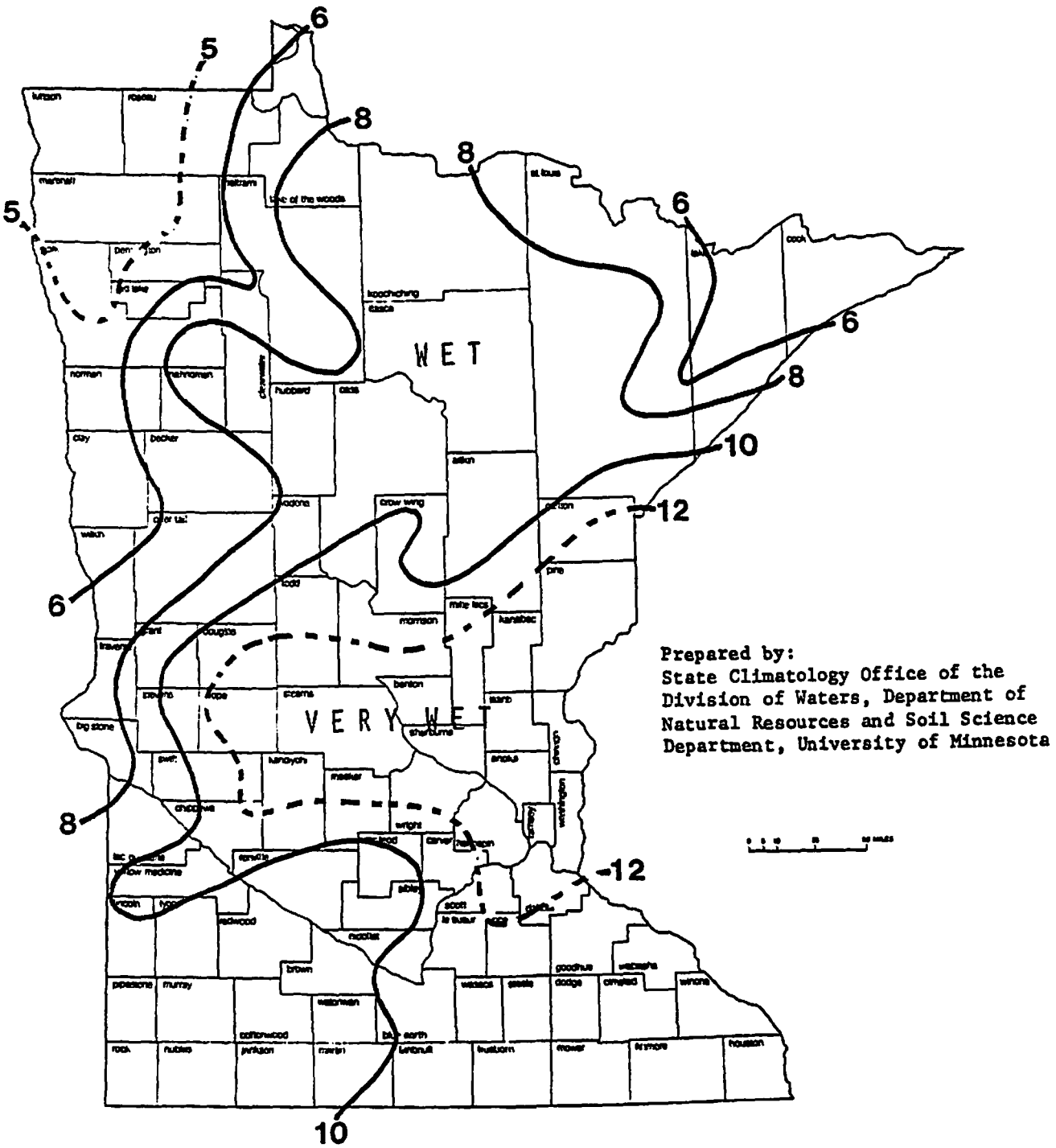

Figure 23. Plant available soil moisture on November 1, 1984 expressed in inches for the top five feet of medium to fine textured soils. Data derived from a soil moisture model based on precipitation data only.

INFLUENCE OF NITROGEN FORM, NITROGEN RATE, TIMING OF NITROGEN APPLICATION AND NITRIFICATION INHIBITORS FOR IRRIGATED CORN - BECKER, MN 1984

G.L. Malzer and T. Graff

Nitrogen management on the coarse textured irrigated soils of Minnesota is a major decision that all corn growers must make in their production system. Nitrogen management includes many aspects of nitrogen fertilization such as rates, forms, methods, times, equipment, and additives. Nitrogen fertilizer application is an essential component for top yields on these coarse textured soils, and many times the producer does not have the flexibility in nitrogen management that a producer on a finer textured soil might have. The use of nitrification inhibitors under irrigation also presents some new nitrogen management techniques that should be considered. The most common method for application of nitrification inhibitors is with simultaneous application of anhydrous ammonia. Under irrigation, nitrogen application may take place in several manners, ranging from one single application to multiple application, which may be facilitated through the irrigation water. With such management systems a variety of fertilizer nitrogen forms may be utilized. These management alternatives often add to the cost of production and require a reasonable amount of timeliness to avoid yield reductions. A new trial was established in 1982 to evaluate the significance of nitrogen rates, nitrogen form, timing of nitrogen application and the use of nitrification inhibitors for irrigated corn production.

Experimental Procedures

An experiment consisting of 25 treatments, with four replications was arranged in a randomized complete block design and established at the Sand Plain Research Farm near Becker, Minnesota. Variables in the experiment consisted of three nitrogen rates (0, 84, 168 kg/ha), three nitrogen sources (anhydrous ammonia, urea and 28% nitrogen solution), two types of application (preplant or sidedress at 10-leaf growth stage) and three nitrification inhibitors (none, N-Serve and DCD). Due to the different types and rates of material utilized, the experiment was not conducted in a complete factorial arrangement. Modifications include: 1) Nitrification inhibitor treatments were applied only with preplant N applications; 2) only 28% N solutions and anhydrous ammonia were applied as sidedress N application; 3) N-Serve applications were made at 0.56 kg/ha rate of application; 4) the DCD treatments were applied as a percentage of the total N applied. Urea and 28% N solution were applied at rates of 10% DCDN while anhydrous ammonia was applied at a rate of 2.5% and 5% N as DCD. Urea was supplied by SKW containing 10% DCDN, applications of DCDL were made to 28% N solution and DCDG to anhydrous ammonia to obtain the appropriate concentration of DCDN.

Prior to planting, broadcast application of potassium-magnesium sulfate (336 kg/ha 0-0-22), potassium (252 kg/ha 0-0-60), and phosphorus (112 kg/ha 0-46-0) were made and incorporated by plowing. Nitrogen applications were made prior to planting (May 2nd) and at the 10-leaf stage of growth (June 21st). Corn (Pioneer 3906 - 95 relative maturity) was planted on May 3rd in .76 m rows at a population of 75,800 seeds/ha. Starter fertilizer was applied at the rate of 185 kg/ha 8-10-30 side banded at planting. A tank mix of Atrazine (2.24 kg/ha) and Lasso (2.24 kg/ha) was applied on May 4th for weed control. The insecticide Lorsban was applied through the irrigation system on July 11th at the rate of 8.12 kg/ha for corn bore control.

Leaf samples from opposite and below the ear at mid-silking were obtained on July 19th, dried and analyzed for Kjeldahl nitrogen. Total dry matter production and final yields were determined on September 19th by hand harvesting 11.6 m^2 of plot area. Ears were separated from the stalks, field weights of each obtained, and samples removed for moisture and nitrogen determination. Grain yields were adjusted to 15.5% moisture.

The irrigation program was started on June 28th and continued through September 5th with a total of 31.4 cm being applied through irrigation. An additional 46.2 cm of water was obtained during the growing season as rainfall. Large rainfall events were received in mid-June and were responsible for significant leaching of nitrate-N especially with some of the treatments applied early in the season.

General Results

The experimental results and statistical analysis are presented in Tables 1 and 2. Due to the incomplete factorial nature of the treatments the statistical analysis was conducted utilizing several different combinations of the treatments. The different methods included: 1) mean

comparison of the 25 treatments, and factorial combinations including 2) two nitrogen rates with three nitrogen forms with and without N-Serve, 3) two N rates with two N forms applied at two different times of application, 4) two N rates with four nitrification inhibitor treatments applied with anhydrous ammonia, and 5) two N rates with three nitrification inhibitor treatments with urea.

The information included in Tables 1 and 2 present information regarding grain, stover, and total dry matter production as well as N concentrations within the plant parts and N removal. This brief discussion will include evaluation of only grain yields.

The leaching losses of nitrate-N associated with many of the early spring N applications were extremely severe at this location in 1984. This is primarily the result of the major precipitation event that occurred approximately five weeks after the early N applications. This time period allowed for substantial nitrification of ammonium-N to nitrate-N so relatively large quantities of nitrate were lost by leaching. The extent of N loss on yield reduction can be evaluated by comparing the yields associated with preplant N applications with treatments applied at the 10-leaf stage of growth.

Nitrogen rate - Grain yields was significantly (.05) increased up through the highest rate of N application (168 kg/ha). This would be expected since the highest N rate is slightly lower than the currently recommended rate of application. The factorial combinations for grain yield indicated significant interactions for rate x form, rate x time, rate x inhibitor, and rate x form x time. The number of interactions reflect the complexity of nitrogen rate as a component of nitrogen management. The rate x form interaction suggests that yields obtained with urea and 28% N solution were reduced dramatically at both N rates while anhydrous ammonia did not reflect as much N loss at the higher rate of N application. The rate x time of application interaction suggested that N losses were more severe at the low N rate than at the higher N rate. This would suggest that the conversion of ammonium-N to nitrate-N probably took place faster under the lower rate of N application. The N rate x inhibitor interaction would suggest that DCD performed better across N rates than did N-Serve. N-Serve demonstrated yield increases at the higher N rate, but provided minimal influence at the low N rate. The inhibitor DCD provided yield increases at both N rates.

Nitrogen Form - When nitrogen losses are minimal, different N fertilization sources would tend to provide similar results. However, in 1984 leaching losses due to mid-season precipitation were very severe. Under these conditions anhydrous ammonia was superior to the other nitrogen sources. Broadcast forms of fertilizer N such as urea and 28% solution produced similar results. Although urea is 100% ammonium forming, it is possible that differential nitrification due to method of application (broadcast incorporated vs. injected ammonia) coupled with the mid-season leaching events were responsible for the observed results.

Nitrification inhibitors - All nitrification inhibitors tested provided significant positive yield increases. At the low N rate DCD was the most effective inhibitor across all three N sources tested. At the higher N rate N-Serve and DCD provided similar results when used with anhydrous ammonia (both were effective in reducing N loss). The product DCD was clearly superior to N-Serve at the higher N rate when used with urea and 28% N solution.

Table 1. Influence of N form, N rates, nitrification inhibitors, and timing of application on yield grain, and dry matter production on irrigated corn Becker, MN - 1984.

Treatments				Grain Yields		Dry Matter Production		
N-Rates	N-Form	Inhibitor	Time			Grain	Stover	Total
kg/ha				Bu/A	mt/ha	----------mt/ha----------		
Control	------	---------	-----	57.6	3.62	3.04	3.00	6.04
84	AA	---------	PPL	98.3	6.18	5.20	5.35	10.57
84	AA	---------	10-lf	147.0	9.24	7.79	5.80	13.59
84	28%	---------	PPL	69.8	4.34	3.69	3.33	7.03
84	28%	---------	10-lf	99.1	6.23	5.24	4.75	9.99
84	UREA	---------	PPL	65.4	4.11	3.45	3.65	7.12
84	AA	N-Serve	PPL	92.6	5.82	4.90	5.06	9.97
84	28%	N-Serve	PPL	71.7	4.51	3.78	4.03	7.84
84	UREA	N-Serve	PPL	77.7	4.89	4.12	4.48	8.60
168	AA	---------	PPL	135.3	8.51	7.17	6.58	13.75
168	AA	---------	10-lf	169.9	10.68	9.00	6.27	15.27
168	28%	---------	PPL	72.9	4.58	3.85	3.92	7.77
168	28%	---------	10-lf	148.1	9.31	7.84	5.87	13.73
168	UREA	---------	PPL	58.3	3.67	3.09	3.06	6.16
168	AA	N-Serve	PPL	161.1	10.13	8.53	7.10	15.63
168	28%	N-Serve	PPL	75.5	4.75	3.99	4.55	8.55
168	UREA	N-Serve	PPL	88.4	5.56	4.68	5.67	10.35
84	UREA	10% DCDN	PPL	96.1	6.04	5.08	5.39	10.50
84	AA	2.5% DCDG	PPL	125.8	7.91	6.63	6.56	13.24
84	AA	5% DCDG	PPL	129.3	8.13	6.85	6.65	13.51
84	28%	10% DCDL	PPL	93.4	5.87	4.95	5.08	10.06
168	UREA	10% DCDN	PPL	176.6	11.11	9.34	7.84	17.20
168	AA	2.5% DCDG	PPL	166.7	10.48	8.82	7.21	16.04
168	AA	5% DCDG	PPL	164.8	10.36	8.74	7.43	16.19
168	28%	10% DCDL	PPL	104.0	6.35	5.51	5.71	11.22
P-Value				99	99	99	99	99
BLSD (.05)				13.2	0.83	0.69	0.74	1.32
Factorial Arrangement (N-Rate X N-Form X Inhibitor)								
N-Rate								
84				79.3	4.99	4.19	4.32	8.53
168				98.6	6.20	5.21	5.15	10.63
P-Value				99	99	99	99	99
N-Form								
AA				121.8	7.66	6.45	6.02	12.47
28%				72.5	4.56	3.83	3.96	7.79
UREA				72.4	4.55	3.83	4.21	8.06
P-Value				99	99	99	99	99
Inhibitor								
Control				83.3	5.23	4.41	4.32	8.73
N-Serve				94.5	5.94	4.99	5.15	10.17
P-Value				99	99	99	99	99
Rate X Form				99	99	99	97	99
Rate X Inhibitor				98	98	98	96	98
Form X Inhibitor				93	93	93	99	97
Rate X Form X Inhibitor				84	84	84	82	78

Table 1 continued on next page

Table 1 continued

Treatments N-Rate	N-Form	Inhibitor	Time	Grain Yield		Dry Matter Production Grain	Stover	Total
kg/ha				Bu/A	mt/ha	----------mt/ha----------		
Factorial Arrangement (N-Rate X N-Form X Time)								
N-Rate								
84				103.6	6.51	5.49	4.82	10.30
168				131.5	8.27	6.97	5.67	12.63
P-Value				99	99	99	99	99
N-Form								
AA				137.6	8.65	7.28	6.00	13.30
28%				97.5	6.13	5.15	4.46	9.63
P-Value				99	99	99	99	99
Time								
PPL				94.1	5.92	4.97	4.79	9.79
10-lf				141.0	8.87	7.46	5.67	13.15
P-Value				99	99	99	99	99
Rate X Form				39	39	39	2	20
Rate X Time				95	95	95	16	68
Form X Time				83	83	83	99	99
Rate X Form X Time				99	99	99	83	99
Factorial Arrangement (N-Rate X Inhibitor with AA)								
N-Rate								
84				111.1	6.99	5.91	5.91	11.83
168				157.0	9.87	8.31	7.08	15.41
P-Value				99	99	99	99	99
Inhibitor								
Control				116.8	7.34	6.18	5.96	12.16
N-Serve				126.9	7.98	6.72	6.07	12.81
2.5% DCDG				146.3	9.20	7.75	6.88	14.45
5% DCDG				147.1	9.25	7.79	7.03	14.85
P-Value				99	99	99	99	99
DLSD (.05)							0.65	
N-Rate X Inhibitor				99	99	99	83	97
Factorial Arrangement (N-Rate X Inhibitor with Urea)								
N-Rate								
84				79.7	5.01	4.21	4.50	8.74
168				107.8	6.78	5.71	5.53	11.24
P-Value				99	99	99	99	99
Inhibitor								
Control				61.8	3.89	3.27	3.36	6.63
N-Serve				83.1	5.23	4.39	5.06	9.47
10% DCDN				136.3	8.57	7.21	6.63	13.86
P-Value				99	99	99	99	99
N-Rate X Inhibitor				99	99	99	99	99

Table 2. Influence of N form, N rates, nitrification inhibitors, and timing of N application on leaf N content grain N content and total N removal by irrigated corn. Becker, MN - 1984

Treatments				N-Concentration			N-Removal		
N-Rates	N-Form	Inhibitor	Time	Leaf	Grain	Stover	Grain	Stover	Total
kg/ha				----------%----------			----------kg/ha---------		
Control	------	---------	-----	1.39	1.22	0.50	37.4	15.0	52.4
84	AA	---------	PPL	1.91	1.11	0.39	58.0	21.3	79.4
84	AA	---------	10-lf	2.83	1.29	0.53	100.5	30.9	131.5
84	28%	---------	PPL	1.49	1.20	0.49	44.7	16.5	61.1
84	28%	---------	10-lf	2.34	1.13	0.46	59.6	22.2	81.8
84	UREA	---------	PPL	1.39	1.08	0.43	37.5	15.8	53.4
84	AA	N-Serve	PPL	2.00	1.23	0.43	60.6	21.7	82.3
84	28%	N-Serve	PPL	1.20	1.11	0.41	42.2	16.6	58.9
84	UREA	N-Serve	PPL	1.39	1.18	0.43	49.0	19.5	68.6
168	AA	---------	PPL	2.50	1.21	0.47	86.9	31.6	118.5
168	AA	---------	10-lf	2.89	1.54	0.55	140.0	34.7	173.8
168	28%	---------	PPL	1.48	1.12	0.44	43.0	17.1	60.2
168	28%	---------	10-lf	2.64	1.39	0.61	109.3	35.9	145.4
168	UREA	---------	PPL	1.49	1.22	0.49	37.9	15.2	53.3
168	AA	N-Serve	PPL	2.60	1.26	0.54	108.4	38.5	146.9
168	28%	N-Serve	PPL	1.56	1.20	0.41	47.9	18.6	66.6
168	UREA	N-Serve	PPL	1.73	1.09	0.39	51.3	22.6	73.8
84	UREA	10% DCDN	PPL	1.55	1.16	0.41	59.5	22.5	80.3
84	AA	2.5% DCDG	PPL	2.22	1.22	0.41	81.7	26.7	108.5
84	AA	5% DCDG	PPL	2.35	1.23	0.43	85.5	28.6	114.3
84	28%	10% DCDL	PPL	1.15	1.19	0.41	58.6	21.0	79.6
168	UREA	10% DCDN	PPL	2.61	1.35	0.49	126.7	39.3	165.9
168	AA	2.5% DCDG	PPL	2.80	1.33	0.41	118.2	29.4	147.7
168	AA	5% DCDG	PPL	2.58	1.39	0.49	121.5	37.1	158.7
168	28%	10% DCDL	PPL	1.73	1.11	0.43	61.8	24.5	86.3
P-Value				99	99	99	99	99	99
BLSD (.05)				0.28	0.10	0.09	11.2	6.3	14.8
Factorial Arrangement (N-Rate X N-Form X Inhibitor)									
N-Rate									
84				1.56	1.15	0.43	48.7	18.6	67.3
168				1.89	1.18	0.46	62.6	23.8	86.6
P-Value				99	86	94	99	99	99
N-Form									
AA				2.25	1.20	0.46	78.5	28.2	106.8
28%				1.43	1.15	0.43	44.4	17.2	61.7
UREA				1.50	1.14	0.44	44.0	18.2	62.3
P-Value				99	92	67	99	99	99
Inhibitor									
Control				1.71	1.16	0.45	51.4	19.6	71.0
N-Serve				1.74	1.18	0.43	59.9	22.9	82.9
P-Value				43	62	80	99	99	99
Rate X Form				98	48	99	99	99	99
Rate X Inhibitor				89	43	23	94	89	95
Form X Inhibitor				73	87	99	94	89	95
Rate X Form X Inhibitor				49	99	90	76	35	62

Table 2 continued on next page

Table 2 continued

Treatments				N-Concentration			N-Removal		
N-Rate	N-Form	Inhibitor	Time	Leaf	Grain	Stover	Grain	Stover	Total
				----------%----------			----------kg/ha--------		
Factorial Arrangement (N-Rate X N-Form X Time)									
N-Rate									
84				2.14	1.18	0.47	65.7	22.7	88.5
168				2.38	1.31	0.52	94.5	29.9	124.5
P-Value				99	99	95	99	99	99
N-Form									
AA				2.53	1.29	0.49	96.1	29.7	125.8
28%				1.99	1.21	0.50	64.2	23.0	87.1
P-Value				99	99	40	99	99	99
Time									
PPL				1.84	1.16	0.45	58.1	21.6	79.8
10-lf				2.68	1.34	0.54	102.1	30.9	133.0
P-Value				99	99	99	99	99	99
Rate X Form				69	85	1	89	6	80
Rate X Time				46	99	82	99	63	99
Form X Time				95	98	54	74	87	9
Rate X Form X Time				98	89	98	99	98	99
Factorial Arrangement (N-Rate X Inhibitor in AA)									
N-Rate									
84				2.12	1.20	0.41	71.4	24.6	96.2
168				2.62	1.30	0.48	108.7	34.2	142.9
P-Value				99	99	97	99	99	99
Inhibitor									
Control				2.20	1.16	0.43	72.5	26.4	99.0
N-Serve				2.30	1.25	0.48	84.4	30.1	114.6
2.5% DCDG				2.51	1.28	0.41	99.9	28.1	128.1
5% DCDG				2.46	1.31	0.46	103.5	32.9	136.5
P-Value				92	99	81	99	80	99
N-Rate X Inhibitor				62	54	48	71	82	80
Factorial Arrangement (N-Rate X Inhibitor with Urea)									
N-Rate									
84				1.45	1.14	0.42	48.7	19.3	68.1
168				1.94	1.22	0.46	72.0	25.6	97.7
P-Value				99	98	94	99	99	99
Inhibitor									
Control				1.44	1.15	0.46	37.7	15.5	53.4
N-Serve				1.56	1.13	0.41	50.2	20.9	71.2
10% DCDN				2.08	1.25	0.45	93.1	30.9	123.9
P-Value				99	98	96	99	99	99
N-Rate X Inhibitor				99	99	97	99	99	99

INFLUENCE OF BORDER ROWS ON TPF YIELD AND NUTRIENT UTILIZATION OF SIX CORN HYBRIDS

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The agricultural producer is becoming increasingly aware of the importance of management for maximum economic return. With the severe economic pressures producers are currently encountering, the tendency is to cut back on some of the variable inputs used in crop production. The lowering of production cost is a viable consideration in increasing economic return, as long as decreased production does not offset the benefit from decreasing the production cost. An alternative to the above approach is improved management. If a producer can obtain higher yields with relatively little change in inputs, higher economic returns would result. Management for higher production and at the same time highest economic return is very complicated and it takes a top manager to evaluate all of the alternatives which are available. A trial was established at the Sand Plain Research Farm near Becker, Minnesota to evaluate the ability of six corn hybrids to respond to row competition in a "non-limiting" production environment.

Experimental Procedure

To examine the influence of border rows, hybrids were randomly allocated into experimental plots 45 ft. long and 20 ft. wide. Each experimental plot was split to allow for two hybrids. Four rows (30" spacing) of the randomly selected hybrid were planted to the right or left of the center split. Enough experimental plots were established to allow for the six hybrids with four replications to be established in a complete block arrangement. The experimental area therefore looked like eight rows of corn (two hybrids) separated from the next eight rows by 10 ft. of non-planted area. Each row within the experimental plot was treated as an individual experimental unit and evaluated separately. Row position was numbered 1-4 with 1 being closest to the non-planted area. The corn hybrids tested included DeKalb DK447, Northrup King PX9242, Pioneer 3906 (94-95 day relative maturity - R.M.), Jacques JX77 (100 day R.M.), Funks G4342 and Pioneer 3732 (105 day R.M.).

Prior to planting, potassium magnesium sulfate (300 #/a 0-0-22), phosphorus (80 #/a 0-46-0), and potassium (250 #/a 0-0-60) was broadcast and incorporated by plowing. Nitrogen was applied in split applications as anhydrous ammonia and 28% nitrogen solution (UAN). The first N application was made on May 2nd (prior to planting) of 175 #N/A as anhydrous ammonia with N-Serve (0.5 #ai/a). Three more applications of nitrogen were applied through the irrigation system by UAN solution. Applications of UAN were made on June 27th (20 #N/a), July 5th (50 #N/a), and July 31st (30 #N/a). These application times would correspond to the 9-10 leaf vegetative stage, pretassel, and post pollination. A portion of the N at the pretassel application (20%) was applied as ammonium sulfate rather then UAN.

Corn was planted on May 2nd in 30 inch rows at a population of 34,800 seeds/a. in a north to south orientation. Weed control was accomplished with a preemergence application of Atrazine (2 #ai/a) plus Lasso (2 #ai/A). To minimize corn bore damage, Lorsban was applied through the irrigation system on July 11th.

Leaf samples from opposite and below the ear at mid-silking were taken on July 19th. Samples were dried ground, and analyzed for elemental concentrations. Grain yields and total dry matter production was measured on September 24th. Samples were obtained by hand harvesting the whole plot area. Ears were separated from the stalks and separate field weights, and samples obtained from each portion (grain and stover) for moisture determination and elemental concentrations. Grain yields were adjusted to 15.5% moisture.

The irrigation program was started on June 26th and continued through August 30th with a total of 10.05 inches of water being applied through irrigation. An additional 19.42 inches of water was obtained during the growing season as rainfall.

General Results

A summary of the yield components and nutrient utilization characteristics are presented in Tables 1-7. As a general statement, both hybrid and row position influenced yield and nutrient uptakes. It is interesting to note that the yield components (Table 1) were influenced by hybrid and row position but there was no interaction. This suggests that all varieties reacted in a similar manner as row position changed. This relationship was not observed with most of the nutrient utilization data. Although hybrid and row position were important, there was in most cases a highly significant interaction. This would suggest that the hybrids did not respond equally to the change in

competition placed upon them by row position. Although this study did not isolate why these interactions existed, it does pose some interesting questions related to the effectiveness of a hybrid in taking up nutrients at various levels of competition.

Because of the volume of data collected and the number of additional calculations that can be made, it is impossible to completely interpret all of the data. With respect to grain yield, Funks G4342, Pioneer 3732 and DeKalb DK477 were among the highest yields while Jacques JX77, Pioneer 3906 and Northrup King PX9242 were somewhat lower. Although longer relative maturity hybrid are normally associated with high yields, this trend was not observed for all hybrids. DeKalb DK477 which was among the highest yielding had the lowest relative maturity. The yields from all hybrids responded to row position in the same manner, and there was no influence of row position on any yield parameter past the first row (outside).

Unlike the yield parameters, nutrient utilization characteristics of the hybrids did not respond to row position in the same manner (significant interactions). Pioneer 3732 in row position one had the highest total P uptake, and P uptake decreased substantially with increasing row number. Other hybrids exhibited little or no variation in total P uptake due to row position. Although Pioneer 3906 in row position one had the highest total K uptake, the highest yielding hybrid, Funks G4342, had the highest total K uptake across rows. This reflects the fact that row position had less influence on K uptake with Funks G4342 than with any other hybrid.

Table 1. Leaf N content, grain yield, dry matter production, grain N content and nitrogen removal by six corn hybrids Becker MN. 1984.

Treatments	Row No	Grain Yield	Dry Matter Production Grain	Stover	Total	N-Conc. Grain	Stover	N-Removal Grain	Stover	Total
		Bu/A	---T/A---			---%---		---#/A---		
Funks G4342	1	251.9	5.96	4.05	10.00	1.32	0.62	157.3	50.4	207.7
Funks G4342	2	203.8	4.82	3.54	8.37	1.30	0.65	126.0	46.4	172.4
Funks G4342	3	204.4	4.84	3.57	8.42	1.26	0.69	122.1	49.2	171.3
Funks G4342	4	217.3	5.14	3.58	8.72	1.22	0.59	125.8	42.5	168.3
Northrup King PX 9242	1	205.6	4.86	3.53	8.47	1.69	0.77	165.1	55.4	220.5
Northrup King PX 9242	2	182.2	4.31	3.27	7.59	1.49	0.69	129.1	45.5	174.6
Northrup King PX 9242	3	175.9	4.16	3.07	7.24	1.41	0.80	117.2	50.0	167.3
Northrup King PX 9242	4	179.6	4.25	3.42	7.67	1.27	0.72	108.1	49.6	157.8
Dekalb DK477	1	241.3	5.70	3.75	9.46	1.44	0.77	165.4	58.2	223.7
Dekalb DK477	2	197.1	4.66	3.07	7.73	1.33	0.63	125.0	38.6	163.7
Dekalb DK477	3	198.2	4.68	3.04	7.74	1.34	0.65	125.8	39.9	165.8
Dekalb DK477	4	204.7	4.84	3.12	7.12	1.22	0.61	118.8	38.4	157.2
Jacques JX77	1	214.8	5.08	3.69	8.77	1.36	0.69	138.9	51.3	190.2
Jacques JX77	2	193.2	4.57	3.01	7.58	1.32	0.68	121.1	41.0	162.1
Jacques JX77	3	192.6	4.55	3.01	7.57	1.29	0.70	118.3	42.2	160.6
Jacques JX77	4	191.3	4.52	2.89	7.42	1.26	0.67	114.2	39.1	153.3
Pioneer 3732	1	249.1	5.89	4.35	10.24	1.24	0.82	146.8	71.8	218.7
Pioneer 3732	2	201.8	4.77	3.61	8.38	1.23	0.77	117.2	55.9	173.1
Pioneer 3732	3	199.9	4.73	3.77	8.50	1.21	0.71	114.6	54.2	168.8
Pioneer 3732	4	213.4	5.04	3.76	8.80	1.16	0.66	117.6	50.3	167.9
Pioneer 3906	1	229.0	5.41	4.01	9.42	1.59	0.68	172.4	55.0	227.5
Pioneer 3906	2	189.7	4.48	3.44	7.93	1.57	0.65	141.4	45.0	186.5
Pioneer 3906	3	194.6	4.60	3.30	7.91	1.57	0.57	141.9	37.8	179.7
Pioneer 3906	4	188.9	4.47	3.34	7.81	1.36	0.59	121.5	39.9	161.4
Main Effects										
Hybrids										
Funks G4342		219.3	5.19	3.69	8.88	1.27	0.64	132.8	47.1	180.0
Northrup King PX9242		185.8	4.39	3.34	7.74	1.46	0.75	129.9	50.1	180.0
Dekalb DK477		210.3	4.97	3.24	8.22	1.33	0.67	133.7	43.8	177.6
Jacques JX77		198.0	4.68	3.14	7.82	1.31	0.68	123.1	43.4	166.6
Pioneer 3732		216.0	5.11	3.87	8.98	1.21	0.74	124.0	58.0	182.1
Pioneer 3906		200.5	4.74	3.52	8.27	1.51	0.62	144.3	44.4	188.7
P-Value		99	99	99	99	99	98	98	99	83
BLSD (.05)		7.3	0.17	0.17	0.33				4.5	
Row										
1		231.9	5.48	3.90	9.40	1.44	0.72	157.6	57.0	214.7
2		194.6	4.60	3.32	7.93	1.37	0.68	126.6	45.4	172.1
3		194.3	4.59	3.29	7.90	1.34	0.69	123.3	45.6	168.9
4		199.2	4.71	3.35	8.06	1.25	0.64	117.7	43.3	161.0
P-Value		99	99	99	99	99	99	99	99	99
BLSD).05)		5.8	0.14	0.15	0.26				3.8	7.0
Hybrids X Row		62	62	3	8	99	90	90	66	49

Table 2. The elememtal concentration of silage stover by six corn hybrids.

Treatment	Row No	N	P	K	Ca	Mg	Mn	Zn	Cu	B
		Elemental Concentration Silage Stover								
		%					ppm			
Funks G4342	1	0.62	0.05	1.57	0.46	0.27	64	23	12	14
Funks G4342	2	0.65	0.07	1.63	0.45	0.26	83	31	13	16
Funks G4342	3	0.69	0.06	1.81	0.44	0.24	90	22	10	18
Funks G4342	4	0.59	0.06	1.54	0.51	0.27	82	20	11	17
Northrup King PX 9242	1	0.77	0.07	1.44	0.41	0.26	79	26	12	15
Northrup King PX 9242	2	0.69	0.06	1.42	0.44	0.20	76	21	9	17
Northrup King PX 9242	3	0.80	0.06	1.59	0.50	0.29	79	21	12	13
Northrup King PX 9242	4	0.72	0.07	1.51	0.41	0.26	76	30	13	13
Dekalb 4DK477	1	0.77	0.06	1.83	0.44	0.25	95	23	12	15
Dekalb DK477	2	0.63	0.05	1.48	0.46	0.26	87	22	10	15
Dekalb DK477	3	0.65	0.10	1.50	0.37	0.25	76	29	14	14
Dekalb DK477	4	0.61	0.07	1.60	0.47	0.23	84	22	11	16
Jacques JX77	1	0.69	0.05	1.51	0.51	0.29	61	21	14	15
Jacques JX77	2	0.68	0.08	1.65	0.44	0.28	92	30	14	19
Jacques JX77	3	0.70	0.06	1.92	0.51	0.26	94	23	15	19
Jacques JX77	4	0.67	0.47	1.27	0.48	0.25	87	18	11	16
Pioneer 3732	1	0.82	0.07	1.38	0.40	0.28	69	30	15	15
Pioneer 3732	2	0.77	0.05	1.45	0.49	0.25	81	20	12	19
Pioneer 3732	3	0.71	0.06	1.38	0.52	0.26	89	21	13	17
Pioneer 3732	4	0.66	0.07	1.50	0.44	0.27	86	29	14	16
Pioneer 3906	1	0.68	0.05	1.84	0.46	0.27	101	20	12	17
Pioneer 3906	2	0.65	0.05	1.43	0.48	0.27	92	20	12	16
Pioneer 3906	3	0.57	0.07	1.46	0.41	0.27	79	26	14	15
Pioneer 3906	4	0.59	0.07	1.39	0.43	0.22	86	21	11	17
Main Effects										
Hybrids										
Funks G4342		0.64	0.06	1.64	0.47	0.26	80	24	11	16
Northrup King PX 9242		0.75	0.06	1.49	0.44	0.25	78	24	12	15
Dekalb DK477		0.67	0.07	1.60	0.43	0.25	85	24	12	15
Jacques JX77		0.68	0.06	1.59	0.48	0.27	83	23	14	17
Pioneer 3732		0.74	0.06	1.43	0.46	0.27	81	25	13	17
Pioneer 3906		0.62	0.06	1.53	0.45	0.26	89	22	12	16
P-Value		98	94	99	78	83	69	74	99	99
BLSD (.05)										
Row										
1		0.72	0.06	1.59	0.45	0.27	78	24	13	15
2		0.68	0.06	1.51	0.46	0.25	85	24	12	17
3		0.69	0.07	1.61	0.46	0.26	83	23	12	16
4		0.64	0.06	1.47	0.46	0.25	83	23	12	16
P-Value		99	99	99	15	96	87	29	99	99
BLSD (.05)										
Hybrids X Row		90	99	99	99	99	99	99	99	99

Table 3. The elememtal concentration of grain by six corn hybrids.

Treatment	Row No	N	P	K	Ca	Mg	Mn	Zn	Cu	B
		Elemental Concentration Grain								
		%					ppm			
Funks G4342	1	1.32	0.25	0.34	0.003	0.11	6	28	9	3
Funks G4342	2	1.30	0.30	0.39	0.002	0.14	7	27	9	4
Funks G4342	3	1.26	0.25	0.37	0.005	0.13	7	28	9	2
Funks G4342	4	1.22	0.26	0.36	0.003	0.13	6	28	9	3
Northrup King PX 9242	1	1.69	0.29	0.38	0.003	0.12	7	27	9	5
Northrup King PX 9242	2	1.49	0.32	0.38	0.004	0.15	8	32	9	4
Northrup King PX 9242	3	1.41	0.27	0.35	0.004	0.12	7	28	9	3
Northrup King PX 9242	4	1.27	0.33	0.40	0.003	0.15	7	27	9	6
Dekalb DK477	1	1.44	0.26	0.36	0.005	0.13	7	30	10	3
Dekalb DK477	2	1.33	0.26	0.36	0.003	0.13	7	28	9	3
Dekalb DK477	3	1.34	0.30	0.38	0.003	0.12	7	28	10	6
Dekalb DK477	4	1.22	0.31	0.37	0.004	0.14	8	30	10	4
Jacques JX77	1	1.36	0.26	0.38	0.004	0.12	6	28	9	2
Jacques JX77	2	1.32	0.32	0.41	0.003	0.15	8	27	9	4
Jacques JX77	3	1.29	0.28	0.39	0.004	0.15	8	32	9	3
Jacques JX77	4	1.26	0.26	0.37	0.003	0.13	7	27	9	2
Pioneer 3732	1	1.24	0.30	0.39	0.003	0.12	7	28	9	5
Pioneer 3732	2	1.23	0.28	0.38	0.004	0.14	8	30	10	3
Pioneer 3732	3	1.21	0.25	0.36	0.004	0.11	7	26	9	3
Pioneer 3732	4	1.16	0.29	0.38	0.003	0.13	7	26	10	4
Pioneer 3906	1	1.59	0.27	0.37	0.004	0.14	7	28	9	3
Pioneer 3906	2	1.57	0.28	0.39	0.003	0.14	7	25	8	5
Pioneer 3906	3	1.54	0.29	0.37	0.002	0.12	7	25	8	5
Pioneer 3906	4	1.36	0.31	0.39	0.004	0.15	9	29	9	4
Main Effects										
Hybrids										
Funks G4342		1.27	0.27	0.37	0.004	0.13	7	28	9	3
Northrup King PX 9242		1.46	0.30	0.38	0.003	0.13	7	29	9	5
Dekalb DK477		1.33	0.28	0.37	0.004	0.13	7	29	9	4
Jacques JX77		1.31	0.28	0.39	0.004	0.14	7	29	9	3
Pioneer 3732		1.21	0.28	0.38	0.003	0.13	7	27	9	4
Pioneer 3906		1.51	0.28	0.38	0.003	0.14	8	27	9	4
P-Value BLSD (.05)		99	93	87	99	89	95	98	89	99
Row										
1		1.44	0.27	0.37	0.004	0.12	7	28	9	4
2		1.37	0.29	0.38	0.003	0.14	8	28	9	4
3		1.34	0.27	0.37	0.004	0.13	7	28	9	4
4		1.25	0.29	0.38	0.003	0.14	8	28	9	4
P-Value BLSD (.05)		99	99	99	99	99	99	37	83	90
Hybrids X Row		99	93	99	99	99	99	99	5	99

Table 4. The elememtal concentration of the leaf opposite and below the ear at silking by six corn hybrids.

Treatment	Row No	N	P	K	Ca	Mg	Mn	Zn	Cu	B
		Elemental Concentration Leaf								
		%					ppm			
Funks G4342	1	2.75	0.27	2.70	0.46	0.27	80	26	11	14
Funks G4342	2	2.70	0.27	2.77	0.38	0.29	73	28	9	12
Funks G4342	3	2.71	0.27	3.01	0.41	0.24	76	26	9	16
Funks G4342	4	2.66	0.27	3.09	0.61	0.30	58	20	9	17
Northrup King PX 9242	1	2.76	0.29	2.54	0.40	0.29	72	29	10	13
Northrup King PX 9242	2	2.55	0.28	2.72	0.52	0.31	79	29	10	14
Northrup King PX 9242	3	2.74	0.27	2.73	0.43	0.26	73	24	9	13
Northrup King PX 9242	4	2.70	0.28	2.62	0.42	0.31	70	27	8	11
Dekalb DK477	1	2.69	0.26	3.03	0.37	0.23	68	24	8	13
Dekalb DK477	2	2.68	0.27	3.12	0.53	0.31	63	20	9	13
Dekalb DK477	3	2.56	0.27	2.60	0.39	0.28	67	27	8	11
Dekalb DK477	4	2.85	0.27	2.75	0.45	0.32	64	25	8	12
Jacques JX77	1	2.68	0.27	2.69	0.45	0.26	72	30	15	15
Jacques JX77	2	2.63	0.27	2.63	0.43	0.31	81	28	10	15
Jacques JX77	3	2.96	0.25	3.24	0.36	0.23	75	27	12	13
Jacques JX77	4	2.65	0.24	3.47	0.48	0.29	70	20	9	17
Pioneer 3732	1	2.49	0.27	2.60	0.37	0.29	66	29	11	13
Pioneer 3732	2	2.63	0.26	2.79	0.43	0.31	66	28	13	12
Pioneer 3732	3	2.64	0.27	2.58	0.46	0.26	85	28	14	16
Pioneer 3732	4	2.50	0.26	2.53	0.42	0.29	87	30	13	18
Pioneer 3906	1	2.74	0.24	3.02	0.38	0.24	79	27	12	15
Pioneer 3906	2	2.85	0.26	2.88	0.53	0.28	58	22	12	13
Pioneer 3906	3	2.82	0.27	2.44	0.39	0.29	75	30	13	18
Pioneer 3906	4	2.68	0.28	2.63	0.48	0.31	77	32	13	12
Main Effects										
Hyrids										
Funks G4342		2.70	0.27	2.92	0.46	0.28	72	25	10	15
Northrup King PX 9242		2.69	0.28	2.65	0.44	0.29	74	27	10	13
Dekalb DK477		2.69	0.26	2.88	0.43	0.28	66	24	8	12
Jacques JX77		2.73	0.26	3.01	0.43	0.27	75	26	11	15
Pioneer 3732		2.56	0.26	2.62	0.42	0.29	76	29	13	14
Pioneer 3906		2.77	0.26	2.74	0.44	0.28	72	28	12	15
P-Value		92	99	99	85	95	98	99	99	99
BLSD (.05)										
Row										
1		2.68	0.27	2.76	0.40	0.26	73	28	11	14
2		2.67	0.27	2.82	0.47	0.31	70	26	11	14
3		2.74	0.27	2.78	0.41	0.26	75	27	11	15
4		2.67	0.27	2.85	0.47	0.30	71	26	10	14
P-Value		61	7	96	99	99	80	99	99	99
BLSD (.05)										
Hybrids X Row		96	99	99	99	99	99	99	99	99

Table 5. The total elemental removal of silage stover at physiological maturity by six corn hybrids.

Treatment	Row No	P	K	Ca	Mg	Mn	Zn	Cu	B
		Total Elemental Removal Silage Stover							
		#/A							
Funks G4342	1	4.4	126.8	38.1	22.3	0.52	0.19	0.09	0.11
Funks G4342	2	5.0	115.5	32.7	19.2	0.59	0.22	0.09	0.11
Funks G4342	3	4.8	129.9	32.0	17.6	0.64	0.16	0.07	0.13
Funks G4342	4	4.4	110.2	36.8	19.7	0.59	0.14	0.07	0.12
Northrup King PX 9242	1	5.4	103.4	30.3	18.9	0.58	0.18	0.09	0.11
Northrup King PX 9242	2	3.9	93.3	28.8	13.2	0.50	0.14	0.06	0.11
Northrup King PX 9242	3	3.8	98.2	31.4	18.0	0.49	0.12	0.07	0.08
Northrup King PX 9242	4	5.4	103.7	28.6	18.1	0.52	0.20	0.09	0.09
Dekalb DK477	1	4.4	137.6	33.2	19.0	0.71	0.17	0.09	0.11
Dekalb DK477	2	3.4	90.7	28.2	16.0	0.54	0.13	0.06	0.09
Dekalb DK477	3	6.2	91.5	23.0	15.5	0.46	0.17	0.08	0.08
Dekalb DK477	4	4.2	99.4	29.9	14.5	0.52	0.13	0.07	0.10
Jacques JX77	1	3.7	112.2	37.9	21.8	0.44	0.16	0.10	0.11
Jacques JX77	2	4.8	100.1	26.6	17.5	0.55	0.18	0.08	0.11
Jacques JX77	3	3.6	115.7	31.1	16.1	0.56	0.14	0.09	0.11
Jacques JX77	4	2.7	73.9	27.8	14.6	0.50	0.11	0.06	0.09
Pioneer 3732	1	6.5	120.4	35.4	24.9	0.60	0.26	0.13	0.13
Pioneer 3732	2	4.1	104.7	35.8	18.6	0.58	0.15	0.08	0.14
Pioneer 3732	3	4.7	104.8	39.5	20.3	0.68	0.15	0.10	0.13
Pioneer 3732	4	5.4	112.8	33.8	20.3	0.65	0.21	0.10	0.12
Pioneer 3906	1	4.1	147.4	37.2	21.7	0.81	0.16	0.10	0.14
Pioneer 3906	2	4.0	98.3	33.3	18.6	0.63	0.14	0.08	0.11
Pioneer 3906	3	5.0	97.2	27.2	18.2	0.52	0.17	0.09	0.10
Pioneer 3906	4	4.8	93.7	28.8	15.2	0.57	0.14	0.07	0.11
Main Effects									
Hybrids									
Funks G4342		4.7	120.6	34.9	19.7	0.58	0.18	0.08	0.12
Northrup King PX 9242		4.6	99.7	29.8	17.0	0.52	0.16	0.08	0.10
Dekalb DK477		4.5	104.8	28.6	16.2	0.56	0.15	0.07	0.10
Jacques JX77		3.7	100.5	30.9	17.4	0.51	0.14	0.08	0.11
Pioneer 3732		5.2	110.7	36.1	21.0	0.63	0.19	0.10	0.13
Pioneer 3906		4.4	109.1	31.6	18.4	0.63	0.15	0.08	0.11
P-Value		99	99	98	99	99	99	99	99
BLSD (.05)									
Row									
1		4.7	124.6	35.4	21.4	0.61	0.19	0.10	0.12
2		4.2	100.4	30.9	17.1	0.56	0.16	0.08	0.11
3		4.7	106.2	30.7	17.6	0.56	0.15	0.08	0.10
4		4.5	99.0	31.0	17.1	0.56	0.15	0.08	0.10
P-Value		99	99	99	99	89	99	99	99
BLSD (.05)									
Hybrids X Row		99	99	94	99	96	99	99	99

Table 6. The total elemental removal of grain at physiological maturity by six corn hybrids.

Treatment	Row No	P	K	Ca	Mg	Mn	Zn	Cu	B
		Total Elemental Removal Grain							
		#/A							
Funks G4342	1	30.7	41.4	0.50	14.1	0.07	0.33	0.11	0.03
Funks G4342	2	29.8	37.7	0.28	14.0	0.07	0.26	0.08	0.04
Funks G4342	3	25.0	36.5	0.51	13.1	0.07	0.27	0.08	0.02
Funks G4342	4	27.2	37.7	0.36	14.0	0.06	0.29	0.09	0.02
Northrup King PX 9242	1	28.4	37.3	0.27	11.6	0.06	0.27	0.08	0.05
Northrup King PX 9242	2	27.6	33.1	0.34	13.0	0.07	0.27	0.08	0.03
Northrup King PX 9242	3	22.5	29.2	0.31	10.1	0.05	0.23	0.07	0.02
Northrup King PX 9242	4	28.7	34.5	0.24	12.6	0.06	0.23	0.08	0.04
Dekalb DK477	1	29.9	41.6	0.53	15.8	0.08	0.34	0.11	0.03
Dekalb DK477	2	24.8	34.3	0.30	12.5	0.06	0.26	0.08	0.02
Dekalb DK477	3	28.2	36.4	0.28	11.4	0.06	0.27	0.09	0.05
Dekalb DK477	4	30.2	35.9	0.36	14.3	0.08	0.29	0.10	0.04
Jacques JX77	1	27.1	38.7	0.37	12.4	0.06	0.29	0.09	0.02
Jacques JX77	2	30.1	38.2	0.25	14.3	0.07	0.24	0.08	0.04
Jacques JX77	3	25.5	36.2	0.44	13.6	0.07	0.29	0.08	0.02
Jacques JX77	4	24.0	34.2	0.28	11.9	0.06	0.25	0.08	0.02
Pioneer 3732	1	35.5	46.9	0.30	14.7	0.08	0.33	0.10	0.05
Pioneer 3732	2	27.6	36.5	0.34	14.2	0.07	0.28	0.09	0.03
Pioneer 3732	3	23.9	34.0	0.35	10.7	0.06	0.24	0.08	0.02
Pioneer 3732	4	29.3	38.5	0.33	14.0	0.07	0.26	0.10	0.04
Pioneer 3906	1	29.5	41.0	0.45	16.0	0.08	0.30	0.09	0.03
Pioneer 3906	2	25.3	35.2	0.27	12.8	0.06	0.23	0.07	0.02
Pioneer 3906	3	27.0	34.8	0.23	11.5	0.06	0.22	0.07	0.04
Pioneer 3906	4	27.5	35.3	0.33	13.6	0.08	0.25	0.08	0.03
Main Effects									
Hybrids									
Funks G4342		28.2	38.3	0.41	13.8	0.07	0.29	0.09	0.03
Northrup King PX 9242		26.8	33.5	0.29	11.8	0.06	0.25	0.08	0.04
Dekalb DK477		28.3	37.1	0.37	13.5	0.07	0.29	0.09	0.04
Jacques JX77		26.7	36.8	0.33	13.1	0.06	0.27	0.08	0.02
Pioneer 3732		29.1	39.0	0.33	13.4	0.07	0.28	0.09	0.03
Pioneer 3906		27.3	36.6	0.32	13.5	0.07	0.25	0.08	0.03
P-Value		85	99	99	99	95	99	99	99
BLSD (.05)									
Row									
1		30.2	41.2	0.40	14.1	0.07	0.31	0.10	0.03
2		27.5	35.8	0.30	13.5	0.07	0.26	0.08	0.03
3		25.4	34.5	0.35	11.7	0.65	0.25	0.08	0.03
4		27.8	36.0	0.32	13.4	0.07	0.26	0.09	0.03
P-Value		99	99	99	99	99	99	99	99
BLSD (.05)									
Hybrids X Row		90	93	99	99	99	99	18	99

Table 7. The total elemental removal of silage stover plus grain at physiological maturity by six corn hybrids.

Treatment	Row No	P	K	Ca	Mg	Mn	Zn	Cu	B
		Total Elemental Removal Silage Stover + Grain							
		#/A							
Funks G4342	1	35.2	168.3	38.6	36.5	0.59	0.53	0.21	0.15
Funks G4342	2	34.8	153.2	32.9	33.2	0.66	0.48	0.18	0.16
Funks G4342	3	29.9	166.4	32.5	30.7	0.72	0.43	0.16	0.15
Funks G4342	4	31.6	148.0	37.2	33.8	0.66	0.43	0.17	0.15
Northrup King PX 9242	1	33.8	140.7	30.6	30.5	0.64	0.45	0.17	0.16
Northrup King PX 9242	2	31.5	126.5	29.1	26.3	0.57	0.42	0.14	0.15
Northrup King PX 9242	3	26.4	127.5	31.7	28.1	0.55	0.36	0.15	0.11
Northrup King PX 9242	4	34.1	138.2	28.9	30.7	0.58	0.43	0.17	0.14
Dekalb DK477	1	34.3	179.3	33.8	34.8	0.79	0.51	0.21	0.14
Dekalb DK477	2	28.2	125.1	28.5	28.6	0.60	0.39	0.14	0.12
Dekalb DK477	3	34.5	127.9	23.3	26.9	0.05	0.45	0.18	0.13
Dekalb DK477	4	34.5	135.4	30.2	28.9	0.60	0.43	0.17	0.14
Jacques JX77	1	30.9	150.9	38.3	34.3	0.51	0.45	0.20	0.14
Jacques JX77	2	35.0	138.4	26.8	31.6	0.62	0.42	0.17	0.16
Jacques JX77	3	29.2	152.0	31.6	29.8	0.64	0.43	0.17	0.14
Jacques JX77	4	26.7	108.2	28.1	26.5	0.56	0.35	0.15	0.11
Pioneer 3732	1	42.0	167.3	35.7	39.6	0.68	0.59	0.24	0.19
Pioneer 3732	2	31.8	141.2	36.2	32.9	0.66	0.44	0.18	0.17
Pioneer 3732	3	28.6	138.9	39.8	31.1	0.74	0.40	0.18	0.15
Pioneer 3732	4	34.7	151.3	34.1	34.4	0.72	0.47	0.21	0.16
Pioneer 3906	1	33.6	188.4	37.6	37.8	0.89	0.46	0.19	0.17
Pioneer 3906	2	29.3	133.6	33.6	31.5	0.69	0.37	0.15	0.13
Pioneer 3906	3	32.1	132.0	27.4	29.7	0.58	0.40	0.17	0.14
Pioneer 3906	4	32.3	129.1	29.1	28.9	0.65	0.40	0.16	0.15
Main Effects									
Hybrids									
Funks G4342		32.9	159.0	35.3	33.5	0.66	0.47	0.18	0.15
Northrup King PX 9242		31.4	133.2	30.1	28.9	0.59	0.42	0.16	0.14
Dekalb DK477		32.9	141.9	29.0	29.8	0.63	0.45	0.17	0.13
Jacques JX77		30.5	137.4	31.2	30.5	0.58	0.41	0.17	0.13
Pioneer 3732		34.3	149.7	36.5	34.5	0.70	0.47	0.20	0.17
Pioneer 3906		31.8	145.8	31.9	32.0	0.70	0.41	0.17	0.15
P-Value		96	99	99	99	96	99	99	99
BLSD (.05)					2.1				
Row									
1		35.0	156.8	35.8	35.6	0.68	0.50	0.20	0.16
2		31.8	136.3	31.2	30.7	0.63	0.42	0.16	0.15
3		30.1	140.8	31.1	29.4	0.63	0.41	0.17	0.14
4		32.3	135.0	31.3	30.5	0.63	0.42	0.17	0.14
P-Value		99	99	99	99	94	99	99	99
BLSD (.05)					1.6				
Hybrids X Row		99	99	94	83	99	99	92	99

Evaluation of Formolene foliar feed N source on potatoes at Becker, 1984.

W. E. Fenster, M. O'Leary and G. Buzicky

Experiments on the Formolene product were conducted on potatoes at Becker in 1983 and 1984. The objective of using a liquid nitrogen product is to add substantial amounts to the potato foliage when the nutrient demand is the greatest. The Formolene fertilizer (30-0-2) efficiency was compared to normal amounts of soil applied ammonium nitrate (34-0-0) on irrigated sandy textured soils. Fifty pounds per acre of N were applied during tuberization to the control plots to offset the possibility of blight spreading from the control area to the adjacent plots. All plots were replicated 4 times.

Soil test means were: pH=6.5, P=65, K=223, Mg=325, Zn=.8 ppm, S=4 ppm O.M=Med.

Treatments were as follows:

1. Control
2. U. of MN recommendations (soil applied)

across all plots except control	P_2O_5	= 100#/A (planting time)
	K_2O	= 300#/A (planting time)
	S	= 15#/A (planting time)
	N	= 25#/A (planting time)
	Total N	= 210#/A split

Splitting of 210# N as follows:
85# N/A at emergence
50# N/A at tuberization
50# N/A at canopy closure

3. Formolene foliar at 60# N/A
   + 25# N at planting and 85# N/A at emergence as ammonium nitrate to soil (total of 170# N/A).

   Foliar scheme

   a. 10# N/A at 10" to 12"
   b. 30# N/A at tuberization
   c. 20# N/A at canopy closure.

4. Formolene foliar at 100# N/A
   + 25# N/A at planting and 85# N/A at emergence to soil (total of 210# N/A).

   Foliar scheme

   a. 20# N/A at 10" to 12"
   b. 20# N/A at tuberization
   c. 30# N/A at plant bloom
   d. 30# N/A at canopy closure.

5. U. of MN rate of soil applied, with 40# N/A reduction from recommendation (170# N/A total).

   25# N/A at planting
   85# N/A at emergence
   30# N/A at tuberization
   30# N/A at canopy closure.

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

Table 1. Yields and size difference of potatoes comparing Formolene and ammonium nitrate fertilizer 1984.

Treatment Treatment	Tuber yield CW 7/A	% of sample by weight (oz.) 0-3	3-6	6-9	9-12	>12
1	332	3	27	36	22	12
2	478	4	31	33	18	14
3	418	3	27	35	17	18
4	437	3	25	33	24	15
5	457	3	24	29	27	17
Significance	**	ns	ns	ns	ns	ns
BLSD	42	--	--	--	--	--
C.V.	7	78	25	24	36	51

Summary

Where equal amounts of N were applied there were no significant differences in tuber yield due to nitrogen sources. Even though there was 50 pounds of N applied to the control plots the fertilizer treatments from both N sources showed a significant yield increase over the control.

There was no significant effect on tuber size due to method of treatment.

NITROGEN FERTILIZATION FOR PROCESSING SWEET CORN ON AN IRRIGATED SAND: INFLUENCE OF RATES, TIMING AND A NITRIFICATION INHIBITOR -- 1984

C. J. Rosen and H. J. Buchite

Nitrogen fertilizer management for processing sweet corn is an important concern to processors and their growers. Coarse-textured soils are subject to excessive drainage which consequently increases nitrate-nitrogen losses from the root zone. Although many studies have been conducted dealing with nitrogen management for field corn, the differences in growing season and harvested product make it difficult to extrapolate the data from these studies to processing sweet corn. The objectives of the present study were to: 1) optimize rates and timing of nitrogen fertilizer for sweet corn on coarse-textured irrigated soils, and 2) evaluate the effectiveness of N-Serve, a nitrification inhibitor, for sweet corn production.

Procedures:

The experiment was conducted at the Sand Plains Research Farm in Becker, Minnesota on a Hubbard loamy sand (1.9% organic matter). Prior to planting, phosphorus, potassium and sulfur were broadcast according to soil test recommendations. There were nine treatments which included a control, 4 nitrogen rates (50, 100, 150, 200 lb N/A), 100 lb N/A plus N-Serve (0.5 lb ai/A), 150 lb N/A plus N-Serve (0.5 lb ai/A), 100 lb N/A split (1/2 preplant, 1/2 6-8 leaf stage), 150 lb N/A split (1/3 preplant, 1/3 6-8 leaf stage, 1/3 12 leaf stage). Nitrogen source for all preplant applications was anhydrous ammonia. For the split applications, anhydrous ammonia was used preplant and ammonium nitrate as a sidedress. All preplant treatments were applied 3 May 1984. Each treatment was replicated 4 times in a randomized complete block design.

Two varieties, Code 5 (early maturing) and Jubilee (midseason maturing), were planted on 4 May 1984 along with a banded application of 160 lb/A 0-26-26. Plant population was approximately 22,000/A. Each plot consisted of 4 - 40 ft rows with 2.5 ft between the rows.

Whole plant samples collected at the 6-8 leaf stage (before any sidedress application) and leaf samples from opposite and above ear collected at mid-silking were dried, ground and analyzed for total nitrogen content. Leaf samples from the 100 and 150 lb N/A treatment with and without inhibitors were analyzed for P, K, Ca, Mg, Fe, Mn, Zn, Cu, and B using an inductively coupled plasma emission spectrometer.

Total yield (ear and husk), husked yield, and stover yield were obtained by harvesting 2 - 15 ft rows within each plot. Subsamples of ears, husk and stover were taken to determine % moisture for nitrogen uptake calculations. The following quality measurements were also made: ear length, % moisture in kernels, and % usable ears (5.5 inches or greater with tip removed).

From May through July, approximately 7 inches of water was supplied by an overhead irrigation system and 14.8 inches was provided from rainfall. Code 5 was harvested 30 July 1984 and Jubilee was harvested 7 August 1984.

Results:

Both sweet corn varieties responded to nitrogen applications up to 200 lb N/A compared to the check plot. No significant gain in ear fresh weight yields was obtained over the 150 lb N/A rate (Tables 1 and 3). Code 5 had significantly greater ear yields with N-Serve or split N applications at the 100 lb rate compared to the 100 lb N/A preplant. There was no significant difference between 100 lb N/A plus N-Serve and 150 lb N/A as a preplant, split application or with N-Serve. Although similar trends were observed with Jubilee, 150 lb N/A as a preplant gave superior yields compared to 100 lb N/A as a preplant, split application or with N-Serve. For both varieties, yields on plots receiving preplant applications at 150 lb N/A were not significantly different from those receiving 150 lb N/A with N-Serve or split applied. In general, ear length and % COC eligible followed yield trends. Maximum quality was obtained from sweet corn that received 100 lb N/A or more regardless of whether applications were split, preplant or with N-Serve added.

Nitrogen concentrations in whole plant samples at the 6-8 leaf stage were lower for the control and 50 lb N/A treatments compared to the other nitrogen treatments (Tables 2 and 4). At the 6-8 leaf stage all split application treatments had received only 50 lb N/A. In general, plants having nitrogen concentrations less than 3.3% at the 6-8 leaf stage without subsequent sidedress applica-

tions ended up deficient in nitrogen at silking as measured by leaf nitrogen. It should be noted that subsequent nitrogen deficiency may still occur on plants with nitrogen concentrations greater than 3.3% at the 6-8 leaf stage if nitrogen availability is limited after this point. Ear leaf nitrogen concentrations increased with nitrogen applications rate. N-Serve and split applications had no effect on ear leaf nitrogen concentration at a given rate. Ear, husk and stover N concentrations generally increased with nitrogen application rate. Total nitrogen uptake increased with increasing nitrogen rates. N-Serve and sidedress applications appeared to enhance N uptake compared to the preplant application at the 100 lb rate. There were no differences in total N uptake between preplant, N-Serve addition or split application at the 150 lb rate.

Leaf elemental concentrations of calcium at mid-silking were significantly lower in N-Serve treatments compared to those without N-Serve (Tables 5 and 6). In Code 5, leaf K and Mg were also significantly lower when N-Serve was used.

General Comments:

Results from these experiments are based on one year of data. Differences in time and amount of rainfall can profoundly alter nitrogen leaching and subsequent plant response on coarse-textured soils. In general, N-Serve and split applications at 150 lb N/A offered no advantage over a single preplant application. At the 100 lb N/A rate, N-Serve or split application were necessary in order to avoid yield loss. This research will be conducted next year to gain a broader data base for sweet corn response to nitrogen fertilization and management on coarse-textured soils.

The assistance of G. Titrud, G. Buzicky and T. King during the course of this research is gratefully acknowledged.

Table 1. Effect of nitrogen rate, nitrification inhibitor and sidedress applications on Code 5 sweet corn yield and quality.

Treatment lb N/A	Yield (T/A) Green	Yield (T/A) Husked	Ear Length inches	% Moisture in Kernels	% COC Eligible
0	2.29	1.58	5.9	77.2	31.2
50	3.76	2.66	6.8	76.1	58.1
100	5.52	3.48	7.6	75.2	70.0
150	7.22	4.61	8.4	73.3	83.9
200	7.54	4.72	8.1	74.0	72.1
100+N-Serve	7.09	4.32	7.8	74.0	74.2
150+N-Serve	7.26	4.53	8.1	75.7	79.9
100 2 splits	6.82	4.22	7.8	73.2	76.1
150 3 splits	7.54	4.65	8.1	72.7	72.5
Significance	**	**	**	NS	**
BLSD (.05)	0.85	0.52	0.8	—	16.4

Table 2. Effect of nitrogen rate, nitrification inhibitor and sidedress applications on nitrogen concentration in various plant tissues during the growing season and total nitrogen uptake (Code 5).

Treatment lb N/A	% N Whole Plant (6-8 Leaf)	% N Leaf Above Ear (Silking)	% N Ear (Harvest)	% N Husk (Harvest)	% N Stover (Harvest)	N Content Ear lb N/A	N Content Husk lb N/A	N Content Stover lb N/A	Total N Uptake lb N/A
0	3.19	2.88	1.60	0.57	1.46	8.1	1.5	39.9	49.5
50	3.53	2.97	1.65	0.53	1.24	14.8	2.0	44.9	61.8
100	3.55	3.42	1.66	0.56	1.30	24.1	4.0	54.0	82.0
150	3.63	3.73	1.72	0.62	1.63	29.8	6.0	74.5	110.3
200	3.79	3.79	1.75	0.64	1.88	31.6	6.4	81.7	119.7
100+N-Serve	4.13	3.48	1.70	0.61	1.66	29.5	6.5	76.1	114.0
150+N-Serve	3.84	3.75	1.71	0.73	1.51	29.0	7.6	66.9	103.6
100 2 splits	3.16	3.58	1.59	0.68	1.36	25.7	6.5	58.7	90.9
150 3 splits	3.37	3.80	1.61	0.70	1.84	27.8	7.2	65.4	100.4
Significance	**	**	NS	NS	*	**	**	**	**
BLSD (.05)	0.37	0.20	--	—	0.40	5.6	1.6	16.2	18.6

Table 3. Effect of nitrogren rate, nitrification inhibitor and sidedress applications on Jubilee sweet corn yield and quality.

Treatment lb N/A	Yield (T/A) Green	Yield (T/A) Husked	Ear Length inches	% Moisture in Kernels	% COC Eligible
0	3.40	2.47	6.2	75.4	34.8
50	3.91	2.81	6.5	74.2	46.6
100	7.10	4.96	7.5	75.5	84.3
150	9.60	6.60	7.5	75.3	75.6
200	9.11	6.27	7.7	74.7	75.9
100+N-Serve	8.00	5.80	7.6	75.0	79.2
150+N-Serve	9.00	6.29	7.6	75.8	80.0
100 2 splits	7.66	5.43	7.5	75.0	79.2
150 3 splits	8.18	5.86	7.7	74.6	80.6
Significance	**	**	**	NS	**
BLSD (.05)	1.65	0.98	0.4	--	14.8

Table 4. Effect of nitrogen rate, nitrification inhibitor and sidedress applications on nitrogen concentration in various plant tissues during the growing season and total nitrogen uptake (Jubilee).

Treatment lb N/A	% N Whole Plant (6-8 Leaf)	% N Leaf Above Ear (Silking)	% N Ear (Harvest)	% N Husk (Harvest)	% N Stover (Harvest)	N Content Ear lb N/A	N Content Husk lb N/A	N Content Stover lb N/A	Total N Uptake lb N/A
0	3.11	2.03	1.52	0.49	0.93	15.9	1.4	22.4	39.7
50	3.16	1.89	1.42	0.46	0.92	17.6	1.6	23.6	42.8
100	3.85	2.66	1.48	0.53	1.18	37.4	4.2	48.6	90.2
150	3.81	3.32	1.71	0.94	1.40	50.4	9.9	58.5	118.5
200	3.85	3.24	1.60	0.76	1.45	47.9	6.8	58.5	113.3
100+N-Serve	3.80	3.11	1.48	0.63	1.37	42.2	3.9	63.2	109.4
150+N-Serve	4.01	3.31	1.65	0.65	1.57	50.4	5.8	64.2	120.4
100 2 splits	3.31	3.02	1.48	0.72	1.30	38.5	5.7	49.8	93.7
150 3 splits	3.25	3.38	1.74	0.74	1.66	43.1	5.6	68.0	116.7
Significance	**	**	*	**	**	**	*	**	**
BLSD (.05)	0.42	0.27	0.25	0.24	0.36	12.6	4.4	14.2	24.4

Table 5. Influence of N-Serve and N rate on leaf elemental concentrations at mid-silking: Code 5.

Treatment lb N/A	N	P	K	Ca	Mg	Fe	Mn	Zn	Cu	B
	%					ppm				
100	3.42	0.36	3.22	0.54	0.32	126	104	29	21	5
150	3.73	0.36	3.19	0.56	0.33	132	142	31	22	5
100+N-Serve	3.48	0.34	3.07	0.50	0.29	122	88	30	22	6
150+N-Serve	3.75	0.37	3.06	0.50	0.28	126	112	31	22	5
N rate effect	**	NS	NS	NS	NS	NS	NS	NS	NS	NS
N-Serve effect	NS	NS	*	*	**	NS	*	NS	NS	NS
N rate X N-Serve	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

Table 6. Influence of N-Serve and N rate on leaf elemental concentrations at mid-silking: Jubilee.

Treatment lb N/A	N	P	K	Ca	Mg	Fe	Mn	Zn	Cu	B
	%					ppm				
100	2.66	0.30	2.82	0.63	0.35	91	116	21	8	6
150	3.32	0.37	2.97	0.65	0.39	106	162	31	11	6
100+N-Serve	3.11	0.37	3.04	0.58	0.37	100	91	28	10	6
150+N-Serve	3.31	0.39	2.91	0.59	0.38	103	120	27	10	6
N rate effect	*	*	NS	NS	NS	*	*	NS	*	NS
N-Serve effect	NS	*	NS	**	NS	NS	*	NS	NS	NS
N rate X N-Serve	NS	NS	*	NS	NS	NS	NS	NS	*	NS

1984 WEATHER

R. K. Severson

Mild temperatures during January and February of 1984 kept the snow depth to a minimum. The maximum snow depth of 5 inches occurred during the first week of February regressing to only a trace of snow on the ground by the last week of February. On the average, February 1984 was the fourth warmest February recorded at Crookston since 1890. February 16 set a new daily record maximum for precipitation with 0.53 inches of moisture of which .35 inches fell as rain. Two new all-time high temperature records were also set in January with readings of 38°F on January 4 and 40°F on January 6.

The ground frost reached a maximum of 39 inches during the first week of March. By March 18 the entire snow-pack had melted and the surface ground frost began thawing. By April 1, the frost was out to six inches from the surface. March and April were about normal in regard to average temperature and one-inch below normal in average precipitation.

May was unusually dry receiving only one-third the normal precipitation for this period as can be noted in the following table. On the other hand, June marked a period of well-above normal precipitation. In a six-day period from June 3-8, 5.65 inches of rain fell leaving water standing in most fields which was devastating to some crops. On June 7, 3.28 inches of the 5.65 inches were received. In the 95-year history of weather records for the month of June in Crookston, June 1984 ranked fourth in most precipitation.

July marked the driest July recorded in the weather station history. The .48 inches of rain received was only 15% of the normal 3.09 inches expected for this month. August and September were also below normal for precipitation with deficits of .81 inches and 1.42 inches, respectively. August was also about 3.5°F above normal in regard to average temperature with a record high temperature of 98°F recorded August 28. August 20 set a new record for daily precipitation with 1.23 inches of rain recorded.

October will be remembered for years by many people in the sugarbeet industry. Above-normal temperatures during the first third of the month halted piling operations. October 13 marked the beginning of a 9-day period of rain dumping 3.31 inches again halting piling operations. The last week of October the temperatures dropped to the mid-teens and then to single digits freezing the remaining sugarbeet crop in the ground. October ranked as the third wettest October in weather station history with 3.91 inches of precipitation. A new record low temperature record was also set October 31 when the mercury dipped to 5°F surpassing the old mark of 10°F set in 1906.

November was well-below normal in regard to precipitation with .13 inches recorded of which .11 inches was received in 2 inches of snow. Another temperature record was surpassed November 25 with a reading of 54°F recorded. The old record was 50°F set in 1914.

The mean temperature for the year was 0.7°F above normal. The last spring frost was recorded May 25 (29°) which initiated a 111-day growing season ending September 14 (29°) when the first fall frost occurred.

The precipitation for 1984 totaled 18.42 inches of which 16.69 inches were recorded as rain and 1.73 inches were contained in 24.2 inches of snow.

Table 1. Weather summary for 1984 with averages for precipitation and mean temperature (1890-1979).

	Precipitation					Mean Temperature	
Month	Snow	Precip.	Rain	Total	1890-1979	1984	1890-1979
	Inches					°F	
January	5.5	.23	--	.23	.56	6.6	3.7
February	3.8	.55	.35	.90	.59	21.4	8.1
March	6.9	.24	.01	.25	.84	21.1	22.9
April	--	--	1.19	1.19	1.57	44.5	41.4
May	--	--	.79	.79	2.59	52.5	54.6
June	--	--	7.11	7.11	3.56	64.5	64.4
July	--	--	.48	.48	3.09	70.0	69.6
August	--	--	2.09	2.09	2.90	71.0	67.4
September	--	--	.74	.74	2.16	51.5	51.5
October	T	T	3.91	3.91	1.43	45.3	45.3
November	2.0	.11	.02	.13	.78	26.0	26.7
December	6.0	.60	--	.60	.60	6.4	11.5
TOTAL	24.2	1.73	16.69	18.42	20.67	40.1	39.4

SOIL TEST LEVELS AND CROP QUALITY AS AFFECTED BY DIFFERENT FERTILIZER PROGRAMS IN A CONTINUOUS WHEAT CROPPING SYSTEM

J. A. Lamb and R. K. Severson

The objective of this study was to measure the effects of different fertilizer programs, so called maintenance versus build, over a 10-year period on soil test levels and crop quality in a continuous wheat cropping system. Soil test and crop quality measurements are taken to provide information for evaluation and determination of the most effective program. The study was originated in the spring of 1978.

Experimental Procedure: Five treatments with 4 replications were arranged in a randomized complete block design. Each of the 5 fertilizer treatments was based upon soil test data from the plots on which that treatment had been applied to in the previous years. All of the treatments were applied in the fall of 1983 and plowed down. Marshall wheat was planted May 2, 1984 and harvested August 16, 1984. Whole plant samples were taken at maturity (July 30, 1984) for elemental analyses. Whole plant samples taken at maturity (soft dough) were used to determine forage yields and to calculate N, P, and K uptake. Soil samples were taken after crop removal to measure the effects of the treatments.

Results and Discussion: The effect of the treatments on elemental analyses at maturity is shown in Table 1. Significant differences in analyses occurred between the check and other treatments for N, K, Ca, Mg, Zn, and B.

The plants receiving fertilizer treatments had greater concentrations of N, K, Ca, Mg, and B. The addition of N, P, and K above the recommendations did not increase the concentration of these minerals. Plant Zn concentration decreased by the increased P fertilizer supplied to the plant.

Table 1. The effect of 5 fertilizer programs on the elemental analyses of whole plant samples taken at maturity (soft dough) of spring wheat.

Treatment			Elemental Analyses								
N	P_2O_5	K_2O	N	P	K	Ca	Mg	Mn	Zn	Cu	B
- - - - lb/ac - - - -			- - - - - - - - - % - - - - - - - - -					- - - - - - ppm - - - -			
0	0	0 1/	1.15	0.23	0.90	0.09	0.14	35	24	1	2
90	35	30 2/	1.52	0.24	1.38	0.14	0.19	39	22	1	3
90	35	30 3/	1.47	0.24	1.26	0.12	0.18	38	22	1	3
80	35	30 4/	1.51	0.23	1.29	0.15	0.19	36	20	1	3
50	35	30 5/	1.46	0.23	1.26	0.14	0.19	38	16	1	3
Significance			**	N.S.	**	**	**	N.S.	+	N.S.	**
B.L.S.D. (.05)			0.20		0.13	0.03	0.02		5.9		0.30
C.V. (%)			9.0	4.1	7.3	16.4	8.1	12.9	16.6	23.8	8.1

1/ Check
2/ Soil test recommendation
3/ Soil test recommendation + 30 lb K_2O/ac
4/ Soil test recommendation + 30 lb N/ac
5/ Soil test recommendation + 30 lb P_2O_5/ac
** and + are 0.01 and 0.10 significance levels, respectively.

The grain yield, protein, grain N removal, D.M. yield, forage P uptake, and K uptake were significantly affected by the addition of fertilizer from any of the 4 fertilizer treatments (Table 2). There were no differences in these variables between fertilizer treatments. The forage N uptake was significantly affected by the use of the 4 fertilizer programs. The additional P treatment had a lower N uptake but still considerably greater than the check.

Table 2. The effect of 5 fertilizer programs on grain yield, test weight, protein, grain N removal, forage yield, N, P, and K uptake of spring wheat.

Treatment			Grain				Forage			
				Test		N	D.M.	Uptake		
N	P_2O_5	K_2O	Yield	Weight	Protein	Removal	Yield	N	P	K
- - - - lb/ac - - - -			Bu/ac	lb/Bu	%	lb/ac	- - - - - - lb/ac - - - - -			
0	0	0 1/	41.9	62.0	12.45	55.4	5604	64.7	13.0	50.2
90	35	30 2/	67.4	61.3	14.55	103.3	9689	146.8	22.7	134.7
90	35	30 3/	70.8	61.7	14.54	108.2	9487	139.8	22.7	119.3
80	35	30 4/	69.0	61.9	15.05	109.3	10388	157.4	23.9	134.1
50	35	30 5/	71.1	62.4	14.61	110.2	9141	132.3	21.1	114.4
Significance			**	N.S.	**	**	**	**	**	**
B.L.S.D. (.05)			5.0		1.15	11.8	1410	26.6	2.6	26.0
C.V. (%)			5.5	1.0	5.2	8.5	10.9	14.2	8.7	16.1

1/ Check
2/ Soil test recommendation
3/ Soil test recommendation + 30 lb K_2O/ac
4/ Soil test recommendation + 30 lb N/ac
5/ Soil test recommendation + 30 lb P_2O_5/ac
** is the 0.01 significance level

The soil test values for the 5 treatments are shown in Table 3. The only soil nutrient significantly affected by fertilizer treatments was P at both the 0-6" and 6-12" depths. The check had a significantly lower soil P level compared to the fertilized treatments. The +30# P_2O_5 showed a trend toward higher soil P values of both depths.

Table 3. The effect of 5 fertilizer programs on residual NO_3-N, P, and K soil test levels after seven years in a continuous wheat cropping system.

Treatment			Soil Test Levels										
			NO_3-N							$NaHCO_3$ P 6/		Exchangeable K 6/	
N	P_2O_5	K_2O	0-1'	1-2'	2-3'	3-4'	4-5'	0-2'	0-5'	0-6"	6-12"	0-6"	6-12"
- - - - lb/ac - - - -			- - - - - - -lb/depth - - - - - -							- - - - - - - - - lb/ac - - - - - - - -			
0	0	0 1/	15.5	8.0	7.0	8.0	17.0	23.5	55.5	8.0	4.3	281	226
90	35	30 2/	25.0	12.0	15.5	22.5	20.0	37.0	95.0	19.3	9.3	294	225
90	35	30 3/	21.0	10.5	19.5	25.5	22.5	31.5	99.0	17.8	11.3	309	235
80	35	30 4/	25.0	16.0	30.0	31.5	26.5	41.0	129.0	13.5	10.0	274	208
50	35	30 5/	27.5	17.0	26.0	31.5	25.5	44.5	127.5	19.3	12.5	318	231
Significance			N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	**	**	N.S.	N.S.
B.L.S.D. (.05)										5.0	5.0		
C.V. (%)			28.5	58.1	75.7	60.1	43.1	35.9	44.2	22.3	29.9	12.7	11.7

1/ Check
2/ Soil test recommendation
3/ Soil test recommendation + 30 lb K_2O/ac
4/ Soil test recommendation + 30 lb N/ac
5/ Soil test recommendation + 30 lb P_2O_5/ac
6/ ppm = lb/ac times 0.05
** is the 0.01 significance level

RESIDUAL SOIL N, FERTILIZER N, AND INOCULATION EFFECTS ON SOYBEAN PRODUCTION IN NORTHWESTERN MINNESOTA

J. A. Lamb, R. K. Severson, G. W. Rehm, and M. O. Johnson

Objectives: The overall objectives of this study are to measure the effects of residual NO_3^--N, fertilizer N, seed inoculation, the interactions of these three variables on soybean production in the Red River Valley of Minnesota.

Procedures: Four locations were established in Spring 1984 with residual NO_3^--N for 0-2 ft. ranging from 13 to 102 lb NO_3^--N/ac. The textures ranged from sandy loam to a silty clay. The statistical design was a split plot with four replications. The main plots were inoculated or noninoculated seed and the split plots were N rates (0, 30, 60, 90, and 120 lbs N/ac). The N fertilizer was applied as urea and incorporated before the plots were planted. The Hegne, Wheatville, and R. Peterson locations were planted May 16, 1984. The R. Buchholz location was planted May 25, 1984. Plant samples were taken from the last full trifoliate leaves at early bloom. Periodic root observations were made to determine the status of nodule formation through the growing season. The plots were hand harvested September 25-26, 1984.

Results and Discussion: The soybean yields for 1984 are reported in Table 1. Three locations responded to the application of N fertilizer. The Hegne location showed the largest N response. This was caused by the low residual NO_3^--N in the soil (Table 2) at the beginning of the study. The noninoculated treatment had lower yields than the inoculated and a response was detected ($P < 0.20$). This effect could not be documented by root observations during the growing season. Very few nodules (<3) were found on plants in any treatment at any location. An inoculation x N rate interaction occurred and indicates the lower yield from lack of inoculation can be made up by the addition of N fertilizer. The plant analysis (Table 3) at the Hegne location indicates no effect of inoculation but did indicate a positive relationship between yield and plant N content ($r = 0.51$).

The Wheatville location had a quadratic response caused by N fertilizer. The majority of the positive response occurred with the first 30 lb increment. The plant trifoliate N concentration increased linearly with the amount of N applied. This increase did not correlate with yield. The smaller N response and lack of response to inoculation was caused by the larger amount of NO_3^--N in the soil (72 lb/ac).

Table 1. Soybean grain yields for inoculation - N rate study in 1984.

	Site							
	NWES				Off Station			
	Hegne		Wheatville		R. Peterson		R. Buccholz	
N Rate	0[1/]	I[2/]	0	I	0	I	0	I
lb/ac	bu/ac							
0	15.7	24.9	27.2	25.0	27.4	26.6	29.0	28.5
30	19.9	26.0	31.1	29.1	27.8	28.0	27.5	31.4
60	21.4	26.1	31.1	32.8	29.0	28.4	28.7	30.1
90	26.6	27.4	32.0	29.5	26.3	29.0	28.9	31.1
120	28.8	27.0	31.1	28.5	26.1	27.8	27.2	28.8
STATISTICS								
Inoculation	+		N.S.		N.S.		+	
N Rate	**		N.S.		N.S.		++	
Linear	**		N.S.		N.S.		N.S.	
Quadratic	N.S.		++		N.S.		*	
Inoculation x N Rate	*		N.S.		N.S.		N.S.	
C.V.	13.6		5.8		10.8		5.4	

1/ 0 = Not inoculated
2/ I = Inoculated
**, *, ++, and + are 0.01, 0.05, 0.10, and 0.20 probability levels, respectively.

Table 2. Soil parameters for soybean study locations in 1984.

Site	Organic Matter	pH	P 1,2/ 0-6"	K 0-6"	NO_3^--N 0-6"	6-12"	12-24"	0-24"	Soluble Salts
	%		lb/ac						mmhos
NWES Hegne	2.7	7.9	12	343	16	10	13	39	.4
NWES Wheatville	4.3	7.7	13	282	28	16	28	72	.5
R. Peterson	2.1	8.0	17	145	28	25	49	102	.25
R. Buchholz	5.5	8.0	12	240	—	--	--	85 3/	.5

1/ $NaHCO_3$ Extractable P
2/ ppm = lb/ac times 0.5
3/ Sampled only to 18"

Table 3. Nitrogen concentration of the youngest full trifoliate petiole at bloom for soybean study in 1984.

	Site							
	NWES				Off Station			
	Hegne		Wheatville		R. Peterson		R. Buchholz	
N Rate	O 1/	I 2/	O	I	O	I	O	I
lb/ac	% N							
0	4.49	4.57	5.19	5.39	5.31	5.28	5.73	5.28
30	4.35	4.80	5.32	5.23	5.29	5.27	5.33	5.06
60	4.80	4.80	5.31	5.30	5.34	5.33	5.79	5.48
90	5.11	5.17	5.29	5.51	5.27	5.34	5.71	5.23
120	5.13	5.21	5.76	5.67	5.33	5.40	5.46	5.30
STATISTICS								
Inoculation	N.S.		N.S.		N.S.		++	
N Rate	**		*		N.S.		++	
Linear	**		**		N.S.		N.S.	
Quadratic	N.S.		++		N.S.		N.S.	
Inoculation x N Rate	N.S.		N.S.		N.S.		N.S.	
C.V.	7.0		5.1		4.0		5.2	

1/ O = Not inoculated
2/ I = Inoculated
**, *, ++, and + are 0.01, 0.05, 0.10, and 0.20 probability levels, respectively.

No response to any treatment was found at the R. Peterson location. This particular location had a high soil NO_3^--N of 102 lb/ac in the top 2 feet.

A small quadratic yield response to N occurred at the R. Buchholz location. This was not expected because of the high soil NO_3^--N level (85 lb/ac in top 1.5 feet). The positive response was only one bushel but was statistically significant. A positive response in yield was caused by inoculation. As stated earlier no visual increase in nodules from inoculation was observed. The plant trifoliate N concentration analysis indicated no response to N. There was a negative response from inoculation. The reason for this is not clear.

Overall, this study has revealed that soil NO_3^--N levels do influence yield response to N fertilizer in Northwest Minnesota. Also, some unknown factor, besides high soil NO_3^--N levels, is restricting the plant's ability to produce N fixing nodules.

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HIGH PHOSPHORUS AND POTASSIUM RATES ON CONTINUOUS SPRING WHEAT

J. A. Lamb and R. K. Severson

This study was designed to determine the effect of P and K rate combinations on spring wheat yield, nutrient uptake, and soil test P and K levels over an extended period of time. The P and K rate combinations used were selected to provide information on response curves and "maintenance" rates for both elements. The experiment was located on a Wheatville loam soil.

Experimental procedure: Ten treatments consisting of P and K combinations have been used. Treatment combinations and applications made to date are shown in Table 1. Treatments applied in the fall of 1983 were broadcast and plowed down. Nitrogen, as urea, was fall applied at 90 lb N/A and incorporated with a field cultivator on September 26, 1983. Marshall wheat was planted on May 2, 1984 and harvested for grain yields on August 15, 1984. Whole plant samples were taken at soft dough July 30, 1984 for elemental analyses and used to determine forage yields and N, P, and K uptake. Soil samples were taken after crop removal to measure the residual effects of the treatments.

Results: Elemental analyses of the whole plant samples taken at soft dough are shown in Table 2. Significant differences in N, P, K, Ca, Mg, and Zn at soft dough (Table 2) were obtained between treatments.

Grain yield, protein, test weight, forage yield, N, P, and K uptake values shown in Table 3 indicate that yield, grain protein, dry matter yield, test weight, and P uptake were affected by the treatments.

Soil test results from the fall of 1984 sampling date are shown in Table 4. Samples were analyzed by North Dakota State University's soil testing laboratory. Significant differences in residual P and K levels were obtained.

Discussion: Grain yields (Table 3) were very good this year because of ideal environment conditions for small grains. A response in grain yield to treatments that involved the addition of P and K fertilizers was shown. The soil test results (Table 4) would indicate that the increased P and K levels in the soil increased grain yields with a majority of the increase from P fertilization. Treatments 9 and 10 involved one application at the establishment of the study and had smaller yield responses and lower soil test values. The soil data indicates that current recommendations for addition of K fertilizer when the soil test level is less than 300 lb K/ac (150 ppm) is correct.

Plant P (soft dough) and P uptake (forage) correlated well with yield (r = .83 and .94). Potassium uptake (forage) and plant K (soft dough) correlated moderately (r = .56) and poorly (r = .18) with yield, respectively.

Table 1. Phosphorus and potassium treatment combinations at Crookston in the high P and K study.

Treatment No.	Application Date				
	Spring 1980	Fall 1980	Fall 1981	Fall 1982	Fall 1983
	P_2O_5 (lb/ac) + K_2O (lb/ac)				
1	0 + 0	0 + 0	0 + 0	0 + 0	0 + 0
2	0 + 100	0 + 100	0 + 100	0 + 100	0 + 100
3	50 + 100	50 + 100	50 + 100	50 + 100	50 + 100
4	100 + 100	100 + 100	100 + 100	100 + 100	100 + 100
5	150 + 100	0 + 100	0 + 100	150 + 100	0 + 100
6	100 + 0	100 + 0	100 + 0	100 + 0	100 + 0
7	100 + 50	100 + 50	100 + 50	100 + 50	100 + 50
8	100 + 150	100 + 0	100 + 0	100 + 150	100 + 0
9	150 + 100	0 + 0	0 + 0	0 + 0	0 + 0
10	100 + 150	0 + 0	0 + 0	0 + 0	0 + 0

Table 2. Effect of P and K rate combinations on the elemental analyses of whole plant samples of spring wheat taken at maturity (soft dough).

Treatment No.	Elemental Analyses								
	N	P	K	Ca	Mg	Mn	Zn	Cu	B
	%					ppm			
1	1.63	0.22	1.27	0.13	0.20	41	24	3	3
2	1.56	0.22	1.38	0.14	0.18	42	26	2	3
3	1.36	0.24	1.13	0.11	0.17	38	16	2	3
4	1.47	0.25	1.35	0.14	0.19	42	14	2	3
5	1.43	0.24	1.31	0.14	0.16	38	16	2	2
6	1.51	0.24	1.11	0.12	0.20	40	11	2	3
7	1.53	0.25	1.22	0.14	0.18	40	13	2	3
8	1.36	0.25	1.19	0.14	0.18	36	15	2	3
9	1.53	0.23	1.19	0.15	0.20	39	20	2	3
10	1.59	0.23	1.28	0.17	0.19	40	23	6	3
Significance	**	**	*	*	*	N.S.	**	N.S.	N.S.
B.L.S.D. (.05)	.17	.02	.21	.03	.03		4		
C.V. (%)	6.9	5.0	9.4	14.0	9.8	8.7	18.2	107.8	19.9

** and * are 0.01 and 0.05 significance levels, respectively.

Table 3. Effect of P and K rate combinations on grain yield, protein, test weight, forage yield, N, P, and K uptake.

Treatment No.	Forage			Forage			
					Uptake		
	Yield	Protein	Test Weight	D.M. Yield	N	P	K
	Bu/A	%	lb/Bu	lb/ac			
0	50.36	15.58	58.3	7029	114.4	15.1	89.8
2	55.88	14.92	60.4	8063	126.3	17.7	112.0
3	63.12	13.78	62.1	8470	115.2	20.5	96.2
4	62.41	14.19	61.5	8256	121.7	20.2	111.3
5	64.95	14.51	60.9	8893	127.2	21.0	117.0
6	59.38	14.26	60.6	8677	131.4	20.4	96.5
7	63.42	13.85	61.6	8940	137.4	21.9	109.3
8	61.97	13.61	61.8	8682	117.8	21.2	103.2
9	57.32	14.56	59.8	7911	121.1	17.8	93.5
10	58.93	14.78	60.1	8320	132.3	19.2	106.5
Significance	**	**	**	*	N.S.	**	N.S.
B.L.S.D. (.05)	5.50	1.08	1.3	1219		2.7	
C.V. (%)	6.3	4.6	1.5	8.5	13.2	9.6	15.3

** and * are 0.01 and 0.05 significance levels, respectively.

Table 4. Effect of P and K rate combinations on residual P and K soil test levels after five years of application

Treatment No.	pH 0-6"	pH 6-12"	$NaHCO_3$ P 0-6"	$NaHCO_3$ P 6-12"	Exchangeable K 0-6"	Exchangeable K 6-12"
			- - - - - - - - - - - - lb/ac[1/]		- - - - - - - -	
1	8.1	8.2	7	6	281	243
2	8.0	8.1	8	7	356	299
3	8.1	8.1	26	16	359	304
4	8.1	8.1	48	23	365	281
5	8.0	8.0	27	16	373	304
6	8.1	8.1	41	27	270	238
7	8.0	8.1	42	23	315	253
8	8.0	8.1	55	28	359	291
9	8.0	8.1	14	9	296	246
10	8.1	8.0	11	9	279	249
Significance	N.S.	+	**	**	**	**
B.L.S.D. (.05)		0.1	5	4	41	35
C.V. (%)	1.0	0.9	13.6	16.5	8.9	8.8

1/ ppm = lb/ac times 0.5
** and + are 0.01 and 0.10 significance levels, respectively

AVAILABILITY OF RESIDUAL NITRATE-N TO CORN

Lamberton, 1983 and 1984

G. W. Randall and W. W. Nelson

Application of fertilizer N at rates exceeding crop removal can result in rather significant amounts of residual N left in the soil for the succeeding crop. For instance, after a very dry season, the quantity of residual N may be such that crop response the following year to added fertilizer may not be obtained. The purpose of this study is to determine crop response to residual NO_3-N and to measure loss of this N to tile lines.

Experimental Procedures

Nitrogen fertilizer was applied as urea annually from 1973-1979 to tile drained plots each measuring 45' x 50' and lined with plastic at Lamberton. Rates of 18, 100, 200, and 400 lb N/A were replicated three times. An additional treatment (200 lb N/A as soybean meal) was applied to isolated plots which were not within the original replications. Consequently, statistical analyses have been performed only on the former four treatments.

Corn has been grown continuously from 1973 thru 1984. The grain has been removed and all remaining residue plowed down annually. Nitrogen removal in the grain has been measured. In addition, N losses thru the tile lines have been determined by measuring flow rate and NO_3-N concentrations when tile flow occurred. Each fall (when possible) soil samples have been taken to a 10-foot depth to determine residual NO_3-N in the soil.

Because some of the N treatments exceeded the N removal rates, substantial amounts of NO_3-N accumulated from 1973-1979. Consequently, no fertilizer N has been applied to the plots since May 1979. Research efforts since 1979 have attempted to monitor the availability of the residual NO_3-N to corn and to follow the movement of NO_3-N either in the soil or into the tile lines. Results from 1980-82 can be found in University of Minnesota Agr. Exp. Stn. Misc. Pub 2 (revised) - 1983. p 78-81.

In 1983 and 1984, 125 lb N/A as anhydrous ammonia was applied to an isolated 6-row strip between the plots so that crop response to the residual N could be compared to this annual application. Because the soil NO_3-N concentrations in the top 3' were very low in the fall of 1983, 40 lb N/A was applied as urea to all plots in the spring of 1984. Weeds and insects were controlled adequately on all plots by pesticides. All plots have been moldboard plowed each fall.

Results - 1983

Because of extremely wet conditions in the fall of 1982, deep soil samples were not taken until May, 1983. Residual NO_3-N concentrations from this spring sampling are presented in Table 1 and do show the effects of the previous N applications over the 7-year period (1973-79). A slight increase in NO_3-N throughout the 10-foot profile was found with the 100-lb rate compared to the 18-lb rate. Nitrate-N remaining in the profile 4 years after discontinuing the 200- and 400-lb annual applications was 2X and 5X, respectively, that remaining with the recommended N rate (100-lb N/A). Moreover, most of the residual NO_3-N was below five feet and, thus, was below the rooting depth of corn. Even though slightly less residual remained with the 200-lb organic N treatment the distribution was very similar to the 200-lb fertilizer N treatment.

Corn yields shown in Table 2 were very low due to the hot and dry conditions during July and August, 1983. Grain yields from all of the previous N treatments were substantially below the yield of 86.1 bu/A obtained from the 6-row strip where N was applied in 1983. Although the grain yield from the 400-lb treatment appeared to be slightly higher than from the other treatments, the differences among treatments were not consistent and were not significant at the 95% level. Grain N concentration was not affected by the previous N treatments. Silage yield and total N uptake (silage yield x N concentration) were both increased by the carryover N from the 400-lb N treatment. In summary, residual NO_3-N found in the soil profile in May did not have a consistent effect on corn production in 1983. Perhaps the NO_3-N, which had accumulated with the 200- and 400-lb rates, was too deep for sufficient plant uptake.

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

Table 1. Residual NO_3-N in the 0-10' soil profile in May, 1983 as influenced by previous N application at Lamberton.

Profile depth	Annual N rate (lb/A) 1/				
	18	100	200	400	200 org.
feet	ppm				
0-1	1.6	2.7	3.7	4.5	3.4
1-2	0.7	1.0	1.5	1.7	1.3
2-3	0.7	0.9	1.5	2.1	1.8
3-4	0.8	1.1	1.8	8.7	2.9
4-5	0.7	1.5	2.7	20.4	3.7
5-6	0.8	2.1	5.8	24.8	5.2
6-7	1.3	3.4	8.0	20.8	5.2
7-8	1.6	3.2	5.3	15.8	3.8
8-9	1.7	2.4	4.1	8.9	2.3
9-10	1.8	2.0	4.8	6.6	1.9
Total lb NO_3-N in 10-foot profile	47	81	157	457	126

1/ Annual application over 7-year period (1973-79).

Table 2. Corn production and N utilization in 1983 as influenced by residual NO_3-N from annual N applications from 1973-1979 at Lamberton.

Annual N rate	Final popl'n.	Fodder N	Silage Yield	Silage N uptake	Grain Yield	Grain N	Grain N removal
lb N/A	ppA x 10^{-3}	%	T DM/A	lb N/A	bu/A	%	lb N/A
18	25.1	.52	2.20	34.9	39.7	1.24	23.3
100	23.1	.43	2.10	32.2	39.0	1.27	23.3
200	23.5	.49	2.11	32.8	36.8	1.27	22.0
400	23.0	.53	2.49	40.6	46.4	1.24	27.3
Signif. Level (%): 1/	83	92	99	99	92	82	94
BLSD (.05) :			.31	7.1			
CV (%) :	5.0	11.	7.7	11.	13.	4.2	15.
200 org.	23.3	.41	2.46	38.9	47.9	1.30	29.4

1/ Probability level that a difference among the four means listed above is significant.

The tile lines flowed from March thru mid-July in 1983. Tile flow among the treatments was extremely uniform and averaged 15.5 acre inches (Table 3). Average flow-weighted NO_3-N concentrations for 1983 ranged from 6.0 mg/L with the 18-lb treatment to 64.8 mg/L with the 400-lb treatment. Even the 100- and 200-lb treatments which did not contain enough residual NO_3-N in the crop rooting zone to improve corn yields resulted in average NO_3-N concentrations of 11.0 and 25.8 mg/L, respectively.

Table 3. Tile line flow, average NO_3-N concentration and total NO_3-N losses into the tile lines in 1983 as related to annual N application rates from 1973-1979 at Lamberton.

Annual N rate	Total tile flow	Nitrate N Avg. Concentration	Nitrate N Losses
lb N/A	acre-inches	mg/L	lb/A
18	15.45	6.0	21.1
100	14.54	11.0	36.3
200	14.15	25.8	82.6
400	16.70	64.8	245.1
200 org.	16.83	15.2	58.0

Nitrate N concentrations in the tile water decreased during the 1983 season (data not shown). Concentrations decreased from 12 mg/L in March to 10 mg/L in July with the 100-lb, from 31 to 17 mg/L with the 200-lb rate, from 79 to 45 mg/L with the 400-lb rate, and from 19 to 12 mg/L with the 200-lb rate as organic N. Nitrate-N concentrations in the 18-lb rate did not change during 1983.

Nitrate-N losses thru the tile lines were quite high (Table 3) and on a relative basis compared very closely to the amount of residual N found in the 10-foot profile (Table 1). The 200-lb organic N treatment gave a lower NO_3-N concentration and resulted in slightly less NO_3-N losses than did the 200-lb N treatment as urea.

Summary - 1983

Large quantities of residual N found below three feet were lost via tile discharge. The amount of loss and NO_3-N concentrations were directly related to residual NO_3-N levels found at these depths. Corn production with the exception of silage yield and total N uptake, however, was not consistently influenced by the carryover NO_3-N. Perhaps the corn roots were not deep enough to extract the carryover N which was susceptible to tile loss.

Results - 1984

Residual NO_3-N remaining in the soil profile after the 1983 season and available for the 1984 crop is shown in Table 4. Very little carryover N was found following the 18-lb treatment. Carryover of NO_3-N in the top 10-feet was 3X and 9X more with the 200- and 400-lb N treatments compared to the 18-lb treatment. Most of the NO_3-N was found below 5' with the 200-lb treatment and below 4' with the 400-lb treatment. Highest NO_3-N concentrations were found in the 6-8' zone and 5-7' zone with each of these treatments, respectively. Although the NO_3-N distributions were similar, approximately 30% less NO_3-N was found in the soil profile with the 200-lb organic N treatment compared to the same N rate as urea.

Table 4. Residual NO_3-N in the 0-20' soil profile in October, 1983 as influenced by previous N application at Lamberton

Profile depth	Annual N rate (lb/A)[1/]			
	18	200	400	200 org.
feet	ppm			
0-1	2.1	2.7	4.7	3.5
1-2	0.3	0.6	1.0	0.6
2-3	0.5	1.1	1.1	0.8
3-4	0.4	1.8	7.4	1.5
4-5	1.2	3.7	18.8	2.2
5-6	1.0	6.8	30.7	4.1
6-7	2.2	10.5	26.6	6.7
7-8	2.1	9.7	17.7	5.8
8-9	2.4	6.5	15.0	4.9
9-10	2.6	5.3	10.1	4.0
10-11	2.2		5.7	
11-12	2.1		5.5	
12-13	1.8		9.6	
13-14	1.8		9.4	
14-15	1.1		5.6	
15-16	1.2		4.6	
16-17	1.7		4.1	
17-18	1.1		6.7	
18-19	0.9		3.5	
19-20	1.4		2.8	
Total lb NO_3-N in 10-foot profile	59	195	533	136

[1/] Annual application over 7-year period (1973-79).

Soil samples were taken to 20' to determine if NO_3-N had moved through the profile over the 11-year period of this experiment. Very low NO_3-N concentrations were found throughout the profile with the 18-lb N treatment (Table 4). Residual NO_3-N from the 400-lb rate moved to at least the 20-foot depth at the end of 11 years.

With the exception of grain N, none of the corn production parameters shown in Table 5 were affected significantly by the carryover NO_3-N in the soil profile (Table 4). Even though a 40-lb rate of N was added to all plots to stimulate plant growth and root development there was little consistent evidence that the corn was obtaining much of the residual NO_3-N. Because of the high plot variability the "apparent" 12 and 30 bu/A responses with the 200- and 400-lb N rates were not significant (P = 61%). High plot variability also erased the apparent silage yield, total N uptake, and grain N removal responses with the 400-lb rate. Corn yields from all plots were substantially below the 138.3 bu/A yield from the 6-row strip where 125 lb NA was added in 1984. Grain N averaged 1.18% N from this 6-row strip.

Table 5. Corn production and N utilization in 1984 as influenced by residual NO_3-N from annual N applications from 1973-1979 at Lamberton.

Annual N rate	Final popl'n.	Leaf N	Fodder N	Silage Yield	Silage N uptake	Grain Yield	Grain N	Grain N removal
lb N/A	ppA x 10^3	%	%	T DM/A	lb N/A	bu/A	%	lb N/A
18	23.5	2.19	.42	3.38	53.3	86.0	1.10	44.7
100	23.1	2.04	.39	3.30	50.9	82.6	1.09	42.8
200	22.7	1.70	.40	3.78	61.9	97.6	1.14	52.8
400	23.7	2.10	.45	4.34	75.3	116.0	1.18	64.5
Signif. Level (%):[1/]	62	86	68	66	81	61	93	83
CV (%) :	3.6	11.	9.1	21.	23.	25.	3.5	24.
200 org.	23.3	1.84	.40	3.18	48.3	77.6	1.08	39.8

[1/] Probability level that a difference among the four means listed above is significant.

Tile lines flowed from March thru mid-July in 1984, but flow was not as consistent among the treatments as in 1983. This was perhaps due to the extremely heavy rains in June (7.73 inches between June 8 and 23). Tile flow averaged 19.7 acre-inches for the 5-month period. Because of the high rainfall amounts it is possible that some water from the untiled borders around the plots may have moved under the plastic barriers and into the tile plots. This could partially explain the high tile flow which almost exceeded precipitation during this 5-month period (20.20").

Table 6. Tile line flow, average NO_3-N concentration and total NO_3-N losses into the tile lines in 1984 as related to annual N application rates from 1973-1979 at Lamberton.

Annual N rate	Total tile flow	Nitrate-N Avg. Concentration	Nitrate-N Losses
lb N/A	acre-inches	mg/L	lb/A
18	18.27	11.9	49.2
100	16.90	14.6	56.1
200	17.15	18.0	69.7
400	20.77	33.0	155.1
200 org.	25.60	16.2	94.1

Average flow-weighted NO_3-N concentrations ranged from 11.9 to 33.0 mg/L in 1984 (Table 6). Concentrations from the 200- and 400-lb treatments were markedly less than in 1983. However, NO_3-N concentrations from the 18-lb and 100-lb treatments were slightly higher than in 1983, probably due to the 40-lb N addition to all plots and to mineralized N which had accumulated during the dry previous year but which had not been taken up by the 1983 crop.

Nitrate-N losses in the tile discharge were again quite sizable in 1984 (Table 6). Even though NO_3-N concentrations have decreased since 1979, the large flow volumes coupled with concentrations between

12 and 33 mg/L resulted in losses ranging from 49 lb/A with the 18-lb treatment to 155 lb/A with the 400-lb treatment. Both NO_3-N concentrations and losses were higher for the 200-lb organic N treatment compared to the same N rate as urea.

Residual NO_3-N remaining in the soil profile after the 1984 season is shown in Table 7. Approximately 2X and 5X as much NO_3-N was found in the 0-10' profile with the 200- and 400-lb N rates, respectively, compared to the 18-lb N rate. Similar to October, 1983, most of the NO_3-N was found below 5' with the 200-lb treatment and below 4' with the 400-lb treatment. Highest NO_3-N concentrations were found in the 6-8' zone and 5-7' zone with each of the treatments, respectively. Although the distribution of NO_3-N within the profiles was similar, 20% less NO_3-N was found in the soil profile with the 200-lb organic N treatment compared to the same N rate as urea.

Table 7. Residual NO_3-N in the 0-10' soil profile in October, 1984 as influenced by previous N application at Lamberton.

Profile depth	Annual N rate (lb/A)[1/]			
	18	200	400	200 org.
feet	ppm			
0-1	1.9	2.8	3.1	2.5
1-2	1.0	1.7	1.8	1.3
2-3	1.2	2.1	2.7	1.2
3-4	1.4	2.6	4.8	1.9
4-5	1.6	3.2	11.7	3.0
5-6	1.7	4.7	19.9	3.8
6-7	2.2	7.1	19.8	6.9
7-8	2.3	8.1	15.7	6.0
8-9	2.8	7.2	13.5	4.9
9-10	2.9	4.8	10.7	3.8
Total lb NO_3-N in 10-foot profile	76	177	415	141

[1/] Annual application over 7-year period (1973-1979).

Summary - 1984

Large quantities of residual N were lost via tile discharge again in 1984. The source of that lost N was thought to be primarily from N mineralized during the previous season as well as that which had accumulated at depths below 4' from the 1973-79 fertilizer applications. Even though NO_3-N concentrations in the water from the high N rates were lower than in past years, the high flow volumes in 1984 resulted in substantial NO_3-N losses via the tile lines. Corn production, with the exception of grain N concentration, was not affected by the carryover NO_3-N from the previous N treatments. Significant amounts of residual NO_3-N still remained in the soil profile below 5' and 4' at the end of 1984 with the 200- and 400-lb N rates, respectively.

12-YEAR TILE DRAIN SUMMARY

Total NO_3-N losses via tile discharge water are presented in Table 8 for the fertilized period (1973-79) and for the residual period (1980-84). Due to higher precipitation in the last 5 years, approximately two-thirds of the 12-year tile flow occurred in the 5-year residual period. Nitrate-N losses during the residual phase of the study approximated the losses during the 7-year fertilizer application period. From 29 to 41% of the fertilizer applied at the 200- and 400-lb N/A rates (the recommended rate is 100 lb N/A) were lost from the soil thru the tile lines during this 12-year period.

Table 8. Summary of NO_3-N losses thru tile discharge from 1973-84 at Lamberton.

Total Applied N (1973-79) 1/	Nitrate-N Lost thru Tiles 2/			Percent of applied N lost
	1973-79	1980-84	1973-84	
lb N/A	lb NO_3-N/A			%
126	80	87	167	-
700	161	138	299	23
1400	299	239	538	29
2800	639	637	1276	41

1/ Does not include the 40-lb rate applied in 1984.

2/ 20.8 acre-inches tile drainage in 1973-79, 43.0 acre-inches in 1980-84.

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

G. L. Malzer, W. W. Nelson, and T. Graff

(Annual reports of this experiment have been reported in Soil Series 74 through 113 and some of this information will not be included here).

The fertilizer treatments have now been applied annually to the same plots area for 25 years. After ear corn removal and stalks cutting, the fall plow down treatments are broadcast on their respective plots and the entire area is then plowed to an approximate 12 inch depth. The fall surface N treatments are then broadcast, with no further working of the plow area. Each plot is 20' by 77.5' and the 4 replications are arranged in a randomized block. Spring N treatments are broadcast before seedbed preparations late in April or early May. The corn is planted in 30 inch rows at a plant population of 20,000 plants/A, using a band starter fertilizer of 8-24-12 at a rate of 180#/A over the entire expermintal area, thus supplying an additional 14 #N/A to all plots. Nitrogen sidedressing treatments were broadcast in June.

The yields obtained in 1984 were below average when considering the long term previous average for this experiment. Treatments averages in 1984 appeared to follow the trends which had been established with the long term average yields.

TWENTY-FOUR YEAR AVERAGE

The average grain yields for the twenty-four years of this experiment are shown in Table 2. Only modest differences were obtained between nitrogen forms, time of application and incorporation in the 1984 experiment. In 1984 with 40 #N/A applied as urea fall plow down was superior to ammonium nitrate fall plow down. When both materials were applied at the same rate to the surface there was essentially no difference. When urea was applied as a spring top dressed treatment, it was also superior to ammonium nitrate. This is observed in the long term average.

Plowing down 160 #N/A in the fall was much more effective than the lower N rates and approached the yields that were obtained with the sidedress application of nitrogen. Urea applied in the fall produced similar yields to spring applications,ammonium nitrate also produced similar yields.

Table 1 Influence of nitrogen form, nitrogen rates,on grain N content, grain N removal, and grain yield on a Webster loam near Lamberton MN. 1984.

N-Rate	N-Cont. Grain	N-Removal Grain	Rep 1	Rep 2	Rep 3	Rep 4	Ave
#/A [1]	%	#/A		Bu/A 15.5 %			
Check	1.09	28.9	43.8	60.1	51.8	69.7	56.4
40 NH_4NO_3 - fpd [2]	1.02	32.2	68.1	72.2	48.4	78.3	66.8
40 Urea fpd	1.06	36.4	65.3	80.1	65.5	79.3	72.6
40 NH_4NO_3 - fps [3]	1.03	32.4	64.4	63.9	62.2	73.8	66.1
40 Urea - fps	1.08	32.3	50.2	72.3	53.4	76.3	63.0
80 NH_4NO_3 - fpd	1.12	38.9	63.0	114.1	53.1	57.2	71.8
80 Urea - fpd	1.00	36.4	62.1	94.5	70.3	79.5	76.6
160 NH_4NO_3 - fpd	1.08	49.9	102.2	102.2	103.2	81.9	97.4
160 Urea - fpd	1.14	51.9	99.3	120.7	79.3	85.2	96.1
40 NH_4NO_3 - std [4]	1.03	31.8	32.7	95.8	59.5	75.5	65.9
40 Urea - std	1.03	38.5	69.6	62.0	82.9	99.6	78.5
80 NH_4NO_3 - std	0.97	36.9	81.8	81.8	72.5	84.2	80.1
80 Urea - std	1.13	44.4	81.0	91.5	57.9	103.1	83.4
40 NH_4NO_3 - sd [5]	1.04	43.1	85.2	88.9	92.5	81.2	87.0
40 Urea - sd	0.99	42.8	76.7	101.3	108.9	81.0	92.0
80 NH_4NO_3 - sd	1.16	58.1	113.8	115.4	83.2	112.0	106.1
80 Urea - sd	1.27	58.1	92.3	92.4	93.5	107.2	96.4
160 NH_4NO_3 - sd	1.13	58.8	84.1	123.9	116.2	114.2	109.6
P-Value	99	99					99
(BLSD.05)	0.12	9.7					19.0

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

[2] fpd - fall plow down

[3] fps - fall plow surface

[4] std - spring top dress

[5] sd - sidedress

Table 2. Yields of ear corn during 24 years on tiled Webster loam near Lamberton with annual applications of NH_4NO_3 or urea nitrogen at different rates, times, and placement.

N-Rate	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973
#/A [1]						Bu/A								
Check	49.5	88.2	26.1	132.6	72.9	33.1	11.1	53.4	102.4	92.8	85.7	40.8	75.6	69.2
40 NH_4NO_3-fpd [2]	42.3	87.5	30.9	148.6	88.6	34.9	26.8	75.7	131.6	109.3	96.3	88.7	113.6	92.0
40 Urea-fpd	55.1	78.2	29.1	148.8	100.3	38.8	19.8	86.9	132.5	124.5	120.4	100.7	113.9	101.2
40 NH_4NO_3-fps [3]	49.0	96.7	29.6	140.1	101.5	45.6	24.3	75.1	135.2	124.6	122.5	81.5	109.9	93.0
40 Urea-fps	62.3	101.3	37.0	140.7	84.1	57.4	30.9	87.2	134.0	136.1	121.2	82.4	106.7	97.8
80 NH_4NO_3-fpd	67.4	97.9	43.6	149.6	100.8	63.4	47.3	114.3	131.2	146.8	134.7	108.0	143.1	121.7
80 Urea-fpd	61.7	76.9	36.7	154.5	104.9	73.0	37.8	117.2	142.6	144.3	141.4	107.8	140.1	117.9
160 NH_4NO_3-fpd	69.8	97.9	46.7	147.7	100.9	70.8	38.5	127.4	140.2	158.7	141.7	120.2	147.6	121.0
160 Urea-fpd	79.4	112.5	43.5	152.8	112.4	73.5	37.7	121.3	149.9	161.0	140.4	110.6	151.7	114.9
40 NH_4NO_3-std [4]	66.2	92.0	45.4	152.2	99.8	63.4	23.7	99.8	128.0	142.0	125.6	84.0	117.0	104.0
40 Urea-std	45.4	91.1	31.4	147.6	100.6	59.8	33.8	95.0	140.5	143.4	118.9	94.6	116.5	97.1
80 NH_4NO_3-std	59.3	90.0	32.7	149.2	112.5	74.2	49.0	128.3	144.7	159.5	140.4	122.7	142.7	118.0
80 Urea-std	57.7	99.1	40.5	149.3	115.7	84.4	41.8	128.6	138.7	155.9	146.2	116.0	142.1	117.6
40 NH_4NO_3-sd [5]	63.6	92.6	39.5	148.6	90.4	54.8	38.6	96.8	133.4	142.3	127.1	104.5	136.0	99.1
40 Urea-sd	57.7	95.6	24.9	142.3	94.1	48.4	50.4	86.1	132.2	143.3	117.1	100.5	133.9	103.9
80 NH_4NO_3-sd	50.4	98.4	46.7	140.7	113.0	68.1	43.8	101.6	137.7	140.3	127.7	97.6	124.7	109.4
80 Urea-sd	76.9	86.4	48.2	143.8	121.4	64.7	47.3	117.0	146.9	166.2	140.5	124.4	149.8	124.0
160 NH_4NO_3-sd	40.7	97.4	77.7	151.7	109.5	77.6	51.4	120.2	141.5	148.3	136.9	104.2	150.0	117.1
Ave. Bu/A	58.6	93.3	39.4	147.5	101.3	60.3	37.8	101.8	135.7	140.9	127.0	99.4	128.6	106.6

	1974	1975 @	1977	1978	1979	1980	1981	1982	1983	1984	24 yr. Ave
Check	53.4	58.4	141.2	64.6	37.6	46.5	65.8	71.0	30.0	56.3	61.8
40 NH_4NO_3-fpd [2]	80.5	88.6	145.1	98.1	63.1	67.6	77.4	91.5	43.0	66.7	79.2
40 Urea-fpd	96.9	96.6	165.2	110.2	76.7	65.2	87.0	119.1	41.0	72.5	86.3
40 NH_4NO_3-fps [3]	88.3	78.2	149.4	101.3	64.6	69.7	89.4	107.4	41.0	66.0	82.2
40 Urea-fps	85.0	78.9	156.8	101.4	80.2	63.8	80.5	113.0	44.0	63.0	84.8
80 NH_4NO_3-fpd	103.6	89.2	156.9	128.4	94.8	90.3	89.6	132.0	55.0	71.8	98.3
80 Urea-fpd	107.2	96.9	146.0	123.6	86.2	84.7	101.8	131.4	46.0	76.6	97.0
160 NH_4NO_3-fpd	113.1	90.4	149.8	129.3	108.7	109.3	91.3	138.2	66.0	97.3	103.9
160 Urea-fpd	105.1	82.4	163.0	124.4	127.3	103.7	97.6	133.8	63.0	96.1	105.4
40 NH_4NO_3-std [4]	82.8	88.0	160.0	97.4	86.6	77.2	90.0	115.0	46.0	65.8	89.1
40 Urea-std	94.5	89.0	165.2	103.9	74.5	64.3	86.6	102.4	47.0	78.5	88.1
80 NH_4NO_3-std	92.9	97.6	162.9	117.1	87.3	74.4	101.4	134.9	57.0	80.0	100.1
80 Urea-std	108.5	93.6	162.2	127.4	100.3	84.4	102.8	125.9	62.0	83.3	102.1
40 NH_4NO_3-sd [5]	82.7	91.8	153.8	106.8	99.2	71.9	83.6	116.1	49.0	86.9	91.3
40 Urea-sd	80.4	92.6	165.4	104.8	94.2	80.4	87.4	116.2	51.0	91.9	91.2
80 NH_4NO_3-sd	87.6	95.3	163.2	110.6	106.3	76.9	79.3	135.2	49.0	106.1	95.6
80 Urea-sd	95.6	90.1	162.8	126.7	118.1	89.6	87.4	131.0	55.0	96.3	103.4
160 NH_4NO_3-sd	105.5	91.3	160.3	126.0	148.0	109.8	96.7	136.3	70.0	109.6	106.4
Ave Yield Bu/A	92.4	88.3	157.2	111.2	91.9	79.4	88.6	119.5	51.0	81.4	92.6
P-Value										99	99
BLSD(.05)										19.0	5

[1] The entire area receivied an additional 14 #N/A as starter fertilizer annually (8-24-12 @ 180 #/A).
@ 1976 No Yields Taken

[2] fpd - fall plow down

[3] fps - fall plow surface

[4] std - spring top dress

[5] sd - sidedress

WEST CENTRAL EXPERIMENT STATION - MORRIS

WEATHER SUMMARY - 1984

Month	Period	Precipitation 1984	Precipitation 94-yr av.	Precipitation Dev. from av.	Temperature 1984	Temperature 94-yr. av.	Temperature Dev. from av.	Soil Temperature (10 cm depth) 1984	Soil Temperature (10 cm depth) 10-yr. av.
January	1-31	0.74	0.68	+ .06	9.7	8.0	+1.7	*	20.7
February	1-29	1.05	0.67	+ .38	24.8	12.6	+12.2	*	23.9
March	1-31	1.28	1.09	+ .19	21.4	26.7	-5.3	*	29.2
April	1-10	0.05	0.58	- .53	42.8	37.9	+4.9	*	
	11-20	1.65	0.65	+1.00	45.2	44.4	+0.8	*	
	21-30	0.64	1.08	- .44	48.6	48.2	+0.4	44.0	
Total or av.		2.34	2.31	+ .03	45.5	43.5	+2.0	*	41.4
May	1-10	1.70	0.78	+ .92	45.8	51.9	-6.1	44.6	
	11-20	0.39	0.95	- .56	58.6	55.8	+2.8	57.5	
	21-31	0.45	1.25	- .80	55.7	60.1	-4.4	59.6	
Total or av.		2.54	2.98	- .44	53.5	56.1	-2.6	54.0	57.1
June	1-10	2.70	1.26	+1.44	65.6	63.1	+2.5	65.6	
	11-20	2.04	1.27	+ .77	63.1	66.5	-3.4	63.6	
	21-30	1.50	1.38	+ .12	68.0	68.2	-0.2	71.0	
Total or av.		6.24	3.91	+2.33	65.6	66.0	-0.4	66.8	69.3
July	1-10	0.68	1.48	- .80	68.2	70.0	-1.8	74.7	
	11-20	0.38	1.03	- .65	69.0	71.3	-2.3	75.6	
	21-31	0.26	1.03	- .77	71.5	71.5	0	77.5	
Total or av.		1.32	3.54	-2.22	69.6	71.0	-1.4	75.9	76.7
August	1-10	1.84	1.05	+ .79	73.5	70.3	+3.2	76.0	
	11-20	0.08	0.90	- .82	72.4	69.2	+3.2	79.4	
	21-31	4.42	0.98	+3.44	66.7	66.9	-0.2	70.2	
Total or av.		6.34	2.93	+3.41	70.7	68.7	+2.0	75.1	73.9
September	1-30	1.82	2.19	- .37	53.2	59.1	-5.9	58.2	61.5
October	1-31	9.21	1.62	+7.59	47.2	47.3	-0.1	48.2	47.8
November	1-30	0.16	0.96	- .80	30.6	29.7	+0.9	32.2	33.6
December	1-31	1.15	0.68	+ .47	13.0	15.5	-2.5	24.5	23.4
April-August Growing Season		18.78	15.67	+3.11	61.0	61.1	-0.1	*	63.8
January-December Annual		34.19	23.56	+10.63	42.1	42.0	+0.1	*	46.7

*Equipment inoperative.

MANURE RATE STUDY

West Central Experiment Station - Morris

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

Solid and liquid beef manures were applied at three rates and the effects were compared against check plots. Results from previous years are given in Soils Series 91, 95, 97, 99, 103, 105, 107, 109, and Misc. Publ. 2-1982-84. The last manure applications were made in the fall of 1978, but fertilizer has been applied to the fertilized check each year.

I. Planting Information

The plots were planted with Pioneer 3901 on May 1, 1984, @ 24,300 seeds/acre. Counter was applied @ 8.8 lbs/acre (1 lb/acre active ingredient) in the row to the entire area at planting. The fertilized plots received 120 + 50 + 50 ($N + P_2O_5 + K_2O$) lbs/acre on October 25, 1983. Lasso @ 2.5 lbs/acre and Bladex @ 2.2 lbs/acre were applied broadcast on May 11. Silage samples were taken by hand on September 17 and the grain harvest was taken with a plot combine on November 2 and 5.

II. Soil Sampling and Analysis

A. 1983 Measurements

NO_3-N was the only variable measured in the fall of 1983. The values shown in Table 1 indicate some changes from NO_3-N level one year earlier. The NO_3-N in the 0-1' zone increased slightly for all treatments, while values decreased or stayed the same for LB and check treatments in the 1-2' zone. Conversely, in the SB and FE treatments, the NO_3N level in the 1-2' zone increased. NO_3-N levels were consistently lower in both the 2-3' and 3-4' zones.

B. 1984 Measurements

Extremely wet conditions prevented NO_3-N samples from being taken in the fall of 1984.

III. Plant Tissue Analysis

The nutrient concentrations in the ear leaves at silking in 1984 are given in Table 2. There were significant effects on all elements. Solid beef manure generally increased leaf levels of P, K, and Fe and decreased leaf levels of Mg and Zn as compared to the fertilized check. The effects of liquid beef manure were similar to those of solid beef manure but the effects were reduced.

IV. Yield Measurements

A. Grain - Yields of the solid beef manure treatments were not significantly different from the fertilized check, but the LB1 and LB2 treatments were both significantly less.

B. Silage - The LB1 and LB2 treatments yielded significantly less than the fertilized check.

V. Summary

The 1984 season was the sixth since manure had been applied. The LB1 and LB2 treatments of manure were no longer adequate for grain yields to be equal to the fertilized check.

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

Table 1. Effect of two types of beef cattle manure and commercial fertilizer on the NO_3-N level of a Tara soil profile - Fall 1983.

Depth	Treatment							
	CK	FE	SB1	SB2	SB3	LB1	LB2	LB3
- ft -	- - - - - - - - - - - - NO_3-N, ppm - - - - - - - - - - -							
0-1	8.5	11.1	16.3	35.4	43.1	13.6	11.9	15.5
1-2	3.4	28.5	36.4	126.7	77.7	9.5	8.5	29.7
2-3	2.0	71.9	78.9	203.3	169.3	31.9	36.6	88.7
3-4	2.3	61.8	41.7	181.0	162.0	29.4	48.0	120.7

Table 2. Summary of analysis of corn leaves at silking - 1984.

Treatment	Elements									
	N	P	K	Ca	Mg	Fe	Zn	Cu	Mn	B
	- - - - - - % - - - - - -					- - - - - ppm - - - - -				
CK	1.87	0.17	1.42	0.45	0.44	82.0	12.3	3.2	60.3	7.4
FE	2.90	0.26	1.74	0.52	0.40	104.9	19.6	4.8	100.3	6.5
SB1	2.67	0.28	2.10	0.47	0.27	109.3	13.7	5.6	92.7	6.7
SB2	2.74	0.37	2.33	0.47	0.22	155.2	11.5	4.5	90.2	6.9
SB3	2.90	0.43	2.46	0.44	0.20	147.6	13.9	4.6	78.9	6.6
LB1	2.37	0.24	1.74	0.51	0.40	99.6	13.1	5.0	86.9	5.6
LB2	2.55	0.29	1.81	0.50	0.36	113.2	12.3	5.1	100.1	7.3
LB3	2.69	0.34	2.10	0.49	0.32	140.0	11.8	5.2	92.0	7.7
Signif. level (%)	99	99	99	94	99	99	99	99	86	99
BLSD(.05)	0.50	0.05	0.12	0.07	0.04	14.4	2.3	1.2	36.4	0.9
CV(%)	10.5	10.4	3.9	6.5	8.1	7.5	10.2	13.1	18.7	7.0

Table 3. Summary of plant measurements - 1984.

Treatment	Grain		Silage		
	Moisture at harvest	Yield @ 15.5% M	Dry matter at harvest	Silage yield (D.M.)	Ear wt. ÷ Silage wt.
	- % -	- Bu/A -	- % -	lbs/A	- % -
CK	25.1	57.0	44.7	6817	54.7
FE	24.8	136.2	42.4	13401	55.7
SB1	22.9	120.0	46.1	13844	59.2
SB2	23.3	116.9	47.9	16107	60.6
SB3	23.1	132.3	45.2	14060	55.9
LB1	24.0	109.0	46.0	10786	57.7
LB2	25.4	112.2	47.7	12563	58.2
LB3	24.3	120.2	48.7	14568	61.0
Signif. level (%)	47	99	93	99	21
BLSD(.05)	-	22.6	4.6	1962	-
CV(%)	7.2	11.8	4.8	9.4	9.4

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

West Central Experiment Station - Morris
S. D. Evans, P. R. Goodrich and R. C. Munter

The experiment initiated in 1970 was continued. Treatments and results from previous years are given in Soil Series 88, 89, 91, 95, 97, 99, 103, 105, 107, 109, and Misc. Publ. 2-1982-84. Manure was applied in 1970 and 1971 only. Fertilizer has been applied to the fertilized checks each year.

I. Planting Information

The plots were planted with Pioneer 3901 on May 1, 1984, @ 24,000 seeds/acre. Counter was applied @ 8.8 lbs/acre (1 lb/acre active ingredient) in the row to the entire area at planting. The fertilized plots received 120 + 50 + 50 ($N + P_2O_5 + K_2O$) lbs/acre on October 25, 1983. Lasso @ 2.5 lbs/acre and Bladex @ 2.2 lbs/acre were broadcast on May 11. Silage samples were taken by hand on September 17 and the grain harvest was taken with a plot combine on November 5.

II. Soil Sampling and Analysis

A. 1983 Measurements

NO_3-N was the only variable measured in the fall of 1983 (Table 1). In the fall of 1982 the total NO_3-N in the 0-4' profile was greater on all manure treatments than on the fertilized check. The 1983 values indicate that total NO_3-N of LB in the 0-4' profile is greater than the fertilized check, while SB and LH are now less.

B. 1984 Measurements

Extremely wet conditions prevented NO_3-N samples from being taken in the fall of 1984.

III. Plant Tissue Analysis

The nutrient concentrations in the ear leaves at silking in 1984 are given in Table 2. There were significant effects on many elements. The N and Zn concentrations were less for all manure treatments when compared to the fertilized check. Concentrations of Mg were less for SB and LB, and Fe was less for LH as compared to the fertilized check. The SB and LB treatments had significantly greater concentrations of K than did the fertilized check leaves.

IV. Yield Measurements (Table 3)

A. Grain - The LH treatment was the only treatment which had a significantly lower grain yield than the fertilized check.

B. Silage - The silage yield for the LH treatment was also the only one significantly lower than the fertilized check.

V. Summary

This is the first year since manure treatments were applied in 1970 and 1971 that yields were significantly lower for a manure treatment as compared to the fertilized check. Grain and silage yields were both significantly lower for the LH treatment. However, plant analysis indicates that the other two manure treatments may be approaching critically low levels of nutrients, especially N, Mg and Zn.

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

Table 1. Levels of NO_3-N in a Tara soil thirteen years (Fall 1983) after the application of high rates of manure.

Depth	Treatment				
	CK	FE	SB	LB	LH
- ft -	- - - - - - - - - - - NO_3-N, ppm - - - - - - - - - - -				
0-1	7.4	8.8	11.9	10.3	7.4
1-2	1.7	20.8	3.1	17.7	3.0
2-3	1.1	58.1	22.6	65.9	26.6
3-4	1.8	52.1	56.2	105.0	33.9

Table 2. Summary of analysis of corn leaves at silking - 1984.

Treatment	Elements									
	N	P	K	Ca	Mg	Fe	Zn	Cu	Mn	B
	- - - - - - % - - - - - -					- - - - - - ppm - - - - -				
CK	1.38	0.14	1.53	0.45	0.38	80.3	10.6	4.0	62.8	7.7
FE	2.92	0.26	1.68	0.52	0.39	108.6	19.4	5.0	75.4	7.1
SB	2.28	0.27	2.13	0.46	0.24	100.8	12.0	5.1	86.5	7.4
LB	2.24	0.30	2.15	0.47	0.25	102.6	11.7	5.6	74.8	7.3
LH	2.09	0.28	1.93	0.47	0.31	90.7	14.3	4.8	65.7	7.5
Signif. level (%)	99	99	99	94	99	99	99	77	77	17
BLSD(.05)	0.52	0.05	0.25	0.05	0.09	13.9	2.1	-	-	-
CV(%)	12.8	10.3	7.2	5.2	14.7	7.4	8.6	15.8	16.6	8.7

Table 3. Summary of plant measurements - 1984.

Treatment	Grain		Silage		
	Moisture at harvest	Yield @ 15.5% M	Dry matter at harvest	Silage yield (D.M.)	Ear wt. ÷ Silage wt.
	- % -	- Bu/A -	- % -	- lbs/A -	- - % - -
CK	23.4	52.6	44.5	7614	51.7
FE	23.7	122.5	43.4	15172	56.1
SB	22.9	117.6	48.8	13630	58.5
LB	22.6	109.9	47.3	13030	54.8
LH	23.8	76.7	48.1	11215	55.0
Signif. level (%)	50	99	82	99	83
BLSD(.05)	-	28.7	-	3877	6.4
CV(%)	3.9	16.0	6.1	16.4	5.4

SOIL TEST LAB COMPARISON

West Central Experiment Station - Morris

S. D. Evans and G. A. Regimbal

In west central Minnesota there are several laboratories where soil samples are analyzed and fertilizer recommendations given. Recommendations of commercial laboratories sometimes differ greatly from the University of Minnesota Soil Testing Laboratory. In order to develop educational material for extension soils specialists, trials were started at the West Central Experiment Station in 1980 on a corn-wheat rotation. Results from 1980-83 trials were summarized previously (Soil Series 109 and Misc. Publ. 2).

In the fall of 1983 soil samples from the plow layer and 0-2' zone (corn only) were taken from all plots except the check. The soil from the four replications was combined to make two samples (plow layer and 0-2') from each treatment. The samples were dried thoroughly, mixed, subdivided and sent to the appropriate laboratory. Recommendations were requested from five laboratories for corn at a yield goal of 130 Bu/A and spring wheat at a yield goal of 65 Bu/A. Analyses requested were (1) a complete analysis on the plow layer samples and (2) a nitrate-N analysis and recommendation on the 0-2' samples for treatments to be planted to wheat. After receiving the soil tests and recommendations (Tables 1 and 2), the fertilizer treatments were calculated with an adjustment for soil build-up with Lab C. Lab C gave no indication that the 0-2' sample was used for the nitrogen recommendation on wheat.

General

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

Wheat

The N, P, K and S were applied by hand on October 26, 1983. Zinc, manganese, copper and boron were dissolved in water and sprayed on the plots on October 27. All plots were then moldboard plowed. In the spring the plots were field cultivated and dragged. On April 24, 1984, the plots were seeded to Era wheat @ 1 3/4 Bu/A. Hoelon was applied @ 3 pts/A on May 29 and Bromate @ 1 pt/A on June 1. The plots were harvested with a plot combine on August 9.

Corn

N, P, K and S were applied by hand on October 26, 1983. Zinc, Manganese, copper and boron were dissolved in water and sprayed on the plots on October 27. All plots were then moldboard plowed. In the spring the plots were field cultivated and dragged. On May 1, 1984, the plots were planted to Dekalb-Pfizer T950 @ 24,300 seeds/acre. Counter was applied at planting @ 1 lb/A (active ingredient). Lasso @ 3 lbs/A and Bladex @ 2.2 lbs/A were applied broadcast on May 3. The plots were harvested on October 23 with a plot combine.

Results and Discussion of the Wheat Trial

The soil tests and fertilizer recommendations are shown in Table 1. The soil test results were somewhat variable between labs. The recommended amounts of N, P and K had wide variations and labs B, C and D suggested applying sulfur. Lab B also recommended zinc, manganese, and copper and lab C recommended boron. There was a significant difference in lodging between labs, but no differences in grain yield, grain moisture or plant height (Table 3).

Lab E had the lowest fertilizer cost ($30.45) and the highest return over fertilizer ($323.55), while lab D had the highest fertilizer cost ($57.70) and the lowest return over fertilizer ($275.10), except for the check ($151.60) (Table 4).

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

Results and Discussion of the Corn Trial

Soil test results are shown in Table 2. Once again recommendations varied for N, P, K and micronutrients. Sulfur was recommended by labs B, C and D and lab B also recommended manganese and copper and lab D recommended boron.

Table 3 shows no significant difference between labs in plant height, plant weight, grain yield or grain moisture.

Fertilizer costs ranged from $42.40 (lab E) to $67.58 (lab B) (Table 4). Economic return over fertilizer had a range of $245.46 (lab B) to $282.91 (lab D).

Five-Year Summary

The combined average return per year for 1980-1984 shows a range of $38.82 (lab B) to $79.80 (lab E) over the check. For wheat, lab C shows the smallest return over the check, while lab E shows the greatest. For corn, lab B is showing a negative return over the check, while after five years, lab E has returned $101.64 over the check. It appears that the recommendations of labs for sulfur and micronutrients are not resulting in significantly higher yields over those which do not; consequently, economic returns over fertilizers are less for those labs.

Table 1. Soil test results and the suggested fertilizer program for wheat in 1984.

	Soil Test Results				
Test	Lab A	Lab B	Lab C	Lab D	Lab E (UM)
pH	8.0	7.9	7.8	7.9	7.9
P (Bray 1), ppm	-	13 L	-	-	6.0
($NaHCO_3$), ppm	8 L	12 L	23	8 L	7.0
K, ppm	108 H	133 M	127	120	120
O.M., %	3.4	3.7 H	2.6	MH	M
Ca, ppm	5100	2650 H	4422	3720 M	-
Mg, ppm	480	467 VH	453	560 H	-
Na, ppm	9	-	7	-	-
S, ppm	4 L	5 L	3	6 L	1.0
Fe, ppm	12.5 H	12 M	13.1	7.8 H	-
Mn, ppm	4.5 VH	5 L	5.9	2.1 ADQ	-
Zn, ppm	1.02 H	1.9 M	1.3	1.6 H	1.3
Cu, ppm	0.65 H	0.9 M	0.6	0.54 H	-
B, ppm	-	1.4 H	0.6	1.4 M	-
ENR (lb/A)	-	85	-	-	-
Nitrate-N (lb/A)	60	14 M	6	38	16
C.E.C. (meq/100 g)	29.8	17.5	26.2	23.8	-
Soluble salts (mmhos/cm)	0.3	-	0.2	-	-

	Suggested Fertilizer Program[1]				
Nutrient	Lab A	Lab B	Lab C	Lab D	Lab E (UM)
	- - - - - - - - - -		(lb/A)	- - - - - - - - - -	
Nitrogen	92	100	115	70	100
Phosphorus (P_2O_5)	62	70	40	40	40
Potassium (K_2O)	63	95	190[2]	65	30
Sulfur	0	12	20	35	0
Zinc	0	1.5	0	0	0
Manganese	0	3	0	0	0
Copper	0	0.5	0	0	0
Boron	0	0	1.0	0	0

[1]All values indicate pounds of nutrient suggested per acre for a yield goal of 65 bushels per acre for wheat.

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

Table 2. Soil test results and the suggested fertilizer program for corn in 1984.

Test	Soil Test Results				
	Lab A	Lab B	Lab C	Lab D	Lab E (UM)
pH	7.8	7.7	7.4	7.7	7.7
P (Bray 1), ppm	-	17 M	-	-	14
($NaHCO_3$), ppm	17 L	7 L	18	12 M	10
K, ppm	123 H	142 M	151	129 H	128
O.M., %	4.3	3.8	2.7	MH	H
Ca, ppm	4000	2620 H	2753	3400 M	-
Mg, ppm	595	565 VH	543	460 M	-
Na, ppm	10	-	17	-	-
S, ppm	3 L	4 L	2	8 ML	2.0
Fe, ppm	14.6 H	17 H	20.6	9.6 H	-
Mn, ppm	5.8 VH	6 L	7.5	2.3 ADQ	-
Zn, ppm	1.27 H	2.2 M	2.0	1.4 H	1.8
Cu, ppm	0.59 H	0.7 L	0.6	0.52 H	-
B, ppm	-	1.3 H	1.0	0.9 L	-
ENR (lb/A)	-	86	-	-	-
Nitrate N (lb/A)	-	-	-	-	-
C.E.C. (meq/100 g)	25.3	18.2	18.7	21.5	-
Soluble salts (mmhos/cm)	0.38	-	0.2	-	-

Nutrient	Suggested Fertilizer Program[1]				
	Lab A	Lab B	Lab C	Lab D	Lab E (UM)
	- - - - - - - - - -		(lb/A)	- - - - - - - - - -	
Nitrogen	132	145	140	145	90
Phosphorus (P_2O_5)	97	80	55	75	90
Potassium (K_2O)	54	125	125[2]	75	40
Sulfur	0	15	24	30	0
Zinc	0	0	0	0	0
Manganese	0	3	0	0	0
Copper	0	1	0	0	0
Boron	0	0	0	1	0

[1]All values indicate pounds of nutrient suggested per acre for a yield goal of 130 bushels of corn per acre.

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

Table 3. Effect of fertilizer recommendations on various plant measurements - 1984.

Lab	Wheat				Corn			
	Plant Lodging	Plant Height at Harvest	Grain Yield	Grain Moisture	Early Plant Height	Early Plants (10) Dry Weight	Grain Yield	Grain Moisture
	- Score[1] -	- in -	- Bu/A -	- % -	- in -	- grams -	- Bu/A -	- % -
A	1.8	32.5	85.1	13.4	29.6	66.5	116.2	25.4
B	2.2	31.5	84.2	13.4	30.6	81.0	111.8	24.9
C	2.5	31.2	87.0	13.4	30.0	75.5	118.7	25.4
D	1.5	32.5	83.2	13.3	29.4	76.0	121.3	25.0
E (UM)	1.8	32.2	88.5	13.3	29.0	70.0	113.9	25.5
Check	1.0	25.2	37.9	13.2	28.6	68.0	88.3	26.2
Signif. level (%)	91	99	99	47	30	41	97	96
BLSD (.05)	0.7	2.2	8.0	-	-	-	22.2	0.9
CV (%)	24.1	5.0	7.5	1.7	6.3	17.5	11.7	2.1

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

Table 4. Economic return over fertilizer costs - 1984.

Lab	Wheat: Value of Crop @ $4/Bu	Wheat: Fertilizer Cost*	Wheat: Return over Fertilizer	Wheat: Return over Check	Corn: Value of Crop @ $2.80/Bu	Corn: Fertilizer Cost	Corn: Return over Fertilizer	Corn: Return over Check
	$/A							
A	340.40	38.39	302.01	150.41	325.36	52.90	272.46	25.22
B	336.80	53.59	283.21	131.61	313.04	67.58	245.46	-1.78
C	348.00	36.38	311.62	160.02	332.36	60.32	272.04	24.80
D	332.80	57.70	275.10	123.50	339.64	56.73	282.91	35.67
E (UM)	354.00	30.45	323.55	171.95	318.92	42.40	276.52	29.28
Check	151.60	0	151.60	-	247.24	0	247.24	-

*Values used ($/lb) were as follows: N = $0.26, P_2O_5 = $0.25, K_2O = $0.12, S = $0.20, Zn = $0.95, Mn = $1.05, Cu = $2.40, B = $2.30.

Table 5. Five-year summary of yields and economic returns - 1980-84.

Lab	Wheat*: Total 5-year Yield	Wheat*: Total 5-year Fertilizer Cost	Wheat*: Economic Return over Fertilizer	Wheat*: Return over Check	Corn**: Total 5-year Yield	Corn**: Total 5-year Fertilizer Cost	Corn**: Economic Return over Fertilizer	Corn**: Return over Check	Combined Average Return per Year
	- Bu/A -	$/A			- Bu/A -	$/A			- $/A -
A	312.0	137.37	1110.63	252.23	572.9	250.53	1269.17	58.59	62.16
B	320.4	204.23	1077.37	218.97	563.4	300.03	1185.71	-24.87	38.82
C	319.4	235.16	1042.44	184.04	584.2	326.63	1223.01	24.80	41.77
D	302.6	161.55	1048.85	190.45	577.9	291.10	1241.66	31.08	44.31
E (UM)	317.1	112.63	1155.77	297.37	572.1	203.72	1312.22	101.64	79.80
Check	214.6	0	858.40	-	458.6	0	1210.58	-	-

*Wheat valued at $4/Bu, 1980-84.

**Corn valued at $3.00, $2.40, $2.00, $3.00, and $2.80/Bu in 1980, 1981, 1982, 1983, and 1984, respectively.

EFFECTS OF NITROGEN AND PHOSPHORUS APPLICATION METHODS ON SPRING WHEAT - 1984

West Central Experiment Station - Morris

S. D. Evans, W. E. Fenster, J. Grava and G. L. Malzer

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

Experimental Procedures

Soil sample results by rep are given in Table 1. The broadcast 0-46-0 was applied by hand on November 2, 1983. The anhydrous ammonia and 10-34-0 were applied with a dual applicator the same day. The material was placed at about an 8-inch depth with a knife spacing of 12 inches. In the spring of 1984 the plots were field cultivated and drug on April 25. The study was seeded to Era wheat @ 1 3/4 bu/acre.

Whole plant samples were collected on July 26 and were used to calculate forage yield and N and P uptake. The plots were harvested on August 10 with a plot combine.

Yield and Nutrient Uptake

The nutrient uptake and yield results are given in Table 2. A significant difference in dry matter yield occurred between treatment 5 and treatment 8. The difference appears to be due to fertilizer rate and not application method.

The phosphorus concentration in the tissue and phosphorus uptake at the soft dough stage tended to decrease or stay the same as N was increased, except with drill applications where levels stayed the same or increased slightly.

The N concentration and uptake was not significantly different between 50 and 100 lbs N or application methods, but the trend was for increased levels as N was increased.

Grain yield was not significantly affected by N rate except for the N only treatment in which yield was decreased when N was increased. At the 100 N rate the NP1, NP2 drill placement and N knife, P broadcast treatments all outyielded the N only treatment.

Grain protein levels were not significantly different between N rates or placement methods.

The 1984 study on placement methods shows very few effects due to placement or rates on any of the variables measured.

Table 1. Soil test results October 1984.

Rep	P Soil Test Olsen	P Soil Test Bray	Exch. K	Soil pH	NO_3-N[1]
	- - lb/A - -		- lb/A -		- lb/A -
1	8	14	278	8.0	43.2
2	16	17	302	7.8	
3	14	17	289	7.8	53.6
4	9	16	281	8.0	
5	9	14	283	7.9	44.0
6	11	14	297	7.7	

[1]Nitrate samples were taken in October 1983 (0-2') and are an average of reps 1-2, 3-4, and 5-6.

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Table 2. The effect of N and P application methods on spring wheat.

Trt. No.	Treatment Description: Placement	Fertilizer Treatment: Source[1]	N	P_2O_5	Whole Plants @ Soft Dough Stage: D.M. Yield	Phosphorus	Phosphorus Uptake	Nitrogen	Nitrogen Uptake	Grain Yield	Grain Protein
			- lb/A -		lb/A	%	lb/A	%	lb/A	Bu/A	%
1	Check	-	0	0	7865	.204	16.1	1.20	95.0	53.5	12.2
2	Dual NP, Knife	AA,APP	50	40	8844	.217	19.2	1.34	119.6	65.7	12.3
3	Dual NP, Knife	AA,APP	100	40	9022	.192	17.3	1.51	135.8	63.4	13.3
4	N Knife, P BCST	AA,TSP	50	40	8883	.243	21.6	1.34	119.7	65.5	12.7
5	N Knife, P BCST	AA,TSP	100	40	9232	.203	18.8	1.52	140.5	65.4	13.4
6	N Knife, NP1 DRILL[2]	AA,UR,TSP	50	40	9098	.225	20.6	1.33	122.2	68.2	12.3
7	N Knife, NP1 DRILL[2]	AA,UR,TSP	100	40	9151	.226	20.7	1.46	133.1	65.7	13.0
8	N Knife	AA	50	0	8303	.210	17.5	1.27	107.0	64.2	12.2
9	N Knife	AA	100	0	8473	.190	16.1	1.41	120.8	59.4	12.9
10	NP Knife, NP2 DRILL[3]	AA,APP,UR,TSP	50	40	8616	.203	17.4	1.22	105.2	64.6	12.6
11	NP Knife, NP2 DRILL[3]	AA,APP,UR,TSP	100	40	8880	.209	18.6	1.48	131.2	66.0	12.7
Significance level (%):					98	98	99	95	99	99	96
BLSD(.05)					894	.035	3.7	0.29	29.3	4.6	1.1
CV(%)					7.4	11.9	14.9	14.3	17.8	6.4	5.8

[1]AA = Anhydrous Ammonia (82-0-0), APP = Ammonium Polyphosphate (10-34-0), TSP = Triple Super-Phosphate (0-46-0), UR = Urea (46-0-0).

[2]NP1 DRILL = 10 N + 40 P_2O_5 at seeding with drill.

[3]NP2 DRILL = 10 N + 10 P_2O_5 at seeding with drill.

EFFECT OF RESIDUAL SOIL NITRATE-NITROGEN ON SOYBEAN YIELDS

West Central Experiment Station - Morris
S. D. Evans and G. L. Malzer

Many studies in Minnesota and other midwestern states have shown little effect of nitrogen fertilization on soybeans. Trials in Nebraska by Rehm and Sorenson (1977) showed some response to carryover nitrate-nitrogen. There are some reports from farmers in Minnesota that soybeans seem to yield more following corn which was well fertilized with nitrogen. This study was set up to determine if NO_3-N deep in the soil profile would affect soybean yields in Minnesota. The study was set up on a Doland silt loam on a site where a nitrogen fertilization study on corn had been carried out since 1973. Nitrogen rates in this study ranged from a low of 9 lbs/acre (starter fertilizer only) to a high of 160 lbs/acre.

Experimental Procedures

Soil samples were taken in 1-foot increments to a depth of 5 feet in the fall of 1983 to measure the level and location of the residual NO_3-N from the previous treatments. In the spring of 1984 the area was field cultivated once. Treflan @ 3/4 lb/acre and Amiben @ 2 1/5 lbs/acre were applied, the area was field cultivated twice and drug once. The experiment was seeded to Evans soybeans @ 9.5 seeds/foot in 30-inch rows on May 17. Soil samples were taken again to a 5-foot depth on June 17, just as the soybeans were beginning to bloom. The plots were harvested with a plot combine on September 28.

Results and Discussion

The results of the NO_3-N samplings are shown in Tables 1 and 2. The previous N treatments greatly affected the NO_3-N levels in the soil. Soybean yields (Table 3) were not significantly different. Further analysis of the data will be carried out to analyze individual plot yields in relation to the NO_3-N in the various depth increments.

Table 1. Effect of previous N treatment on the residual soil nitrate-nitrogen on a Doland silt loam (October 12, 1983).

Depth Increment	Previous N Treatment (lbs/acre)				
	9	40	80	120	160
- ft -	- - - - - -		NO_3-N (ppm)	- - - - - -	
0-1	2.5	2.9	3.8	5.1	8.6
1-2	1.4	1.4	2.4	7.1	28.5
2-3	1.1	2.0	15.2	33.1	65.0
3-4	1.9	6.4	15.3	42.9	44.3
4-5	4.2	6.6	9.9	30.7	16.5
Average	2.2	3.9	9.3	23.8	31.4

Table 2. Effect of previous N treatment on the residual soil nitrate-nitrogen on a Doland silt loam (June 17, 1984).

Depth Increment	Previous N Treatment (lbs/acre)				
	9	40	80	120	160
- ft -	- - - - - -		NO_3-N (ppm)	- - - - - -	
0-1	13.6	12.8	13.3	17.3	14.8
1-2	6.0	6.6	8.6	9.4	23.4
2-3	5.0	13.9	8.7	13.7	38.2
3-4	5.7	9.5	16.1	24.4	42.5
4-5	5.7	9.7	15.6	35.3	44.0
Average	7.2	10.5	12.5	20.0	32.6

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Table 3. Effect of previous N treatment on soybean yields.

Previous N Treatments	Soybean Yields
- - lbs/acre - -	- bu/acre -
9	40.6
40	40.2
80	43.0
120	43.1
160	42.5
Significance Level (%)	36
BLSD (.05)	-
C.V. (%)	8.2