SOIL SERIES 112

A REPORT ON FIELD RESEARCH IN SOIL SCIENCE

The 1982 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, Scientists at the branch stations of Crookston, Lamberton, Morris, and Waseca; Becker and Staples experimental site; and Soils and Crop area agents. Associated personnel from the Soil Conservation Service, and the Soil and Water Research group of the SEA-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 assistants, 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 1981 experiments only and should be regarded on this basis. Since most data are from only 1981 studies, conclusions are not conclusive and are thus not for further publication without the written consent of the individual researchers involved.

The University of Minnesota, including the Agricultural Experiment Station, is committed to the policy that all persons shall have equal access to its program, facilities, and employment without regard to race, creed, color, sex, national origin, or handicap.

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Soil Moisture

by

D. G. Baker, W. W. Nelson, S. Evans,
G. Randall, G. Varvel, and D. L. Ruschy

Two relative unknowns in the hydrologic cycle have been evapotranspiration and soil moisture. Because it is so difficult to measure, evapotranspiration has usually been either estimated or calculated by empirical formula. The estimates are usually based upon the difference between income and outgo of water from a watershed. If calculated, then it is done by empirical formulas using a minimum of the necessary data, since only temperature and precipitation data are readily available. Soil moisture in turn has usually been omitted because (a) it seemed insignificant relative to the other elements of the hydrologic cycle, (b) the data are difficult to find, or (c) it is simply too difficult and time consuming to get the original data.

The part that soil moisture plays with respect to both our climate and the hydrologic cycle is seldom appreciated. First and foremost soil moisture provides a reservoir which the plants can draw upon between periods of precipitation. For example, over and above the growing season precipitation, the soils in the Lamberton area supply on the average nearly 4 inches of water received and stored outside the heart of the growing season. This is of particular importance, since the normal precipitation received during mid-June through August is ordinarily insufficient for the crop. This deficiency increases from east to west across the state.

Just how soil water affects our climate is even less well understood. Since solar energy is required to evaporate the water consumed in evapotranspiration - approximately 20 inches per year - there is little excess energy available for heating until water supplies are low. Thus as long as soil moisture supplies are plentiful the air temperature does not show great variation. High air temperatures in Minnesota occur as soil moisture supplies begin to be depleted, usually in July and August. This becomes most obvious in periods of drought.

In summary then, soils provide an all important water reservoir and the release of this water by evapotranspiration from the soil and plant surfaces to the atmosphere results in a modification and amelioration of the climate.

1982 Minnesota Spring Soil Moisture Situation

by

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D. L. Ruschy, Soil Science Dept.

Soil Moisture measurements were obtained from 51 sites in late October and early November 1981 by the Soil Monitoring Program directed by the University of Minnesota Soil Science Department and sponsored in part by State Climatology, Division of Waters, Minnesota Department of Natural Resources. Further, to obtain a more detailed analysis of the soil moisture amount, some 670 precipitation reports were used in conjunction with the soil moisture measurements. The soil measurements were made in the first five feet of medium to fine textured soils. Most sites were under corn, except for the northwest where the sites were under small grains (mostly wheat).

The potential plant available water content of the soils sampled averaged 8 to 12 inches. Thus, one should adjust the amount of plant available water held in lighter (sandy) or heavier (clay) soils.

The major feature found in the autumn 1981 soil moisture survey is the extensive areas of average to above average soil water across the state (see Figure 1). It is only in a relative small area adjacent to the South Dakota border extending from southern Big Stone county southward to Lac Qui Parle, western Yellow Medicine, Lincoln, southern Lyon, and northern Pipestone, Murray, and Cottonwood counties where soil moisture is about one to three inches below average.

Major areas of above average soil moisture (wet soils), where the soils contain 2-3 inches above average soil moisture include all of the southeastern and south-central counties west to central Martin, Watonwan, and Brown counties and north, through central McLeod, northern Carver and Scott and southern Dakota counties. Also, the "wet" areas include almost all of the northwestern and north-central counties. Other small "wet" areas are southeast Pope, southwest Stearns and northern Kandiyohi and Meeker counties; and a small area in southeast Crow Wing, southern Aitkin, northwest Pine, and northern Mille Lacs and Kanabec counties.

The spring 1982 soil moisture outlook is therefore in general one of adequate to excessive soil moisture except for the relatively small area in the extreme southwestern and west-central part of the state already mentioned. In the areas of average and higher soil moisture contents, most of the over-winter precipitation is expected to runoff this spring with little moisture entering the soil. An exception is the forested areas of north-central and northeastern Minnesota where most of the runoff will be retained. Even here, wherever the autumn soil moisture indicates above average water content, the spring runoff is expected to be greater than usual.

An interesting situation relative to the entry of spring snowmelt into the soil, or its loss as runoff, is the depth to which soils have frozen. Except for the forested areas of the state, the soil freezing depth has been determined essentially by the date of the first permanent snow cover. An area covering parts of 15 counties in the southeast, extending from Martin to Houston counties and a larger area extending from South Dakota eastward that includes the Twin Cities is where there has been a continous snow cover since December 1.

As of January 19, the frost depth in these areas was about 12-16 inches, 12 at Waseca, 14 at Lamberton, and 16 at St. Paul. These measurements are approximately 20 inches below normal for this time of year. Elsewhere, with a continous snow cover only since December 25 or later, the freezing depth is generally at least 30 inches. For example, at the Morris Agricultural Experiment Station and at the North Dakota Agricultural Experiment Station at Fargo, the soils are frozen to 38 and 39 inches, respectively. At the Crookston Agricultural Experiment Staion the depth is about 30 inches. This is near their average for this time of year. Maximum freezing depth is usually reached in early March in Minnesota.

Of real concern is the chance that soils currently below average in water content will remain below average this spring. Long term data indicate there is one chance in three that soil water will remain below average this spring - or two chances in three that soil water will be average or greater. For the major portion of the state, which has average to above average soil water content, the chances are almost 9 out of 10 that the wet soils will have an average or greater water content, and 7 chances out of 10 that the soils with an average content will have the same or better this spring.

As a result of this soil moisture outlook for Minnesota, the spring planting can be expected to be delayed this year. This situation will probably be most serious in the Red River Valley where the high moisture content soils in conjunction with the level terrain have the potential to delay operations considerably.

This report also contains a map of the precipitation for the agricultural year which runs from September 1, 1980 to August 31, 1981 and a set of graphs showing how the precipitation during that period varied from the normal at six Experiment Stations, (Figures 2 and 3 respectively).

The amount of precipitation and the time it occurred for the 1980-81 agricultural year as a whole was near ideal for most of the agricultural area of the state. The fall, 1980 recharge was above normal except in the west central and southwest. The winter and spring had less precipitation than normal. This worked in the favor of the farmers as they had good planting conditions. The wet summer (June, July, and August) with 2 to 6 inches above normal precipitation amounts was most ideal for crops. These above normal rains, coupled with the adequate soil moisture reserves over most of the state, resulted in record or near record yields for most agricultural districts, except for the southwest where the summer rains came in time to provide a fair crop in the dry areas.

The precipitation map shows that the driest areas were in the southwest and along the western edge of Minnesota as far north as Moorhead. The wettest area was the entire southeast and most of south central and central areas and smaller wet areas in all of the other districts. It was particularly wet in Red Lake and eastern Polk counties.

The graphs of precipitation for the six experiment stations show the variation of rainfall across the state and through the year. All the graphs show the dry winter (the dashed line representing the normal precipitation patterns rises faster than the solid line, which is the 1980-81 precipitation), from late October-early November to late February-early March. All the stations showed the effect of the above normal summer rainfall as the solid line then started climbing faster than the dashed (or normal) line. These summer rains allowed the season total to reach normal at all stations except Waseca, where the 1980-81 total was 7 inches above normal (36.91 for 1980-81 vs. 29.95 for the normal) and Lamberton which was about 6 inches below normal (18.62 for 1980-81 vs. 24.80 for the normal) Even though Lamberton was 6 inches below normal at the end of the agricultural year they were able to produce a fair crop as the summer rains were about three and one half inches above normal.

NOVEMBER, 1981

Date	Cooperator	Address	Crop	Avail..Water	Capacity
10/20	Viken	Roseau	Wheat	13.11 Inches	13.58 In.
10/21	Riopelle	Argyle	Wheat	6.07	13.34
10/21	Driscoll	E. Grand Forks	Wheat	9.44	13.58
10/22	Christenson	Thief River Falls	Wheat	9.92	10.30
10/22	Buchholtz	McIntosh	Wheat	6.80	10.30
10/22	Brendamuhl	Moorhead	Wheat	9.27	13.34
10/22	Lieseth	Moorhead	Wheat	9.62	13.58
10/23	Sethre	Carlisle	Wheat	7.19	12.75
10/23	Evenson	Fergus Falls	Wheat	1.96	12.75
10/28	Homan	Beardsley	Wheat	5.64	13.50
10/28	Dimberg	Ortonville	Corn	1.16	12.75
10/28	Nesvold	Madison	Corn	5.87	12.75
10/23	Pfau	Freeport	Corn	8.95	8.03
10/19	Powers	Hugo	Corn	7.35	8.03
10/27	Krause	Buffalo	Corn	6.51	13.34
10/27	Marklowitz	Litchfield	Corn	7.15	9.34
10/27	Rhoda	Raymond	Corn	7.18	12.23
10/27	Scheibel	Bird Island	Corn	14.27	13.50
10/30	Haubrich	New Ulm	Corn	7.49	14.50
10/29	Jeremiason	Minneota	Corn	6.93	12.23
10/29	Horton	Pipestone	Corn	6.69	13.99
10/29	Keller	Slayton	Corn	7.87	12.23
10/29	Turner	Bingham Lake	Corn	9.10	13.82
10/29	Ruschy	Sherburn	Corn	7.81	9.34
10/30	Van Sickle	Garden City	Corn	Not Available	
10/30	Seetin	Huntley	Corn	15.49	14.50
11/ 4	Hassing	Wells	Corn	7.07	14.50
11/ 4	Gniffke	Hayward	Corn	Not Available	
11/ 3	Goodsell	Spring Valley	Corn	9.95	10.30
11/ 3	Hoscheit	Caledonia	Corn	14.28	15.61
11/ 3	Carter	Eyota	Corn	11.38	15.61
11/ 4	Nordling	Lakeville	Corn	Not Available	
11/ 3	Olson	Welch	Corn	12.16	15.61
11/ 4	(Airport)	Fairbault	Soybeans	Not Available	
		S.C.S. SITES			
10/30	Hamann	Luverne	Corn	11.40	9.81
11/ 6	McNab	Brewster	Alfalfa	1.05	9.81
?	Nichols	Milaca	?	10.61	9.64
11/ 4	Sandbo	Odin	Soybeans	9.57	13.82
10/30	Zickrick	Kellogg	Corn	12.51	15.61
10/29	Woods	Winthrop	Corn	11.49	11.78
11/ 5	Sutherland	Hayfield	Corn	7.85	10.59
-	Hartung	Bertha	Alfalfa	No Data	
		EXPERIMENT STATIONS			
-	North West	Crookston	Corn	No Data	
11/10	West Central	Morris (DSL)	Corn	7.81	9.81
11/10	West Central	Morris (HCL)	Corn	6.31	11.60
10/15	South West	Lamberton	Corn	4.85	9.81
11/ 2	South Central	Waseca	Corn	10.14	-
11/18	Marcell Station (U.S. Forest Service)	Itasca Co.	Forested	11.63	-

Figure 1.

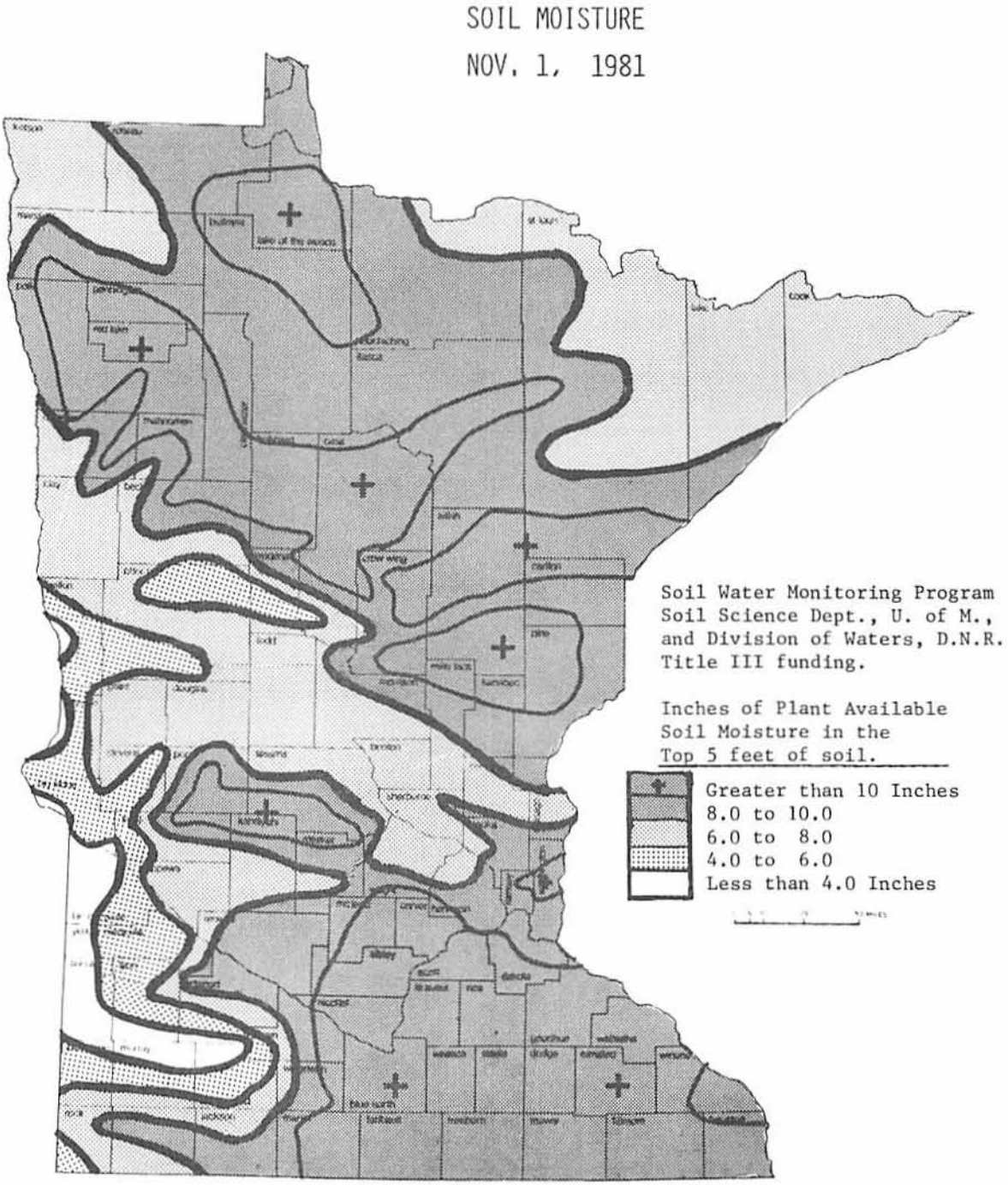

SOIL MOISTURE
NOV. 1, 1981
Soil Water Monitoring Program
Soil Science Dept., U. of M.,
and Division of Waters, D.N.R.
Title III funding.
Inches of Plant Available
Soil Moisture in the
Top 5 feet of soil.
Greater than 10 Inches
8.0 to 10.0
6.0 to 8.0
4.0 to 6.0
Less than 4.0 Inches

Figure 2.

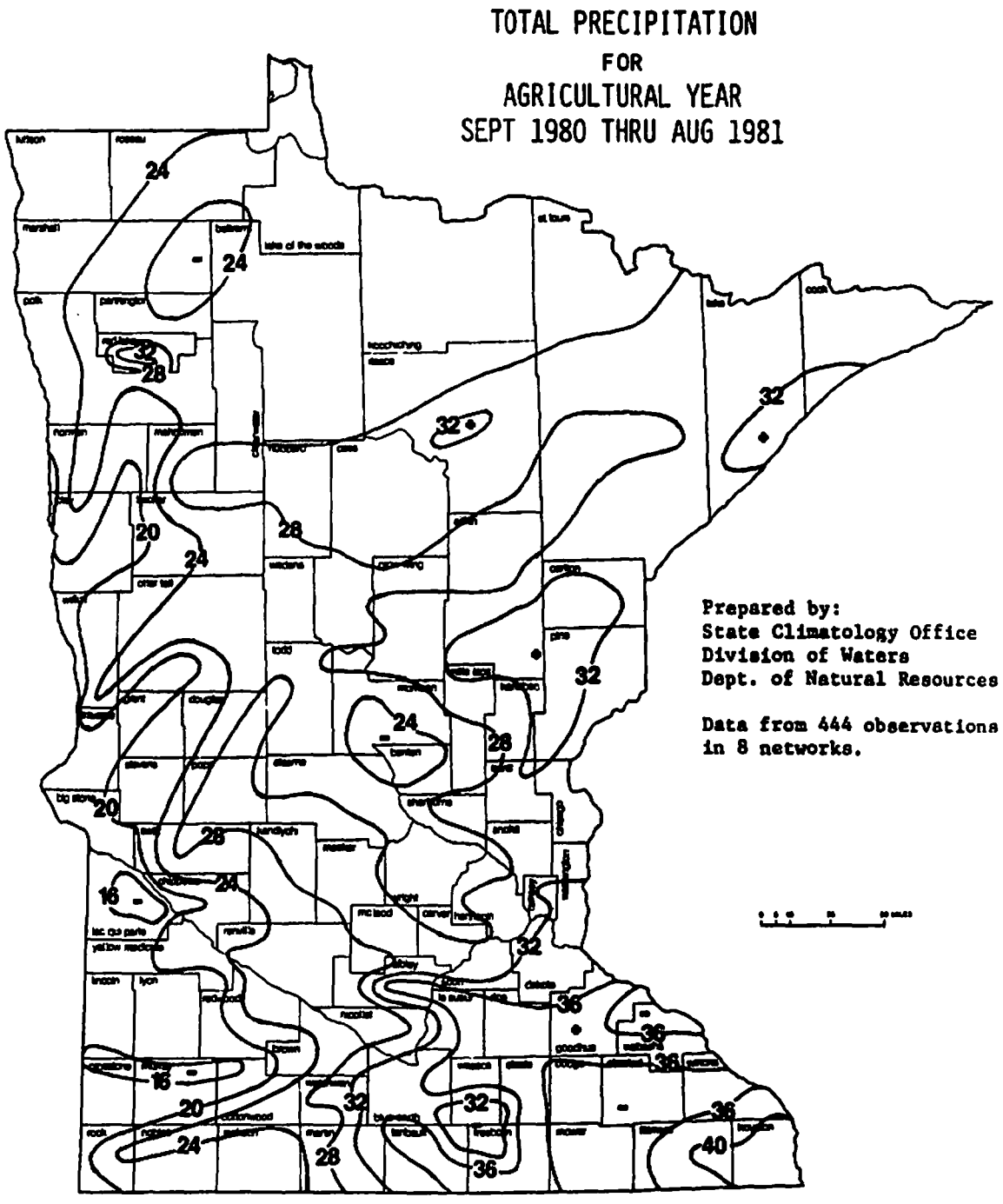
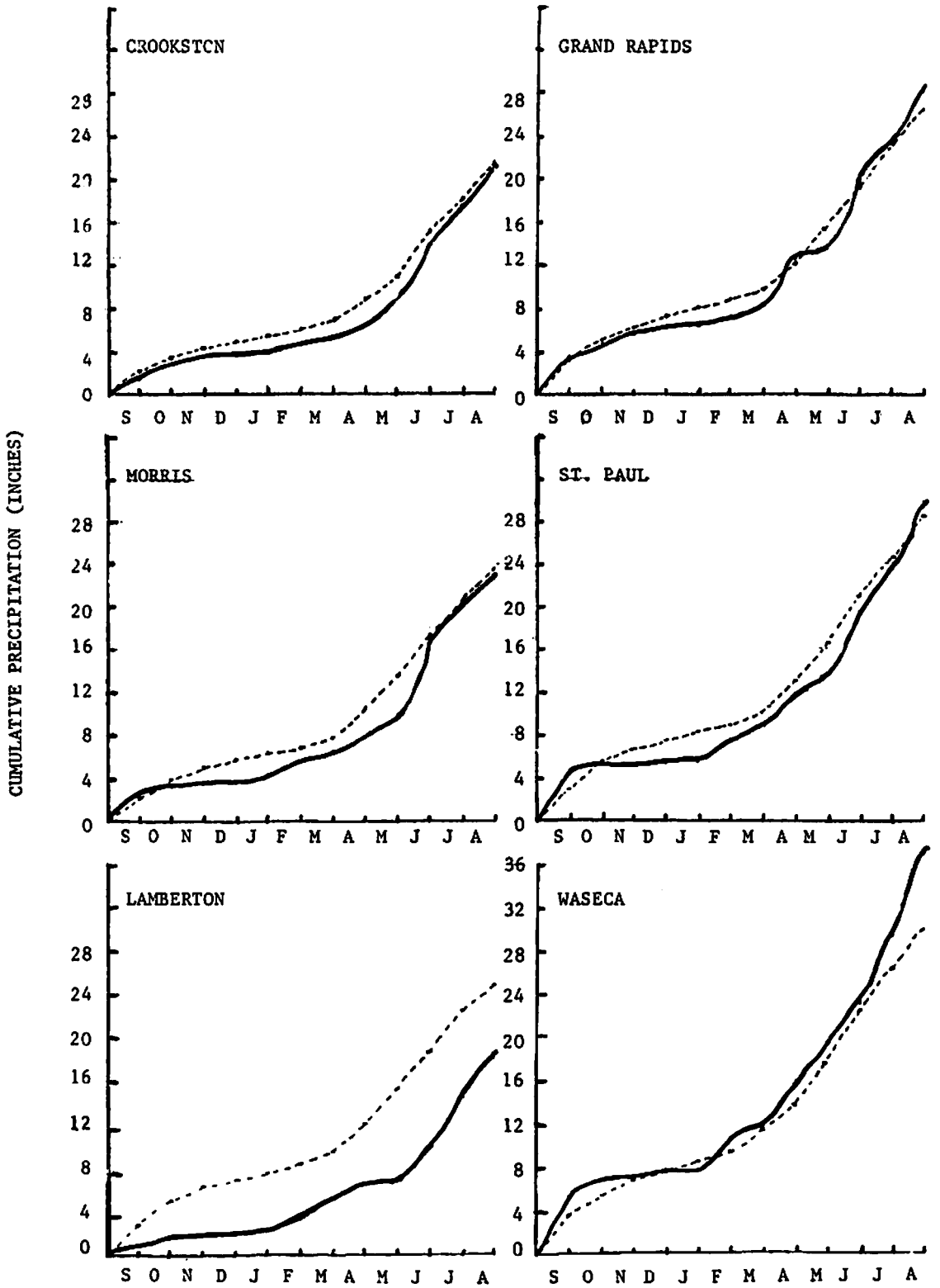

TOTAL PRECIPITATION
FOR
AGRICULTURAL YEAR
SEPT 1980 THRU AUG 1981
Prepared by:
State Climatology Office
Division of Waters
Dept. of Natural Resources
Data from 444 observations
in 8 networks.

Figure 3. AGRICULTURAL YEAR PRECIPITATION FOR SIX EXPERIMENT STATIONS

Sept., 1980 thru Aug., 1981 ————

Normals: (1931 - 1970) ———— (1961-80 at Lamberton and St. Paul)



Long Term Soil Moisture Record

by

D. G. Baker, Soil Science Dept.
W. W. Nelson, S. W. Exp. Station

The long-term historical record of soil moisture at the Southwest Agricultural Experiment Station is shown in Fig. 4. This represents the total amount of plant available water held in a 60 inch column of soil under corn. The line in Fig. 4 is the best-fit line of the weekly mean data. The data continue to support our view first expressed some years ago that there are four periods associated with soil moisture in Minnesota's agricultural soils:

1. The spring recharge period - extends from the soil thaw period until about June 10.
2. The grand consumption period - from about June 10 to the end of August. This is the grand plant growth period where stored soil moisture is drawn upon to make up for the insufficient amount of water supplied by precipitation.
3. The late summer-fall recharge period - from September until the soils are frozen. In the southern one-third of the state this is generally the first week of December. This recharge period is usually more important than the spring recharge period both in terms of the total amount of water added and the efficiency of its entry into the soil.
4. The fourth and final period is when the soils are frozen - about the first week in December to the first week in April in the southern one-quarter of the state. Normally very little of the over-winter precipitation enters the soil.

The timing of the reproductive period (silking and tasseling in the case of corn) relative to the soil moisture supply is all important. One good reason for early planting is to have the reproductive period occur when the soil moisture supplies are still high and before the usual late July period of low precipitation. Presently the average silking-tasseling date in south-central Minnesota is July 21.

Figure 5 shows the 22-year soil moisture record at Lamberton. The moisture profile of each year (the heavy line) is compared to the long-term mean (light line). Of particular interest is the 1973-1976 sequence. The soil moisture was progressively depleted earlier each season finally culminating in the 1976 drought. There was water in the soil but topsoil supplies ran out early and the roots simply could not reach the subsoil water supplies. The mean corn yield in Redwood and neighboring Cottonwood counties departed from the general yield trend by -4, -34, -40, and -53 bushels per acre in 1973-76, respectively.

Figure 4.

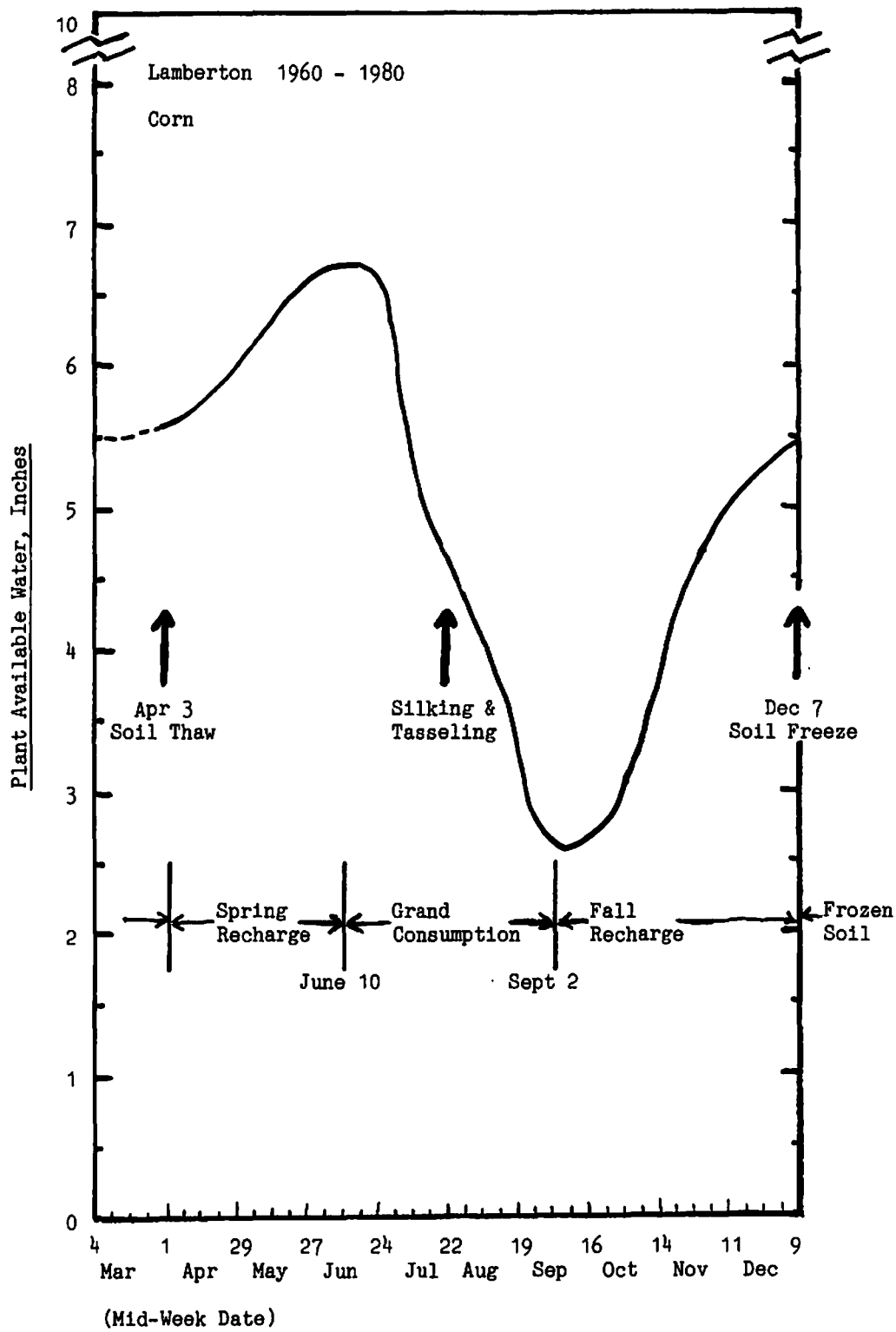
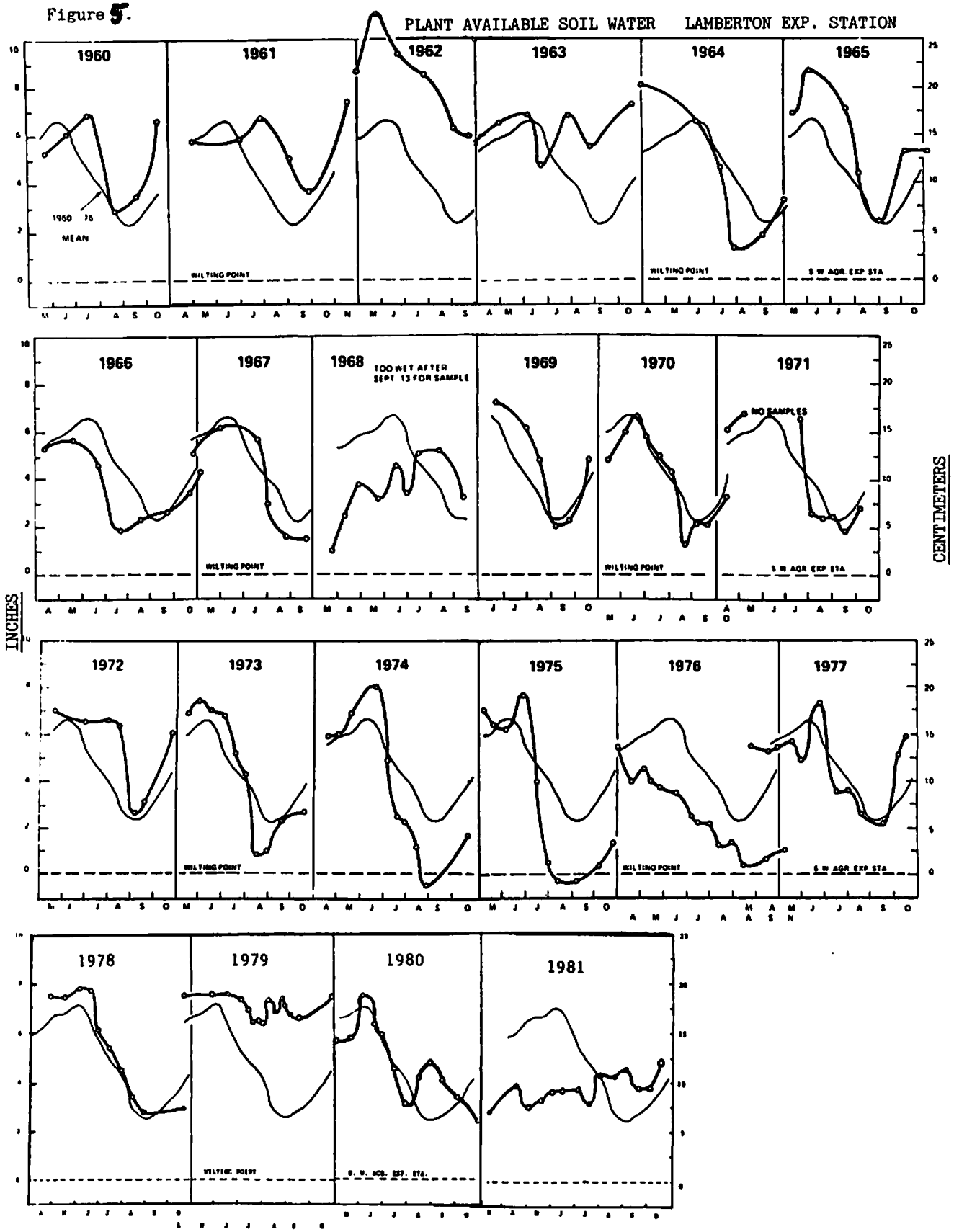

Lamberton 1960 - 1980
Corn
Plant Available Water, Inches
10
8
7
6
5
4
3
2
1
0
Apr 3
Soil Thaw
Silking &
Tasseling
Dec 7
Soil Freeze
Spring
Recharge
Grand
Consumption
Fall
Recharge
Frozen
Soil
June 10
Sept 2
4 Mar
1 Apr
29 May
27 Jun
24 Jul
22 Aug
19 Sep
16 Oct
14 Nov
11 Dec
9
(Mid-Week Date)

Figure 5.

PLANT AVAILABLE SOIL WATER LAMBERTON EXP. STATION



Soil Water Monitoring

D. G. Baker, E. L. Kuehnast, and D. L. Ruschy

(Mr. Kuehnast is with the State Climatology Office, D.N.R.)

A state-wide soil moisture monitoring program has been in progress for 3 years. The map shown in Fig. 1 is the result of the late fall, 1981, sampling and is an example of the detail possible. The soil moisture sites sampled totaled 51 with 36 from the monitoring project. Eight sites are sampled through courtesy of the Soil Conservation Service, U. S. D. A., 2 sites from the Forest Service, U. S. D. A., at Grand Rapids, and 5 Minnesota Agricultural Experiment Station sites. Although uniformity of the sites is not possible, it has been attempted. Sites have been selected with these features in mind: level to nearly level; medium to fine textured soil; continuous crop - corn in the southern part of the state, small grain in the northwest and forest in the north - central and northeast.

It is recognized that the variability of soils and, in particular, the variability of precipitation requires more than 51 sites for an accurate picture of soil moisture. As a result a very dense precipitation network is used in conjunction with the soil moisture network. Thus, a much more detailed picture of soil moisture is permitted. The soil moisture information, for example, shows the efficiency with which precipitation entered the soil and the precipitation data show how the water varied between soil sites. Figure 6 shows the locations of the two networks across the state.

1981 Precipitation

by

E. L. Kuehnast, State Climatologist, D. N. R.
J. A. Zandlo, Assistant State Climatologist, D. N. R.

The annual 1981 precipitation for the state as a whole was about 2 to 6 inches above normal except for the western border counties from Traverse south to the Iowa border which were 2 to 6 inches below normal.

The driest area, more than 6 inches below normal, was in northern Pipestone, Murray, and Cottonwood counties. The wettest areas of 6 to 9 inches above normal were located in Faribault, Red Lake, Fillmore - Houston and in northwestern Cook and northeastern Lake counties. The wetter than normal conditions have resulted in a record productive year for the state on the whole. Only some of the driest areas described above had somewhat below normal production. Further the overall wet conditions have resulted in above normal 1981-82 fall-winter field soil moisture conditions across the entire state except again in the described dry areas. (See Figure 7.)

Figure 6. 1981

Precipitation Observation

Locations (1258 Observers)

and Soil Moisture Sites

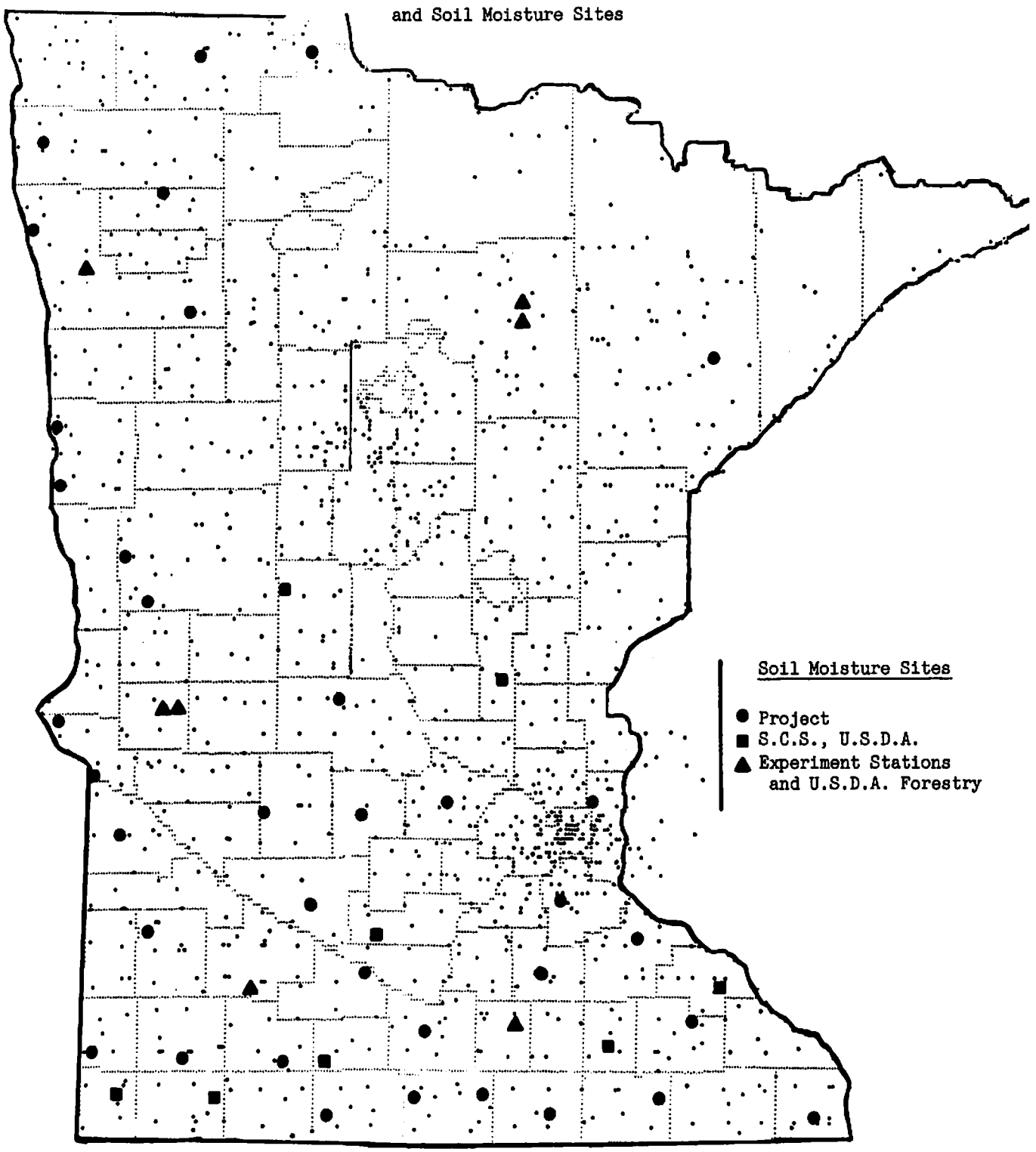
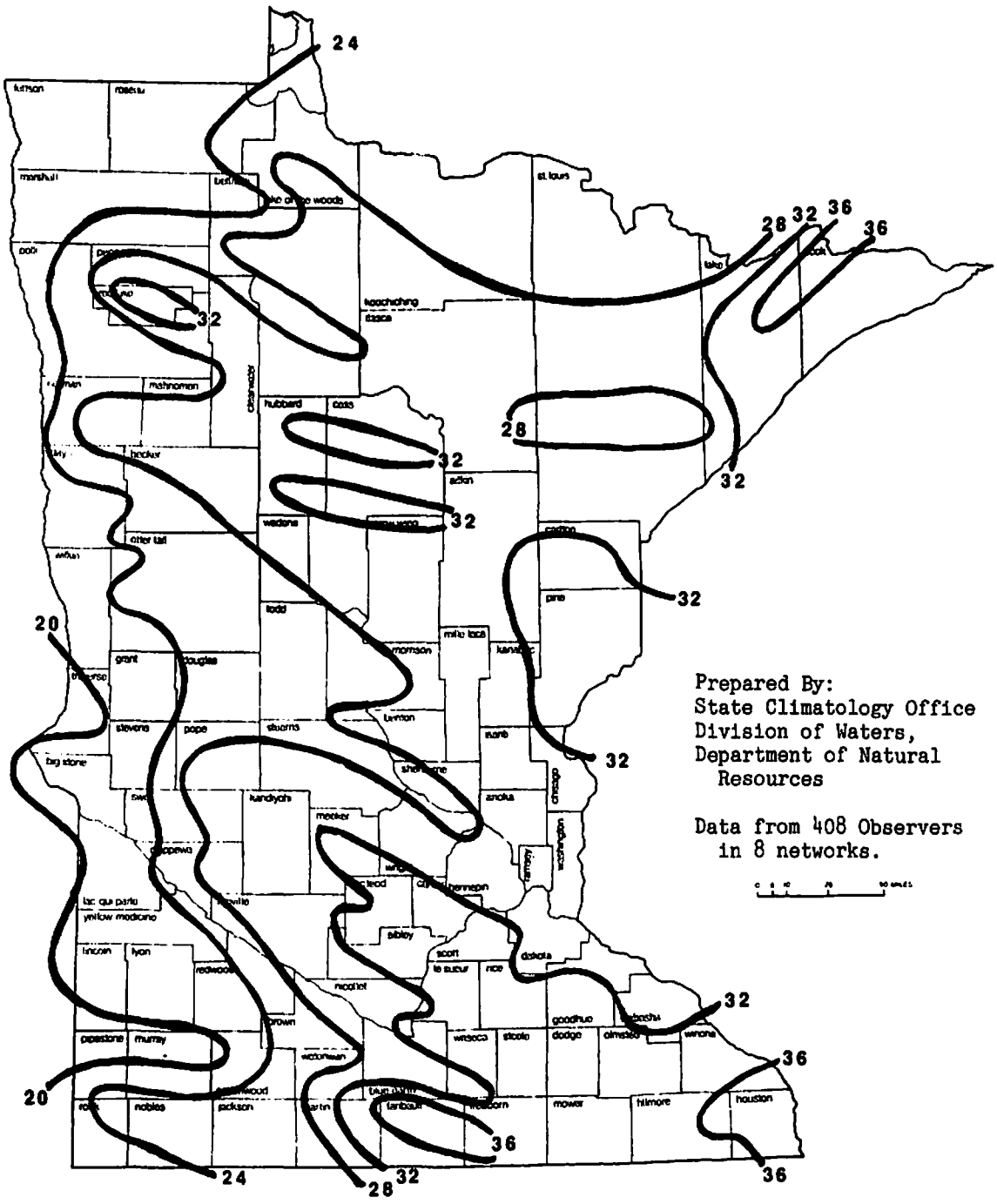


Figure 7.

1981 PRECIPITATION



INFLUENCE OF NITROGEN RATE, TIMING OF NITROGEN APPLICATION AND USE OF NITRIFICATION INHIBITORS FOR IRRIGATED CORN PRODUCTION - Becker, 1981

G.L. Malzer and T.Graff

Nitrogen management on the corase 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. A large portion of the flexibility in nitrogen management is lost due to the potential loss of nitrate nitrogen by leaching prior to plant demand. To minimize these losses, nitrogen applications are often made in split application through the irrigation system or as late sidedressing treatments. These management alternatives often add to the cost of production and require a reasonable amount of timeliness to avoid yield reductions. Commerical availability of chemical additives known as nitrification inhibitors also offer some potential in minimizing nitrogen losses and may addflexibility into the overall nitrogen management program. A new trial was established in 1980 to evaluate the significance of nitrogen rates, timing of nitrogen application and the use of nitrification inhibitors.

Experimental Procedures

An experiment consisting of 54 treatments with four replications was arranged in a randomized complete block design and established at the Sand Plains Research Farm near Becker, MN. A factorial treatment arrangement consisting of three rates of nitrogen (75, 150, and 225 # N/A), three nitrification inhibitors treatments (none, N-Serve-Dow Chemical Co. and Dwell-Terrazole-Olin Corporation) and five nitrogen application programs (all preplant, all 8-leaf, all 12-leaf, 1/3 preplant, 2/3 12-leaf, and 2/3 preplant, 1/3 12 leaf) were utilized. The experimental design also included a control, the three nitrogen rates applied at tasseling, the three N rates applied in split combinations (1/6 preplant, 1/6 8-leaf, 3/6 12-leaf, and 1/6 at tasseling), and one N rate of 150 # N/A with 1/4 #/A inhibitor (N-Serve or Dwell) at the 12-leaf stage. When a nitrification inhibitor was applied with the two times of N application treatments (1/3 - 2/3 or 2/3 - 1/3) the inhibitor was applied only with the preplant application of nitrogen. All nitrogen treatments were applied as urea and all but two nitrification inhibitor treatments were applied at rates of 0.5 # a.i./A as coating on to the urea. All inhibitor treatments were incorporated either by discing in the preplant applications or by utilizing the irrigation water with the later applications. Nitrogen applications were made at preplanting. (April 20th), at the 8-leaf stage of corn growth (June 10th), at the 12-leaf growth stage (June 24th), and at tasseling (July 14th).

Prior to planting broadcast applications of Potassium - Magnesium Sulfate (450 #/A 0-0-22) and Potassium (228 #/A 0-0-60) were made and incorporated by plowing. Corn (Pioneer 3901-100 day R.M.) was planted on April 27th in 30" rows at a population of 30,700 seed/A. Starter fertilizer was applied at the rate of 165 #/A of 8-10-30 banded at planting. A tank mix of Lasso (2 # a.i./A) and Atrazine (1½ # a.i./A) was applied on April 28th for weed control.

Leaf samples from opposite and below the ear at mid-silking were obtained on July 20th dried, ground and analyzed for Kjeldahl nitrogen. Dry matter production was determined on September 21st by hand harvesting 50 ft^2 of plot. Ears were separated from the stalks, field weights obtained and samples removed for moisture and nitrogen determination. Corn yield was determined on October 15th by hand harvesting 100 ft^2 of plot area and samples taken and adjusted to 15.5% moisture.

The irrigation program was started on May 19th and continued through September 3rd with a total of 10.40 inches of water being applied through irrigation. An additional 18.98 inches of water was obtained during the growing season through rainfall.

General Results

Nitrogen loss potential on the coarse textured irrigated soils especially with early nitrogen application were tremendous in 1981. This was primarily due to 5.23 inches of precipitation that was obtained on June 14th and 15th. Nitrogen losses with preplant applications of nitrogen were large enough to reduce potential yields when 225 # N/A had been applied by as much as 84 bu/A when compared to the best nitrogen management treatment. Significant grain yield increases were obtained up through the highest rate of nitrogen application although management (timing) of the nitrogen was more important than the rate applied. When nitrification inhibitors were not compared, the best nitrogen management combination was associated with one late sidedressed appliation (12-leaf) or when applied in four application spread throughout the growing season. Both nitrification inhibitors provided significant grain yield increases indicating that they did minimize nitrogen loss. As has been found in the past, they were not capabable of stopping nitrogen loss, but they did add considerable flexibility into the management program. For example when 150 # N/A was applied at the 12-leaf stage of growth the use of a nitrification inhibitor enabled equal or greater yields when the nitrogen was applied at the 8-leaf growth stage. This type of flexibility may be important to the producer to ensure that adequate nitrogen is available to the crop prior to the tasseling stage of growth.

Table 1. Influence of nitrogen rate, timing of nitrogen application, and nitrification inhibitors on leaf N content, grain yield, yield grain N content and dry matter production on irrigated corn. Becker, MN - 1981

Treatments						Dry Matter Production		
N-Rate	Time	Inh.	Leaf N	Grain Yield	Yield Grain N	Grain	Stover	Total
#/A			%	bu/A	%	--------T/A----------		
Check	-	-	1.26	52.4	0.98	1.30	1.74	3.04
75	ppl	-	1.24	54.8	0.95	1.32	2.30	3.62
75	sp(4)	-	2.47	134.2	1.05	3.18	2.93	6.11
75	sp(2)1/3,2/3	-	2.60	124.3	1.07	3.01	2.65	5.66
75	sp(2)2/3,1/3	-	2.13	93.1	1.02	2.18	2.44	4.62
75	8-leaf	-	2.66	126.6	1.10	3.21	3.05	6.26
75	12-leaf	-	2.82	146.0	1.11	3.44	2.91	6.35
75	Tassel	-	1.67	120.6	1.16	3.05	2.28	5.32
75	ppl	Dwell	1.57	80.0	0.94	1.83	2.26	4.39
75	sp(2)1/3,2/3	Dwell	2.72	124.5	1.03	3.14	3.10	6.24
75	sp(2)2/3,1/3	Dwell	2.18	104.4	1.05	2.38	2.30	4.68
75	8-leaf	Dwell	2.59	147.9	1.05	3.39	3.48	6.87
75	12-leaf	Dwell	2.63	145.9	1.08	3.24	2.98	6.22
75	ppl	N-S	1.59	81.1	0.94	1.64	2.01	3.64
75	sp(2)1/3,2/3	N-S	2.57	123.5	1.01	2.86	2.93	5.80
75	sp(2)2/3,1/3	N-S	2.26	105.4	1.01	2.29	2.54	4.83
75	8-leaf	N-S	2.50	127.6	1.09	2.92	2.80	5.72
75	12-leaf	N-S	2.68	143.1	1.11	3.45	2.88	6.33
150	ppl	-	1.95	92.1	0.97	2.09	2.26	4.35
150	sp(4)	-	2.91	159.0	1.22	3.99	3.52	7.50
150	sp(2)1/3,2/3	-	3.00	133.7	1.12	3.49	3.29	6.78
150	sp(2)2/3,1/3	-	2.68	125.7	1.11	3.14	2.79	5.93
150	8-leaf	-	3.01	157.0	1.30	3.64	3.01	6.65
150	12-leaf	-	3.00	167.5	1.30	4.18	3.23	7.40
150	Tassel	-	1.77	130.4	1.24	3.19	2.22	5.40
150	ppl	Dwell	1.81	95.2	0.99	2.21	2.40	4.61
150	sp(2)1/3,2/3	Dwell	2.92	151.0	1.35	3.88	3.22	7.10
150	sp(2)2/3,1/3	Dwell	2.74	159.6	1.16	3.65	3.11	6.76
150	8-leaf	Dwell	3.00	172.5	1.39	4.05	3.48	7.53
150	12-leaf	Dwell	2.72	175.1	1.28	3.97	3.02	6.98
150	ppl	N-S	2.26	108.3	1.04	2.66	2.56	5.22
150	sp(2)1/3,2/3	N-S	3.11	162.4	1.22	3.94	3.09	7.03
150	sp(2)2/3,1/3	N-S	2.67	149.2	1.12	3.46	3.00	6.46
150	8-leaf	N-S	3.14	177.4	1.41	4.18	3.75	7.93
150	12-leaf	N-S	3.08	159.3	1.26	3.93	2.92	6.85

Table 1 continued on page after next

Table 2. Influence of nitrogen rate, timing of nitrogen application use of nitrification inhibitors on grain N content and nitrogen removal of irrigated corn. Becker, MN - 1981.

Treatment			N Content		N Removal		
N-Rate	Appl. Time	Inhibitor	Grain	Stover	Grain	Stover	Total
#/A			-------%-------		---------lbs/A---------		
Check	-	-	0.96	0.26	25.0	9.2	34.2
75	ppl	-	0.90	0.26	23.7	12.3	36.0
75	sp(4)	-	1.05	0.36	66.6	20.7	87.3
75	sp(2)1/3,2/3	-	1.00	0.32	60.1	16.8	76.9
75	sp(2)2/3,1/3	-	0.95	0.27	41.2	12.9	54.0
75	8-leaf	-	1.03	0.32	66.2	19.5	85.7
75	12-leaf	-	1.10	0.35	75.4	20.3	95.7
75	Tassel	-	1.13	0.45	68.4	20.6	89.0
75	ppl	Dwell	0.92	0.25	33.6	12.8	46.4
75	sp(2)1/3,2/3	Dwell	1.11	0.32	69.3	20.2	89.5
75	sp(2)2/3,1/3	Dwell	1.00	0.28	47.3	12.6	60.0
75	8-leaf	Dwell	1.13	0.35	77.4	24.0	101.3
75	12-leaf	Dwell	1.06	0.36	69.0	21.3	90.3
75	ppl	N-S	0.92	0.26	29.9	10.3	40.2
75	sp(2)1/3,2/3	N-S	1.03	0.29	58.6	16.8	75.4
75	sp(2)2/3,1/3	N-S	0.98	0.29	45.0	14.7	59.7
75	8-leaf	N-S	1.10	0.31	64.0	17.1	81.2
75	12-leaf	N-S	1.11	0.43	76.9	24.6	101.4
150	ppl	-	1.02	0.31	42.8	13.6	56.4
150	sp(4)	-	1.22	0.39	97.2	27.0	124.2
150	sp(2)1/3,2/3	-	1.11	0.34	77.5	22.1	99.5
150	sp(2)2/3,1/3	-	1.06	0.31	66.9	16.9	83.9
150	8-leaf	-	1.23	0.47	89.5	28.3	117.9
150	12-leaf	-	1.22	0.46	101.9	29.6	131.5
150	Tassel	-	1.22	0.47	77.5	20.8	98.3
150	ppl	Dwell	0.99	0.26	43.9	12.5	56.4
150	sp(2)1/3,2/3	Dwell	1.27	0.38	98.0	24.6	122.7
150	sp(2)2/3,1/3	Dwell	1.14	0.37	83.0	23.4	106.4
150	8-leaf	Dewll	1.24	0.60	100.0	41.3	141.2
150	12-leaf	Dwell	1.28	0.52	101.5	31.5	133.0
150	ppl	N-S	0.97	0.29	51.4	14.9	66.3
150	sp(2)1/3,2/3	N-S	1.20	0.46	94.4	28.0	122.3
150	sp(2)2/3,1/3	N-S	1.18	0.35	82.3	20.8	103.1
150	8-leaf	N-S	1.27	0.50	106.4	37.9	144.3
150	12-leaf	N-S	1.27	0.49	99.8	28.4	128.2

Table 2 continued on next page

Table 1 continued

Treatments						Dry Matter Production		
N-Rate	Appl Time	Inh.	Leaf N	Grain Yield	Yield Grain N	Grain	Stover	Total
#/A			%	bu/A	----------T/A----------			
225	ppl	-	1.70	87.4	1.01	2.27	2.39	4.66
225	sp(4)	-	2.86	170.8	1.34	4.20	3.65	7.85
225	sp(2)1/3,2/3	-	3.05	166.5	1.27	3.87	3.42	7.29
225	sp(2)2/3,1/3	-	2.93	160.0	1.26	3.75	3.44	7.20
225	8-leaf	-	3.24	171.6	1.42	4.22	3.82	8.04
225	12-leaf	-	2.97	168.4	1.31	4.04	3.23	7.27
225	Tassel	-	1.85	128.8	1.28	3.06	2.11	5.16
225	ppl	Dwell	2.35	153.3	1.12	3.75	3.70	7.44
225	sp(2)1/3,2/3	Dwell	2.97	179.7	1.34	4.01	3.37	7.39
225	sp(2)2/3,1/3	Dwell	2.83	161.1	1.28	3.88	3.99	7.86
225	8-leaf	Dwell	3.16	169.2	1.39	4.36	3.73	8.09
225	12-leaf	Dwell	3.00	177.6	1.31	3.88	3.18	7.06
225	ppl	N-S	2.52	139.5	1.14	3.00	2.74	5.74
225	sp(2)1/3,2/3	N-S	3.06	174.2	1.38	4.06	2.29	7.35
225	sp(2)2/3,1/3	N-S	2.99	169.6	1.19	3.98	3.31	7.28
225	8-leaf	N-S	3.16	180.5	1.38	4.45	4.19	8.64
225	12-leaf	N-S	3.06	171.6	1.30	4.15	3.35	7.50
150	12-leaf	Dwell 1/4#	2.99	173.5	1.26	4.00	3.58	7.58
150	12-leaf	N-S 1/4#	2.96	170.9	1.28	4.02	3.07	7.08
Significance			**	**	**	**	**	**
BLSD(.05)			0.20	16.4	0.08	0.48	0.60	0.94

(Table 2 con't)

Treatments			N Content		N Removal		
N-Rate	Appl Time	Inhibitor	Grain	Stover	Grain	Stover	Total
#/A			-------%-------		--------lbs/A----------		
225	ppl	-	0.90	0.29	40.7	13.7	54.4
225	sp(4)	-	1.33	0.54	112.1	39.5	151.5
225	Sp(2)1/3,2/3	-	1.24	0.38	95.5	25.8	121.4
225	sp(2)2/3,1/3	-	1.18	0.39	89.2	26.8	116.0
225	8-leaf	-	1.41	0.67	118.6	51.2	169.8
225	12-leaf	-	1.31	0.57	105.2	36.6	141.8
225	Tassel	-	1.26	0.51	76.7	21.0	97.7
225	ppl	Dwell	1.15	0.34	86.7	25.1	111.7
225	sp(2)1/3,2/3	Dwell	1.27	0.54	102.6	36.1	138.7
225	sp(2)2/3,1/3	Dwell	1.23	0.37	95.5	29.3	124.9
225	8-leaf	Dwell	1.38	0.61	120.7	45.0	165.7
225	12-leaf	Dwell	1.32	0.53	102.4	33.1	135.5
225	ppl	N-S	1.12	0.35	68.2	18.8	87.1
225	sp(2)1/3,2/3	N-S	1.24	0.51	101.0	34.0	135.0
225	sp(2)2/3,1/3	N-S	1.24	0.40	98.8	26.1	124.9
225	8-leaf	N-S	1.47	0.59	130.6	49.0	179.6
225	12-leaf	N-S	1.35	0.61	112.1	40.8	152.9
150	12-leaf	Dwell 1/4#	1.23	0.50	98.4	35.7	134.1
150	12-leaf	N-S 1/4 #	1.24	0.49	99.5	30.3	129.8
Significance			**	**	**	**	**
BLSD(.05)			0.09	0.07	13.7	6.1	18.0

Table 1 and 2 (continued)

Treatments	Leaf N	Grain Yield	Yield Grain N	Dry Matter Production Grain	Dry Matter Production Stover	Dry Matter Production Total	N-Content Grain	N-Content Stover	N-Removal Grain	N-Removal Stover	N-Removal Total
	%	bu/A	%	T/A	T/A	T/A	%	%	lb/A	lb/A	lb/A
Factorial Arrangement (Nitrogen Rate X Time of application)											
N-Rate #/A											
75	2.22	114.2	1.06	2.77	2.65	5.42	1.02	0.33	57.4	17.6	75.0
150	2.62	137.9	1.18	3.39	2.90	6.29	1.15	0.39	79.0	22.6	101.7
225	2.65	150.5	1.27	3.63	3.15	6.78	1.23	0.48	91.1	30.7	121.8
Significance	**	**	**	**	**	**	**	**	**	*	**
BLSD(.05)	0.08	6.0	0.03	0.17	0.24	0.37	0.03	0.02	4.4	2.1	5.9
Time											
preplant	1.63	78.1	0.98	1.89	2.32	4.21	0.94	0.28	35.7	13.2	48.9
Sp(4)[1]	2.75	154.7	1.20	3.79	3.36	7.16	1.20	0.43	92.0	29.1	121.0
Sp(2)1/3,2/3	2.88	141.5	1.15	3.46	3.12	6.58	1.12	0.34	77.7	21.6	99.3
Sp(2)2/3,1/3	2.58	126.3	1.13	3.03	2.89	5.92	1.06	0.32	65.8	18.9	84.6
8-Leaf	2.97	151.7	1.27	3.69	3.29	6.98	1.22	0.48	91.4	33.0	124.5
12-Leaf	2.93	160.6	1.24	3.89	3.12	7.01	1.21	0.46	94.2	28.8	123.0
Tassel	1.76	126.6	1.22	3.10	2.30	5.30	1.22	0.48	74.2	20.8	95.0
Significance	**	**	**	**	**	**	**	**	**	**	**
BLSD(.05)	0.12	9.2	0.04	0.26	0.36	0.56	0.04	0.04	6.8	3.2	9.0
Factorial Arrangement (Nitrogen X Inhibitor X Time)											
N-Rate #/A											
75	2.31	115.2	1.04	2.69	2.73	5.42	1.02	0.31	55.8	17.1	72.9
150	2.74	145.7	1.20	3.50	3.01	6.51	1.16	0.41	82.6	24.9	107.5
225	2.86	162.0	1.27	3.84	3.41	7.25	1.25	0.48	97.8	32.8	130.6
Significance	**	**	**	**	**	**	**	**	**	**	**
BLSD(.05)	0.06	4.4	0.02	0.12	0.14	0.23	0.02	0.02	3.5	1.5	4.6
Nitrification Inhibitor											
None	2.60	131.6	1.15	3.19	2.95	6.14	1.11	0.38	72.9	23.1	96.1
Dwell	2.60	146.5	1.18	3.44	3.17	6.62	1.16	0.40	82.1	26.2	108.2
N-Serve	2.71	144.8	1.17	3.40	3.02	6.42	1.16	0.41	81.3	24.5	106.8
Significance	**	**	+	**	*	**	**	**	**	**	**
BLSD(.05)	0.06	4.5	0.03	0.13	0.16	0.26	0.02	0.02	3.7	1.7	4.8
Time											
preplant	1.89	99.1	1.01	2.31	2.55	4.85	0.99	0.29	46.8	14.9	61.7
Sp(2)1/3,2/3	2.89	148.9	1.20	3.58	3.15	6.74	1.16	0.39	84.1	24.9	109.0
Sp(2)2/3,1/3	2.60	136.4	1.13	3.19	2.99	6.18	1.10	0.33	72.1	20.4	92.5
8-Leaf	2.94	158.9	1.28	3.83	3.48	7.30	1.25	0.49	97.0	34.8	131.9
12-Leaf	2.88	161.6	1.23	3.81	3.08	6.89	1.22	0.48	93.8	29.6	123.4
Significance	**	**	**	**	**	**	**	**	**	**	**
BLSD(.05)	0.07	5.7	0.03	0.16	0.19	0.30	0.03	0.02	4.6	2.0	6.0

[1] 1/6, 1/6, 3/6, 1/6

INFLUENCE OF NITROGEN FORM, NITROGEN RATE, TIMING OF NITROGEN APPLICATION AND NITRIFICATION INHIBITORS FOR IRRIGATED CORN - BECKER, MN. 1981

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 feritlizer nitrogen forms may be utlized. 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 1980 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 24 treatments, with four replcation was arranged in a randomized complete block design and established at the Sand Plains Research Farm near Becker, MN. A factorial arrangement consisting of two fertilizer rates, two nitrogen forms and three times of nitrogen application were combined with a second factorial arrangement of two nitrogen rates, two nitrogen forms and two nitrification inhibitor treatments. Four additional treatments including a control, and three urea treatments (150 # N/A applied with three nitrification inhibitor treatments) were also included. Nitrogen fertilizer was applied at rates of 75 and 150 # N/A at one of three time periods including preplant, 8-leaf and 12-leaf growth stages. The nitrogen form used included 28% nitrogen solution and anhydrous ammonia at all times, and rates of application and also included urea at the 150 # N/A as a preplant application. Nitrification inhibitors (N-Serve-Dow Chemical or Dwell-Olin Corporation) were applied at 0.5 # ai/A with the various preplant combinations but was not included with the later sidedress treatments of 28% N solution or anhydrous ammonia.

Prior to planting broadcast application of Potassium-Magnesium Sulfate (462 #/A 0-0-22) and Potassium (228 #/A 0-0-60) were made and incorporated by plowing. Nitrogen application were made prior to planting (April 30th) at the 8-leaf stage (June 12th) and at the 12-leaf stage (June 24th). Corn (Pioneer 3901-100 day R.M.) was planted on May 1 in 30" rows at a population of 30,700 seed/A. Starter fertilizer was applied at the rate of 165 #/A 8-10-30 banded at planting. A tank mix Lasso (2 # ai/A) and Atrazine (1½ # ai/A) was applied on May 5th for weed control.

Leaf samples from opposite and below the ear at mid-silking were obtained on July 20th, dried and analyzed for Kjeldahl nitrogen. Total dry matter production was determined on September 22nd by hand harvesting 50 ft^2 of plot area. Ears were separated from the stalks, field weights obtained, and samples removed for moisture and nitrogen determination. Corn grain yields were obtained on October 14th by hand harvesting 100 ft^2 of plot area. Grain yields were adjusted to 15.5% moisture.

The irrigation program was started on July 2nd and continued through September 10th with a total of 8.75 inches of water being applied through irrigation. An additional 18.57 inches of water obtained during the growing season through rainfall.

General Result

The fertilizer nitrogen loss from this study was not as severe as was obtained on an adjoining study (see this report). This may be partially explained because the preplant applications were made 10 days later on this trial than on the other experiment. Nitrification had probably not advanced to the same degree on this trial when the leaching events took place. Results do suggest that nitrogen losses did take place when nitrogen was applied preplant at the low rate (75 # N/A). The use of 28% N solution was inferior to both anhydrous ammonia and urea across nitrogen rate as well as time of N application. Significant yield increases were obtained to nitrogen application up to 150 # N/A although this N rate appeared to maximize yields when anhydrous ammonia was applied. Since nitrogen losses were not severe, response to nitrification inhibitors when used with anhydrous ammonia were restricted to the preplant applications of 75 # N/A. A 25 bu/A response was obtained with Dwell when used with anhydrous ammonia at 75 # N/A. Inhibitor reponses were also obtained when used with 28% N Solution, but only at the high nitrogen rate.

Table 1. Influence of nitrogen form, nitrogen rates, nitrification inhibitors, timing of nitrogen application on yield grain, yield grain N content, and dry matter production on irrigated corn. Becker, MN-1981.

Treatments				Grain Yield	Yield Grain N	Dry Matter Production			
N-Rate	N-Form	Inh.	Time			Grain	Cob	Stover	Total
#/A				bu/A	%	----------T/A----------			
Check	--	--	--	91.2	0.95	2.02	0.30	1.90	4.27
75	AA	--	ppl	158.2	1.10	3.77	0.53	2.70	7.00
75	AA	--	8-lf	172.7	1.26	4.36	0.62	2.83	7.82
75	AA	--	12-lf	172.3	1.24	3.82	0.52	2.46	6.80
75	28%	--	ppl	144.9	1.04	3.32	0.43	2.46	6.22
75	28%	--	8-lf	143.3	1.09	3.27	0.40	2.26	5.93
75	28%	--	12-lf	148.9	1.07	3.74	0.50	2.52	6.80
75	AA	Dwell	ppl	183.1	1.26	4.26	0.58	2.89	7.72
75	28%	Dwell	ppl	132.1	0.99	3.04	0.42	2.40	5.87
75	AA	N-S	ppl	168.1	1.17	4.18	0.60	2.76	7.54
75	28%	N-S	ppl	131.9	1.02	3.21	0.46	2.48	6.16
150	AA	--	ppl	185.5	1.34	4.44	0.65	3.26	8.35
150	AA	--	8-lf	176.6	1.27	4.20	0.62	2.61	7.43
150	AA	--	12-lf	176.2	1.31	4.06	0.58	2.47	7.10
150	Urea	--	ppl	174.0	1.30	3.92	0.56	2.72	7.20
150	28%	--	ppl	161.9	1.19	3.45	0.55	2.85	6.84
150	28%	--	8-lf	156.5	1.13	3.49	0.44	2.30	6.23
150	28%	--	12-lf	161.4	1.23	3.86	0.50	2.24	6.59
150	AA	Dwell	ppl	185.2	1.32	4.33	0.61	2.79	7.72
150	Urea	Dwell	ppl	176.0	1.26	4.57	0.62	3.08	8.28
150	28%	Dwell	ppl	174.5	1.20	3.92	0.54	3.18	7.64
150	AA	N-S	ppl	191.5	1.35	4.45	0.68	3.07	8.20
150	Urea	N-S	ppl	178.4	1.22	4.29	0.63	3.12	8.04
150	28%	N-S	ppl	176.4	1.14	4.12	0.55	2.91	7.57
Significanace				**	**	**	**	**	**
BLSD(.05)				15.2	0.09	0.47	0.08	0.33	0.72

Factorial Arrangement (Excludes check, and urea treatments)

N-Rate #/A						
75	153.1	1.09	3.63	0.50	2.62	6.75
150	179.2	1.25	4.12	0.59	3.01	7.72
Significance	**	**	**	**	**	**
BLSD(.05)	9.7	0.05	0.28	0.05	0.19	0.40
N-Form						
AA	178.6	1.25	4.24	0.61	2.91	7.76
28%	153.6	1.10	3.51	0.49	2.71	6.72
Significance	**	**	**	**	**	**
BLSD(.05)	9.7	0.05	0.28	0.05	0.19	0.04
Inhibitor						
None	162.6	1.16	3.75	0.54	2.82	7.10
Dwell	168.7	1.19	3.89	0.54	2.81	7.24
N-Serve	167.0	1.17	3.99	0.57	2.81	7.37
Significance	NS	NS	NS	NS	NS	NS
BLSD(.05)	--	--	--	--	--	--

Table 1 (continued on page after next)

Table 2. Influence of nitrogen form, nitrogen rates, nitrification inhibitors, timing of nitrogen application on leaf N content, grain N content and nitrogen removal by irrigated corn. Becker, MN-1981.

Treatments				N-Content			N-Removal		
					Silage				
N-Rate	N-Form	Inh.	Time	Leaf	Grain	Stover	Grain	Stover*	Total
#/A				----------%----------			----------lbs/A----------		
Check	--	--	--	1.42	0.93	0.39	37.2	17.3	54.5
75	AA	--	ppl	2.82	1.07	0.39	80.9	25.4	106.3
75	AA	--	8-lf	3.01	1.20	0.68	105.4	46.4	151.8
75	AA	--	12-lf	2.83	1.27	0.58	96.7	34.7	131.4
75	28%	--	ppl	2.33	1.05	0.41	70.2	23.8	94.1
75	28%	--	8-lf	2.26	1.10	0.42	71.7	22.6	94.2
75	28%	--	12-lf	2.76	1.18	0.64	87.9	39.1	127.0
75	AA	Dwell	ppl	3.02	1.24	0.52	105.4	35.7	141.1
75	28%	Dwell	ppl	2.28	1.01	0.39	61.6	22.2	83.9
75	AA	N-S	ppl	2.70	1.16	0.48	97.3	32.4	129.7
75	28%	N-S	ppl	2.36	1.08	0.46	70.1	26.6	96.7
150	AA	--	ppl	3.23	1.28	0.58	113.4	45.1	158.5
150	AA	--	8-lf	3.22	1.32	0.58	111.4	37.4	148.8
150	AA	--	12-lf	2.77	1.22	0.66	98.8	40.3	139.1
150	Urea	--	ppl	2.76	1.14	0.42	90.8	27.3	118.1
150	28%	--	ppl	2.62	1.04	0.52	71.9	35.0	106.9
150	28%	--	8-lf	2.42	1.06	0.54	73.7	28.8	102.5
150	28%	--	12-lf	2.76	1.25	0.62	96.6	33.8	130.4
150	AA	Dwell	ppl	3.03	1.40	0.58	120.8	39.4	160.2
150	Urea	Dwell	ppl	3.15	1.24	0.54	114.0	40.2	154.7
150	28%	Dwell	ppl	2.87	1.13	0.42	88.9	31.6	120.6
150	AA	N-S	ppl	3.01	1.34	0.68	119.6	51.0	170.7
150	Urea	N-S	ppl	3.12	1.25	0.38	107.0	28.6	135.7
150	28%	N-S	ppl	2.77	1.10	0.42	90.8	29.3	120.1
Significance				**	**	**	**	**	**
BLSD(.05)				0.28	0.10	0.12	13.8	8.1	17.7

Factorial Arrangement (Excludes check, and urea treatments)

N-Rate #/A						
75	2.58	1.10	0.44	80.9	27.7	108.6
150	2.92	1.21	0.53	110.9	38.6	139.5
Significance	**	**	**	**	**	**
BLSD(.05)	0.17	0.06	0.07	8.7	4.9	11.4
N-Form						
AA	2.96	1.25	0.54	106.2	38.2	144.4
28%	2.54	1.07	0.44	75.6	28.1	103.7
Significance	**	**	**	**	**	**
BLSD(.05)	0.17	0.06	0.07	8.7	4.9	11.4
Inhibitor						
None	2.75	1.11	0.48	84.1	32.3	116.4
Dwell	2.80	1.19	0.48	94.2	32.2	126.4
N-Serve	2.71	1.17	0.51	94.4	34.8	129.3
Significance	NS	**	NS	*	NS	*
BLSD(.05)	--	0.05	--	8.4	--	11.7

Table 2 (continued on next page)

Table 1. Influence of nitrogen form, nitrogen rates, nitrification inhibitors, timing of nitrogen application on yield grain, yield grain N content, and dry matter production on irrigated corn. Becker, MN-1981, (continued).

Treatments				Grain Yield	Yield Grain N	Dry Matter Production			
N-Rate	N-Form	Inh.	Time			Grain	Cob	Stover	Total
#/A				bu/A	%	T/A			
Factorial Arrangement (Excludes check, urea, and inhibitor treatments)									
N-Rate #/A									
75				156.7	1.13	3.71	0.51	2.54	6.76
150				169.7	1.24	3.92	0.56	2.62	7.09
Significance				**	**	*	*	NS	*
BLSD(.05)				8.2	0.05	0.18	0.04	--	0.31
N-Form									
AA				173.6	1.25	4.11	0.59	2.72	7.42
28%				152.8	1.12	3.52	0.48	2.44	6.44
Significance				**	**	**	**	**	**
BLSD(.05)				8.2	0.05	0.24	0.51	0.19	0.40
Time									
ppl				162.6	1.16	3.75	0.54	2.82	7.10
8-leaf				162.3	1.19	3.83	0.52	2.50	6.85
12-leaf				164.7	1.22	3.87	0.53	2.42	6.82
Significance				NS	+	NS	NS	**	NS
BLSD(.05)				--	0.04	--	--	0.21	--

Table 2. Influence of nitrogen form, nitrogen rates, nitrification inhibitors, timing of nitrogen application on leaf N content, grain N content and nitrogen removal by irrigated corn. Becker, MN - 1981 (continued)

Treatments				N-Content			N-Removal		
					Silage				
N-Rate	N-Form	Inh.	Time	Leaf	Grain	Stover	Grain	Stover*	Total
				%			lbs/A		
Factorial Arrangement (Excludes check, urea, and inhibitor treatments)									
N-Rate #/A									
75				2.67	1.14	0.52	85.5	32.0	117.5
150				2.84	1.19	0.58	94.3	36.7	131.0
Significance				**	*	*	**	**	**
BLSD (.05)				0.12	0.04	0.06	7.8	4.4	9.3
N-Form									
AA				2.98	1.23	0.58	101.1	38.2	139.3
28%				2.53	1.11	0.52	78.7	30.5	109.2
Significance				**	**	+	**	**	**
BLSD(.05)				0.12	0.06	0.05	7.8	4.4	9.3
Time									
ppl				2.75	1.11	0.48	84.1	32.3	116.4
8-leaf				2.73	1.17	0.56	90.5	33.8	124.3
12-leaf				2.78	1.23	0.62	95.0	37.0	132.0
Significance				NS	**	**	*	+	**
BLSD(.05)				--	0.07	0.09	6.8	3.7	11.5

AA = Anhydrous Ammonia
* Stover includes cob + stover N-Removal

HIGH CORN AND SOYBEAN YIELD TRIALS ON THE COARSE TEXTURED, IRRIGATED SOILS OF MINNESOTA

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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 evalate the impact of three management variables (fertilization, plant population and variety) that may be important for high corn and soybean production. These are only three variables of many that the producer may have to make decisions upon. The producer should have a knowledge of or be aware of what impact these management factors, as well as other might have upon overall production if he is to assess and make wise decisions in improving his management system.

Experimental Procedures

Corn Trial - An experiment consisting of four replications of nine treatments, was arranged in a randomized complete block design. A factorial arrangement consisting of two fertilizer application rates, two varietys and two plant populations, were combined with a control receiving only nitrogen. The fertilizer variables included treatments of 220 + 60 + 220 which might be considered adequate for this site along with a rate of application 50% higher 330 + 90 + 330. Plant population included a base level of 28,000 plants/acre (a reasonable level to utilize under irrigation) a population 50% higher 42,000 plants/acre. The two varieties were Pioneer 3901 and DeKalb XL12. The control treatment which received only 220 lbs N/A as a treatment was planted with Pioneer 3901 at a plant population of 28,000 plants/A.

Soybean Trial - This experiment was located directly south of the corn trial, and was the same site of the previous year corn trial. The soybean experiment consisted of nine treatments, with four replications, and was arranged in a randomized complete block design. A factorial arrangement consisting two fertilizer application rates, two plant populations and two varieties were combined with a control plot receiving no fertilizer treatment. The fertilizer variables included treatments of 0 + 60 + 220 and an application 50% higher 0 + 90 + 330. Plant populations included rates of 5 and 10 seeds/foot of row in 14 inch rows. The two varieties were Hodgson -78 and Exp. #II-68-176. The control treatment was planted with Hodgson-78 at a population of 5 seeds/ft of row. Prior to planting, applications of Potassium magesium sulfate (314 #/A 0-0-22) and zinc (9#/A) as zinc sulfate were broadcast over the experimental area. Boron (2 #/A as Borate 68) was applied with the phosphorus and potassium treatments. The control plots did not receive a boron application. Nitrogen was applied to the corn as broadcast applications of urea throughout the season, with 25% of the nitrogen applied 2 weeks after planting (May 7th), 25% at the 8-leaf stage (June 10th) and 50% of the nitrogen at the 12-leaf stage (July 2nd). Because of a 5.52 inches of precipitation on June 13th and 14th an additional application of nitrogen similar to the amount applied at the8-leaf stage was applied on June 19th. Starter fertilizer was applied at the rate of 165#/A of 8-10-30 banded before planting to mark the rows. Corn (Pioneer 3901 and DeKalb XL12 - 100 day relative maturity) was hand planted into the experimental area on april 24th. Weed control was accomplished utilizing Lasso (2 #ai/A) and mechanically as needed.

Leaf samples from opposite and below the ear at mid-silking were taken on July 6th, dried, ground, and analyzed for elemental concentrations. Total dry matter production was determined on September 22nd by hand harvesting 50 ft^2. Ears were separated from the stalks, field weights obtained, and samples removed for moisture determination and elemental concentration. Corn grain yield were taken on October 9th by hand harvesting 100 ft^2. Grain yields were adjusted to 15.5% moisture. The irrigation program was started on May 16th and continued through September 11th with a total of 9.50 inches of water being applied through irrigation. An additional 18.21 inches of water was obtained during the growing season through rainfall.

The soybeans (Hodgson -78 and Exp. #II-68-176 medium to late maturing) were planted on May 12th utilizing a cone seeder. Leaf samples from the first mature soybean trifoliate were taken on July 28th, dried, ground and analyzed for elemental concentrations. Soybean grain yields were obtained on October 19th. Grain yields were adjusted to 13% moisture. The irrigation program for the soybeans was started on May 16th and continued through September 11th with a total of 9.5 inches of water being applied through irrigation. An additional 21.03 inches of water was obtained during the growing season through rainfall. Weed control was accomplished with Treflan (½ # ai/A) and mechanically as needed.

General Results

The results obtained from the corn and soybean research experiments conducted in 1981 are contained in tables 1-6. The overall corn yield results in 1981 were lower than what has been achieved in the past. In general this is thought to be due to a general lack of both sunshine and warm temperature during pollination and the grain filling period. This resulted in many poorly filled ears. Within the corn experiment, variety had the largest impact on grain yield with Pioneer 3901 on the average being about 20 bu/A better than DeKalb XL12. Increasing plant populations from 28,000 to 42,000 ppa had relatively little influence on grain yield, but did significantly increase stover production as well as total dry matter production. Increasing the rate of fertilization from "high" to "extra high" had no significant influence on grain yield.

Soybean seed yields were significantly higher for Hodgson-78 than for EXP #II-68-178. There was no main effect difference due to increasing the fertilization rate from "high" to "extra high" or by increasing the plant population. There was, however, a significant interaction which suggested that "extra high" fertilization was advantageous at the lower seeding rate.

Table 1. Influence of fertilizer treatment, variety and plant population on corn forage production, grain yield and grain nitrogen. Becker, MN 1981.

Treatments					Corn Forage Production						Harvest Grain			
N	P_2O_5	K_2O	Plant pop	Variety	D.M. Grain	D.M. Stover	Barren Stalks	Grain	Stover	Total	Yield	N Content	D.M. Grain	Shelling
----#/A----					--------%----------			-------T/A--------			bu/A	----------%----------		
220	0	0	28	P	63.08	38.20	2.27	4.15	3.39	7.54	172.0	1.32	70.3	88.3
220	60	220	28	P	64.45	30.40	0.70	4.11	3.29	7.40	170.8	1.45	69.9	88.7
220	60	220	28	D	66.15	32.05	0.78	4.04	3.46	7.50	161.9	1.52	72.2	87.7
220	60	220	42	P	62.18	35.00	1.04	4.25	3.62	7.87	182.7	1.36	69.6	89.2
220	60	220	42	D	64.85	31.85	3.94	4.09	3.81	7.90	160.8	1.56	71.3	87.1
330	90	330	28	P	63.45	30.98	0.63	4.30	3.59	7.88	184.5	1.44	70.5	88.8
330	90	330	28	D	67.40	31.62	0.84	4.05	3.60	7.65	158.2	1.60	73.3	87.0
330	90	330	42	P	62.65	31.68	2.81	4.43	3.99	8.42	185.8	1.38	69.0	89.2
330	90	330	42	D	65.28	33.92	1.24	3.94	3.80	7.73	162.4	1.48	71.7	86.6
Significance					**	*	NS	NS	**	*	**	**	**	**
BLSD(.05)					1.64	5.4	--	--	0.34	0.66	12.8	0.10	1.9	1.2
Factorial Statistics														
Variety														
Pioneer 3901					63.2	32.00	1.30	4.27	3.62	7.89	181.0	1.41	69.8	89.0
DeKalb XL12					65.9	32.40	1.70	4.03	3.67	7.69	160.8	1.54	72.1	87.1
Significance					**	NS	NS	*	NS	NS	**	**	**	**
BLSD(.05)					0.9	--	--	0.18	--	--	6.8	0.05	0.9	0.6
Population (plants per acre)														
28,000					65.4	31.30	0.74	4.12	3.48	7.60	168.9	1.50	71.5	88.0
42,000					63.7	33.10	2.26	4.18	3.80	7.98	172.9	1.44	70.4	88.0
Significance					**	+	*	NS	**	**	NS	*	*	NS
BLSD(.05)					0.9	1.70	1.45	--	0.16	0.27	--	0.05	0.9	--
Fertility														
220+60+220					64.4	32.3	1.62	4.12	3.55	7.67	169.0	1.47	70.8	88.2
330+90+330					64.7	32.0	1.38	4.18	3.74	7.92	172.8	1.48	71.1	87.9
Significance					NS	NS	NS	NS	*	+	NS	NS	NS	NS
BLSD(.05)					--	--	--	--	0.16	0.24	--	--	--	--
Variety X Population														
Pioneer 3901			28		64.0	30.7	0.66	4.20	3.44	7.64	166.4	1.49	70.2	88.8
Pioneer 3901			42		62.4	33.3	1.93	4.34	3.87	8.15	171.4	1.52	69.3	89.2
DeKalb XL12			28		66.8	31.8	0.81	4.04	3.53	7.57	171.7	1.46	72.8	87.3
DeKalb XL12			42		65.1	32.9	2.59	4.01	3.80	7.82	174.1	1.43	71.5	86.8
Significance					NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
BLSD(.05)					--	--	--	--	--	--	--	--	--	--
Variety X Fertility														
Pioneer 3901			220+60+220		63.3	32.7	0.87	4.18	3.46	7.64	176.8	1.40	69.8	88.9
Pioneer 3901			330+90+330		63.0	31.3	1.72	4.36	3.79	8.15	185.2	1.41	69.8	89.0
DeKalb XL12			220+60+220		65.5	32.0	2.36	4.06	3.64	7.70	161.3	1.54	71.8	87.4
DeKalb XL12			330+90+330		66.3	32.8	1.04	3.99	3.70	7.69	160.3	1.54	72.5	86.8
Significance					NS	NS	NS	NS	+	+	NS	NS	NS	NS
BLSD(.05)					--	--	--	--	0.19	0.33	--	--	--	--
Population x Fertility														
28			220+60+220		65.3	31.2	0.74	4.07	3.38	7.45	166.4	1.49	71.1	88.2
28			330+90+330		65.4	31.3	0.73	4.17	3.59	7.76	171.4	1.52	71.9	87.9
42			220+60+220		63.5	33.4	2.49	4.17	3.72	7.88	171.7	1.46	70.4	88.1
42			330+90+330		64.0	32.8	2.02	4.18	3.89	8.08	174.1	1.43	70.4	87.9
Significance			NS		NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
BLSD(.05)					--	--	--	--	--	--	--	--	--	--
Variety x Pop. x Fertility					NS	NS	NS	NS	NS	NS	NS	+	NS	NS
BLSD(.05)					--	--	--	--	--	--	--	0.06	--	--

Table 2. Influence of fertilizer treatment, variety, and plant population on the elemental concentration of the leaf opposite and below the ear at silking. Becker, MN - 1981.

Treatments					Leaf Elemental Concentration											
N	P_2O_5	K_2O	Plant pop	Variety	N	P	K	Ca	Mg	Al	Fe	Na	Mn	Zn	Cu	B
----#/A----					----------%----------					----------ppm----------						
220	0	0	28	P	3.11	0.30	2.31	0.47	0.36	49	119	32	88	26	11	4
220	60	220	28	P	2.96	0.29	2.85	0.40	0.27	55	117	33	74	23	8	8
220	60	220	28	D	2.96	0.31	2.73	0.49	0.31	64	128	29	62	24	10	10
220	60	220	42	P	2.86	0.29	2.70	0.42	0.28	61	120	34	83	22	9	8
220	60	220	42	D	2.92	0.30	2.69	0.49	0.31	56	125	27	58	22	9	9
330	90	330	28	P	3.07	0.31	2.83	0.41	0.26	63	127	34	102	25	9	8
330	90	330	28	D	3.12	0.32	2.92	0.46	0.30	53	124	26	80	26	9	9
330	90	330	42	P	2.84	0.30	2.92	0.39	0.26	54	118	36	84	24	8	9
330	90	330	42	D	3.02	0.30	2.87	0.43	0.27	47	119	29	69	24	8	8
Significance					**	NS	**	**	**	NS	NS	**	**	*	**	**
BLSD(.05)					0.15	--	0.17	0.04	0.03	--	--	6	22	3	1	2
Factorial Statistics																
Variety																
Pioneer 3901					2.93	0.30	2.82	0.40	0.27	58	120	34	86	24	8	8
DeKalb XL12					3.00	0.30	2.80	0.47	0.30	55	124	28	68	24	9	9
Significance					+	NS	NS	**	**	NS	NS	**	**	NS	NS	NS
BLSD(.05)					0.06	--	--	0.02	0.01	--	--	3	11	--	--	--
Population (plants per acre)																
28,000					3.02	0.31	2.83	0.44	0.28	58	124	30	80	24	9	9
42,000					2.91	0.30	2.79	0.43	0.28	54	120	32	74	23	8	9
Significance					**	+	NS	NS	NS	NS	NS	NS	NS	+	*	NS
BLSD(.05)					0.07	0.01	--	--	--	--	--	--	--	1	1	--
Fertility																
220+60+220					2.92	0.30	2.74	0.45	0.29	59	122	31	70	23	9	8
330+90+330					3.01	0.31	2.88	0.42	0.27	54	122	31	84	25	9	8
Significance					*	NS	**	+	*	NS	NS	NS	*	**	NS	NS
BLSD(.05)					0.07	--	0.09	0.02	0.01	--	--	--	11	1	--	--
Variety X Population																
Pioneer 3901			28		3.02	0.30	2.84	0.40	0.26	59	122	34	88	24	9	8
Pioneer 3901			42		2.85	0.29	2.81	0.40	0.27	58	119	35	84	23	8	9
DeKalb XL12			28		3.04	0.31	2.82	0.47	0.31	58	126	28	71	25	9	9
DeKalb XL12			42		2.97	0.30	2.78	0.46	0.29	51	122	28	64	23	8	9
Significance					NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	*
BLSD(.05)					--	--	--	--	--	--	--	--	--	--	--	1
Variety X Fertility																
Pioneer 3901			220+60+220		2.91	0.29	2.77	0.41	0.27	58	119	34	79	23	9	8
Pioneer 3901			330+90+330		2.95	0.30	2.87	0.40	0.26	58	122	35	93	25	8	8
DeKalb XL12			220+60+220		2.94	0.30	2.71	0.49	0.31	60	126	28	60	23	9	10
DeKalb XL12			330+90+330		3.07	0.31	2.90	0.45	0.28	50	121	28	75	25	9	8
Significance					NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
BLSD(.05)					--	--	--	--	--	--	--	--	--	--	--	--
Population X Fertility																
28			220+60+220		2.96	0.30	2.79	0.44	0.29	59	122	31	68	23	9	9
28			330+90+330		3.09	0.32	2.88	0.44	0.28	58	125	30	91	26	9	8
42			220+60+220		2.89	0.29	2.69	0.45	0.30	58	122	31	71	22	9	9
42			330+90+330		2.93	0.30	2.89	0.41	0.27	50	118	32	77	24	8	9
Significance					NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
BLSD(.05)					--	--	--	--	--	--	--	--	--	--	--	--
Variety X Pop. X Fertility					NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
BLSD(.05)					--	--	--	--	--	--	--	--	--	--	--	--

Table 3. Influence of fertilizer treatment, variety, and plant population on the elemental concentration of forage grain at physiological maturity. Becker, MN - 1981.

Treatments					Leaf Elemental Concentration											
N	P_2O_5	K_2O	Plant pop	Variety	N	P	K	Ca	Mg	Al	Fe	Na	Mn	Zn	Cu	B
----#/A----					----------%----------					----------ppm----------						
220	0	0	28	P	1.37	0.23	0.33	.002	0.14	0.9	21	6	6	20	2	2
220	60	220	28	P	1.40	0.26	0.34	.002	0.14	1.7	21	4	6	21	2	2
220	60	220	28	D	1.50	0.27	0.37	.001	0.16	0.6	22	4	6	24	2	2
220	60	220	42	P	1.40	0.24	0.33	.003	0.15	0.4	22	4	6	20	2	2
220	60	220	42	D	1.46	0.25	0.35	.003	0.15	0.5	20	4	7	22	2	2
330	90	330	28	P	1.36	0.26	0.35	.002	0.15	0.4	22	4	6	23	2	2
330	90	330	28	D	1.54	0.27	0.38	.003	0.16	0.4	22	4	6	25	2	2
330	90	330	42	P	1.42	0.24	0.32	.002	0.14	1.0	22	4	6	21	2	2
330	90	330	42	D	1.46	0.26	0.36	.003	0.15	0.6	21	2	7	23	2	2
Significance					*	*	**	**	NS	NS	*	NS	+	**	NS	NS
BLSD(.05)					0.13	0.03	0.03	.001	--	--	1	--	1	2	--	--
Factorial Statistics																
Variety																
Pioneer 3901					1.39	0.25	0.34	.002	0.15	0.9	22	4	6	21	2	1
DeKalb XL12					1.49	0.26	0.36	.003	0.16	0.5	21	3	7	23	2	2
Significance					**	*	**	**	*	NS	NS	NS	*	**	**	**
BLSD(.05)					0.05	0.01	0.01	.001	0.01	--	--	--	1	1	--	1
Population (plants per acre)																
28,000					1.45	0.26	0.36	.002	0.15	0.8	22	4	6	23	2	2
42,000					1.43	0.25	0.34	.003	0.15	0.6	21	4	7	22	2	2
Significance					NS	*	**	*	NS	NS	+	NS	NS	*	NS	NS
BLSD(.05)					--	0.01	0.01	.001	--	--	1	--	--	1	--	--
Fertility																
220+60+220					1.44	0.26	0.35	.003	0.15	0.8	21	4	6	22	2	2
330+90+330					1.44	0.25	0.35	.003	0.15	0.6	22	3	7	23	2	2
Significance					NS	NS	NS	NS	NS	NS	*	NS	NS	*	NS	NS
BLSD(.05)					--	--	--	--	--	--	1	--	--	1	--	--
Variety X Population																
Pioneer 3901			28		1.38	0.26	0.35	.002	0.15	1.1	22	4	6	22	2	2
Pioneer 3901			42		1.41	0.24	0.33	.003	0.14	0.7	22	4	6	21	2	2
DeKalb XL12			28		1.52	0.27	0.37	.003	0.16	0.5	22	4	6	24	2	2
DeKalb XL12			42		1.46	0.25	0.35	.003	0.15	0.5	21	3	7	22	2	2
Significance					+	NS	NS	NS	NS	NS	+	NS	NS	NS	NS	NS
BLSD(.05)					0.07	--	--	--	--	--	1	--	--	--	--	--
Variety X Fertility																
Pioneer 3901			220+60+220		1.40	0.25	0.34	.002	0.15	1.0	21	4	6	20	2	2
Pioneer 3901			330+90+330		1.39	0.25	0.34	.002	0.15	0.8	22	4	6	22	2	2
DeKalb XL12			220+60+220		1.48	0.26	0.36	.003	0.15	0.6	21	4	7	23	2	2
DeKalb XL12			330+90+330		1.50	0.26	0.37	.003	0.16	0.5	21	3	7	24	2	2
Significance					NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
BLSD(.05)					--	--	--	--	--	--	--	--	--	--	--	--
Population X Fertility																
28			330+90+330		1.44	0.26	0.36	.003	0.15	1.1	21	4	6	22	2	2
28			330+90+330		1.45	0.26	0.36	.003	0.15	0.4	22	4	6	24	2	2
42			220+60+220		1.43	0.25	0.34	.003	0.15	0.4	21	4	6	21	2	2
42			330+90+330		1.44	0.25	0.34	.003	0.15	0.8	22	3	7	22	2	2
Significance					NS	NS	NS	NS	NS	+	NS	NS	NS	NS	NS	NS
BLSD(.05)					--	--	--	--	--	0.7	--	--	--	--	--	--
Variety x Pop. X Fertility					NS	NS	NS	NS	NS	NS	*	NS	NS	NS	NS	NS
BLSD(.05)					--	--	--	--	--	--	1	--	--	--	--	-

Table 4. Influence of fertilizer treatment, variety and plant population on the elemental concentration of forage stover at physiological maturity. Becker, MN - 1981.

Treatments					Forage Stover Elemental Concentration											
N	P_2O_5	K_2O	Plant pop	Variety	N	P	K	Ca	Mg	Al	Fe	Na	Mn	Zn	Cu	B
----#/A----					----------%----------					----------ppm----------						
220	0	0	28	P	0.62	0.05	1.46	0.55	0.28	156	132	78	94	16	9	6
220	60	220	28	P	0.64	0.04	2.28	0.34	0.21	166	128	64	59	12	7	9
220	60	220	28	D	0.74	0.06	2.11	0.47	0.37	176	144	79	76	18	9	9
220	60	220	42	P	0.64	0.05	2.09	0.54	0.28	228	176	102	100	22	9	10
220	60	220	42	D	0.68	0.06	2.00	0.48	0.36	188	150	79	83	14	7	10
330	90	330	28	P	0.66	0.04	2.52	0.36	0.22	169	139	63	73	14	6	7
330	90	330	28	D	0.90	0.06	2.73	0.49	0.33	175	152	83	102	25	8	8
330	90	330	42	P	0.74	0.04	2.38	0.45	0.23	156	128	86	88	19	7	11
330	90	330	42	D	0.74	0.05	2.18	0.50	0.32	154	129	80	95	16	7	8
Significance					**	+	**	NS	**	NS	NS	NS	NS	NS	NS	**
BLSD(.05)					0.10	0.01	0.62	--	0.08	--	--	--	--	--	--	3
Factorial Statistics																
Variety																
Pioneer 3901					0.67	0.04	2.32	0.42	0.24	180	142	79	80	16	7	9
DeKalb XL12					0.76	0.05	2.25	0.49	0.34	173	143	80	89	18	8	9
Significance					**	**	NS	NS	**	NS	NS	NS	NS	NS	NS	NS
BLSD(.05)					0.05	0.01	--	--	0.04	--	--	--	--	--	--	--
Population (plants per acre)																
28,000					0.73	0.05	2.41	0.42	0.28	171	141	72	78	17	7	8
42,000					0.70	0.05	2.16	0.50	0.30	181	146	87	92	18	9	10
Significance					NS	NS	+	+	NS	NS	NS	*	NS	NS	NS	*
BLSD(.05)					--	--	0.23	0.08	--	--	--	12	--	--	--	--
Fertility																
220+60+220					0.68	0.05	2.12	0.46	0.30	189	150	81	80	16	8	10
330+90+330					0.76	0.05	2.45	0.45	0.27	163	137	78	89	18	7	8
Significance					**	NS	*	NS	+	NS	NS	NS	NS	NS	NS	*
BLSD(.05)					0.05	--	0.27	--	0.03	--	--	--	--	--	--	1
Variety X Population																
Pioneer 3901			28		0.65	0.04	2.40	0.35	0.21	167	133	64	66	13	6	8
Pioneer 3901			42		0.69	0.05	2.24	0.50	0.26	192	152	94	94	20	8	10
DeKalb XL12			28		0.82	0.06	2.42	0.48	0.35	176	148	81	89	22	9	9
DeKalb XL12			42		0.71	0.05	2.08	0.49	0.34	171	140	80	89	15	8	9
Significance					**	NS	NS	NS	NS	NS	NS	*	NS	*	+	NS
BLSD(.05)					0.07	--	--	--	--	--	--	18	--	8	2	--
Variety X Fertility																
Pioneer 3901			220+60+220		0.64	0.05	2.19	0.44	0.25	197	152	84	80	17	8	10
Pioneer 3901			330+90+330		0.70	0.04	2.45	0.41	0.22	162	133	74	80	16	7	9
DeKalb XL12			220+60+220		0.71	0.06	2.05	0.47	0.36	182	147	79	80	16	8	10
DeKalb XL12			330+90+330		0.82	0.05	2.45	0.50	0.32	164	140	82	98	20	8	8
Significance					NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
BLSD(.05)					--	--	--	--	--	--	--	--	--	--	--	--
Population X Fertility																
28			220+60+220		0.69	0.05	2.20	0.40	0.29	171	136	72	68	15	7	9
28			330+90+330		0.78	0.05	2.62	0.43	0.27	172	145	73	88	19	7	8
42			220+60+220		0.66	0.05	2.04	0.51	0.32	208	163	91	92	18	8	10
42			330+90+330		0.74	0.05	2.28	0.48	0.27	155	128	83	91	17	8	9
Significance					NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
BLSD(.05)					--	--	--	--	--	--	--	--	--	--	--	--
Variety X Pop. X Fertility					+	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
BLSD(.05)					0.06	--	--	--	--	--	--	--	--	--	--	--

Table 5. Influence of fertilizer treatment, variety and plant population on the total elemental removal of corn at physiological maturity. Becker, MN - 1981.

Treatments					Total Elemental Uptake											
N	P_2O_5	K_2O	Plant pop	Variety	N	P	K	Ca	Mg	Al	Fe	Na	Mn	Zn	Cu	B
----#/A----					----#/A----											
220	0	0	28	P	155.8	22.2	125.1	35.3	30.9	1.0	1.0	0.6	0.7	0.28	0.08	0.05
220	60	220	28	P	157.0	23.8	178.8	22.3	25.6	1.1	1.0	0.5	0.4	0.25	0.06	0.08
220	60	220	28	D	171.6	25.7	176.6	32.5	38.4	1.2	1.2	0.6	0.6	0.32	0.08	0.08
220	60	220	42	P	164.9	24.0	179.5	39.6	32.8	1.6	1.4	0.8	0.8	0.33	0.08	0.09
220	60	220	42	D	172.4	25.0	181.1	36.4	39.5	1.4	1.3	0.6	0.7	0.28	0.07	0.09
330	90	330	28	P	163.6	24.9	209.8	26.4	28.6	1.2	1.2	0.5	0.6	0.30	0.06	0.07
330	90	330	28	D	189.7	26.0	224.9	36.1	36.4	1.2	1.3	0.6	0.8	0.38	0.08	0.07
330	90	330	42	P	185.6	24.5	218.9	36.0	31.1	1.3	1.2	0.7	0.8	0.34	0.08	0.10
330	90	330	42	D	171.3	23.8	192.0	40.1	36.5	1.2	1.2	0.6	0.8	0.31	0.08	0.07
Significance					*	NS	**	NS	**	NS	NS	*	NS	NS	NS	**
BLSD(.05)					23.9	--	42.1	--	5.2	--	--	0.2	--	--	--	0.02
Factorial Statistics																
Variety																
Pioneer 3901					167.8	24.3	196.7	31.0	29.6	1.3	1.2	0.6	0.6	0.30	0.07	0.09
DeKalb XL12					176.2	25.1	193.5	36.3	37.7	1.3	1.2	0.6	0.7	0.32	0.08	0.08
Significance					NS	NS	NS	NS	**	NS	NS	NS	NS	NS	NS	NS
BLSD(.05)					--	--	--	--	2.3	--	--	--	--	--	--	--
Population (plants per acre)																
28,000					170.4	25.1	197.0	29.3	32.2	1.2	1.2	0.5	0.6	0.30	0.08	0.08
42,000					173.6	24.4	193.0	38.0	35.0	1.4	1.3	0.7	0.8	0.30	0.09	0.09
Significance					NS	NS	NS	*	*	NS	NS	**	*	NS	NS	**
BLSD(.05)					--	--	--	7.8	2.3	--	--	0.1	0.1	--	--	0.01
Fertility																
220+60+220					166.5	24.7	179.0	32.7	34.1	1.4	1.2	0.6	0.6	0.33	0.07	0.09
330+90+330					177.5	24.8	211.0	34.6	33.2	1.2	1.2	0.6	0.7	0.29	0.07	0.08
Significance					*	NS	**	NS	NS	NS	NS	NS	+	+	NS	NS
BLSD(.05)					10.4	--	20.0	--	--	--	--	--	0.1	0.03	--	--
Variety X Population																
Pioneer 3901			28		160.3	24.0	194.0	24.0	27.0	1.1	1.1	0.5	0.5	0.30	0.06	0.08
Pioneer 3901			42		175.3	24.0	199.0	38.0	32.0	1.4	1.3	0.7	0.8	0.30	0.08	0.10
DeKalb XL12			28		180.6	26.0	201.0	34.0	37.0	1.2	1.2	0.6	0.7	0.30	0.08	0.08
DeKalb XL12			42		171.8	24.0	186.0	38.0	38.0	1.3	1.2	0.6	0.7	0.30	0.08	0.08
Significance					*	NS	NS	NS	+	NS	NS	**	NS	NS	+	+
BLSD(.05)					14.8	--	--	--	1	--	--	0.1	--	--	0.01	0.01
Variety X Fertility																
Pioneer 3901			220+60+220		161.0	24.0	179.0	31.0	29.0	1.4	1.2	0.6	0.6	0.30	0.07	0.09
Pioneer 3901			330+90+330		174.6	25.0	214.0	31.0	30.0	1.2	1.2	0.6	0.7	0.30	0.07	0.09
DeKalb XL12			220+60+220		171.9	25.0	179.0	35.0	39.0	1.3	1.2	0.6	0.6	0.30	0.08	0.09
DeKalb XL12			330+90+330		180.5	25.0	208.0	38.0	36.0	1.2	1.2	0.6	0.8	0.30	0.08	0.07
Significance					NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
BLSD(.05)					--	--	--	--	--	--	--	--	--	--	--	--
Population X Fertility																
28			220+60+220		164.2	25.0	177.0	27.0	32.0	1.2	1.1	0.5	0.5	0.30	0.07	0.08
28			330+90+330		176.6	25.0	217.0	31.0	32.0	1.2	1.2	0.6	0.7	0.30	0.07	0.07
42			220+60+220		168.7	25.0	180.0	38.0	36.0	1.5	1.4	0.7	0.7	0.30	0.08	0.09
42			330+90+330		178.4	24.0	205.0	38.0	34.0	1.2	1.2	0.7	0.8	0.30	0.08	0.09
Significance					NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
BLSD(.05)					--	--	--	--	--	--	--	--	--	--	--	--
Variety X Pop. X Fertility					NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
BLSD(.05)					--	--	--	--	--	--	--	--	--	--	--	--

Table 6. Influence of fertilizer treatment, variety, and plant population on yield and elemental concentration of the first mature soybean trifoliate on July 28th. Becker, MN - 1981.

Treatments					Yield	Leaf Elemental Concentration											
N	P_2O_5	K_2O	Plant pop	Variety	Bu/A	N	P	K	Ca	Mg	Al	Fe	Na	Mn	Zn	Cu	B
----#/A----						----------%----------					----------ppm----------						
0	0	0	5	H	56.8	5.52	0.55	2.54	1.08	0.46	18	122	14	114	48	11	46
0	60	220	5	H	60.0	5.43	0.55	2.56	1.00	0.45	18	127	12	114	48	11	63
0	60	220	5	E	57.8	5.49	0.49	2.43	0.90	0.36	24	120	31	104	47	11	56
0	60	220	10	H	63.1	4.76	0.46	2.41	0.96	0.43	25	122	26	114	44	10	60
0	60	220	10	E	61.6	5.56	0.51	2.53	0.94	0.39	20	112	18	110	49	10	55
0	90	330	5	H	63.6	5.25	0.55	2.64	1.00	0.45	21	127	18	120	49	11	62
0	90	330	5	E	60.2	5.75	0.52	2.78	0.96	0.36	18	123	9	119	48	10	59
0	90	330	10	H	62.9	4.96	0.49	2.56	0.97	0.43	25	126	31	127	47	10	63
0	90	330	10	E	57.5	5.11	0.47	2.55	0.91	0.36	23	115	30	116	47	10	57
Significance					+	*	NS	NS	**	**	NS	NS	NS	**	NS	NS	**
BLSD(.05)					5.6	0.62	--	--	0.06	0.07	--	--	--	9	--	--	8
Variety																	
Hodgson-78					62.4	5.10	0.51	2.54	0.98	0.44	22	126	22	119	47	11	62
Exp. #II-68-176					59.3	5.48	0.50	2.57	0.93	0.37	21	117	22	112	48	10	57
Significance					*	**	NS	NS	**	**	NS	*	NS	*	NS	NS	*
BLSD(.05)					2.4	0.26	--	--	0.03	0.31	--	7	--	5	--	--	4
Population																	
5 plant/ft					60.4	5.48	0.53	2.59	0.96	0.40	20	124	17	114	48	11	60
10 plant/ft					61.3	5.10	0.48	2.51	0.95	0.40	23	119	26	117	47	10	59
Significance					NS	**	NS	NS	NS	NS	NS	+	NS	NS	NS	NS	NS
BLSD(.05)					--	0.26	--	--	--	--	--	6	--	--	--	--	--
Fertility																	
0+60+220					60.6	5.31	0.50	2.48	0.95	0.41	22	120	22	110	47	10	58
0+90+330					61.1	5.27	0.51	2.62	0.96	0.40	22	122	22	121	48	10	60
Significance					NS	NS	NS	*	NS	NS	NS	NS	NS	**	NS	NS	NS
BLSD(.05)					--	--	--	0.12	--	--	--	--	--	5	--	--	--
Variety X Population																	
Hodgson-78			5/ft		61.8	5.34	0.55	2.60	1.00	0.45	20	127	15	117	48	11	62
Hodgson-78			10/ft		63.0	4.86	0.47	2.48	0.97	0.43	25	124	28	120	46	10	62
Exp.#II-68-176			5/ft		59.0	5.62	0.50	2.59	0.93	0.36	21	121	20	112	48	10	58
Exp.#II-68-176			10/ft		59.6	5.34	0.49	2.54	0.92	0.37	22	113	24	113	48	10	56
Significance					NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
BLSD(.05)					--	--	--	--	--	--	--	--	--	--	--	--	--
Variety X Fertility																	
Hodgson-78			0+60+220		61.6	5.10	0.50	2.48	0.92	0.44	22	125	19	114	46	11	62
Hodgson-78			0+90+330		63.3	5.11	0.52	2.60	0.99	0.44	23	126	24	124	48	11	62
Exp.#II-68-176			0+60+220		59.7	5.52	0.50	2.48	0.92	0.38	22	116	24	107	48	10	56
Exp.#II-68-176			0+90+330		58.9	5.43	0.49	2.63	0.93	0.36	20	119	20	118	48	10	58
Significance					NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
BLSD(.05)					--	--	--	--	--	--	--	--	--	--	--	--	--
Population X Fertility																	
5/ft			0+60+220		58.9	5.46	0.52	2.49	0.95	0.40	21	124	21	109	47	11	59
5/ft			0+90+330		62.0	5.50	0.53	2.70	0.98	0.40	19	125	14	120	49	11	60
10/ft			0+60+220		62.4	5.16	0.48	2.47	0.95	0.41	22	117	22	112	47	10	58
10/ft			0+90+330		60.2	5.04	0.48	2.55	0.94	0.39	24	120	30	122	47	10	60
Significance					*	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
BLSD(.05)					3.4	--	--	--	--	--	--	--	--	--	--	--	--
Variety X Population X Fertility																	
Significance					NS	*	NS	NS	NS	NS	+	NS	NS	NS	NS	NS	NS
BLSD(.05)					--	0.37	--	--	--	--	5	--	--	--	--	--	--

MICRONUTRIENT FERTILIZATION OF POTATOES AND CORN UNDER IRRIGATION

G.L. Malzer, T. Graff and G. Titrud

The need for micronutrient fertilization and application of fertilizers other than those which supply N,P, and K continue to be of concern to the producers of potatoes and corn as well as other crops on the coarse textured soils under irrigation. Because of the intensive management operations, high yield potentials, and often low nutrient supplying capactives of these soils, conditions may develop where yield reductions due to the lack of an essential nutrient other than N,P, or K may occur. Three separate experiments were established in 1978 at the Sand Plains Research Farm at Becker, MN. to assess the significance of certain plant nutrients other than N,P, and K on yield and nutrient composition of the plant tissue for potatoes and corn.

Experimental Procedures

Seven treatments, including a control, four micronutrient treatments, and two macronutrient treatments were established in a randomized complete block design with four replications. Rates and types of fertilizer included: 5 lbs. of Copper/A as $C_4SO_4 \cdot 5_2O$, 2 lbs of Boron/A as Solubor, 25 lbs. of Sulfur/A as $CaSO_4$, 75 lbs. of Magnesium as $MgCl_2$, 10 lbs of Zinc/A as $ZnCl_2$ and 3 lbs. of Manganese/A as $MnCl_2$. Application of materials were made to the same plots as was applied in 1978, 1979, and 1980. The corn and potatoes areas were rotated in 1981 so the corn was planted into the 1980 potato area (eight replications) and potatoes were planted into the corn areas, (four replications of each variety).

Fertilizer treatments were applied, incorporated by plowing on April 17th and the potatoes planted on April 23rd. Norlands were planted in 9 inch spacings utilizing 36 inch rows, while Russet Burbanks were planted in 12 inch spacings with the same row width. At the time of planting, starter was used at the rate of 1050 lbs/A of 8-10-30 and a insecticide, Temik 15 G was banded at planting time. Lorox herbicide was applied May 30th at 2#/A (in 53 gal/A spray) for weed control. Sidedressing treatments of nitrogen were made on June 26th (240 lbs/A 34-0-0) and on July 8th (250 lbs/A 34-0-0), along with hilling at the last sidedressing. Samples of the youngest mature potato leaves were obtained 70 days after planting for nutrient composition. The Norland potatoes were harvested on August 28th and the Russet Burbanks on September 23. Irrigation water was applied during the period of May 19th through August 19th with a total addition of 9.75 inches. Precipitation during the period of May-August was 15.28 inches and May-September was 15.55 inches. Utilizing the 1980 potato experimental area, eight replications of the aforementioned treatments were planted to corn. The experimental area had been fertilized with 800 lbs/A 8-10-30 prior to planting on April 27th. A commerical corn variety (Pioneer 3901) was planted in 30" rows at a population of 30,700 seeds/A. Starter fertilizer at the rate of 165 lbs/A of 8-10-30 was banded at planting. Lasso at (2 #/A ai) was used for weed control. Sidedressing applications of nitrogen were made on June 2nd (240 lbs/A 34-0-0) and June 17th (300 lbs/A 34-0-0) for the season. Leaf samples from opposite and below the ear at mid-silking were taken on July 20th, dried, ground, and analyzed for elemental content. Total dry matter production was determined on September 22nd by hand harvesting 50 ft^2. Ears were separated from the stalks, field weights obtained, and samples removed for moisture determination and elemental content. Corn grain yields were taken on October 12th by hand harvesting 100 ft^2. Grain yields were adjusted to 15.5% moisture. The irrigation program was started on May 19th and continued through September 10th with a total of 11.75 inches of water being applied through irrigation. An additional 17.03 inches of water was obtained during the growing season through rainfall.

General Results

This concludes the fourth consecutive year for the establishment of these plots on the same experimental area. Yields from the experimental area were somewhat reduced from the yields which have been obtained in the past. The lowered potato yields especially, may at least partially explain why no response was obtained to the application of any of the treatments. The corn grain yields although good did not suggest any positive response to the addition of the secondary or micronutrients applied. Elemental concentrations within the plant tissue did reflect, in certain cases, the application of zinc, boron, and copper. Zinc and boron application in the past have provided small positive yield responses. If yield levels would have been higher perhaps yields responses would have been obtained. These experiments will be rotated and conducted again in 1982.

Table 1. Influence of micronutrient fertilizer (also Mg and S) on tuber yield and nutrient concentration of the youngest mature leaves 70 days following planting for Norland and Russet Burbank potatoes.

Treatment	rate/A	Tuber Yield	N	P	K	Ca	Mg	Al	Fe	Na	Mn	Zn	Cu	B
			Norland Potatoes											
			Leaf Concentration											
	#/A	cwt/A	%					ppm						
Control	-	378	4.86	0.36	6.14	1.15	.439	109	159	38	280	18	6	35
Cu	5	364	5.10	0.37	5.89	1.27	.488	112	162	38	312	22	14	39
B	2	380	5.11	0.35	5.78	1.14	.435	94	145	32	296	18	5	38
S	25	360	5.01	0.36	5.94	1.15	.396	99	149	35	355	22	8	34
Mg	75	392	5.05	0.36	5.90	1.14	.604	95	153	37	218	20	6	35
Zn	10	378	5.17	0.38	5.88	1.25	.488	128	184	35	339	30	9	34
Mn	3	365	5.26	0.38	6.18	1.30	.536	106	164	36	270	23	9	34
Significance		NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	**	**	NS
BLSD (.05)		-	-	-	-	-	-	-	-	-	-	6	3	-
			Russet Burbank Potatoes											
Control	-	366	5.21	0.42	5.63	0.69	.447	63	108	28	220	22	6	29
Cu	5	342	5.31	0.42	5.83	0.71	.432	60	109	48	225	24	12	32
B	2	380	5.47	0.40	5.63	0.72	.413	67	110	31	229	19	5	31
S	25	368	5.29	0.40	5.63	0.69	.416	69	116	34	259	21	6	29
Mg	75	378	5.24	0.42	5.18	0.60	.494	54	102	29	162	22	7	27
Zn	10	355	5.46	0.42	5.54	0.73	.453	72	120	31	225	28	7	32
Mn	3	335	5.31	0.44	5.32	0.71	.481	51	106	33	201	24	8	31
Significance		NS	NS	NS	NS	**	NS	NS	NS	+	NS	NS	*	**
BLSD (.05)		-	-	-	-	0.06	-	-	-	16	-	-	4	3

Table 2. Influence of micronutrient fertilization (also Mg and S) on corn grain yield and dry matter production.

Treatment	rate/A	Harvest Grain Yield 15.5%	Harvest Grain Dry Matter	Harvest Grain N removal	Dry Matter Production (Phsiological Maturity) Stover	Grain	Cob	Total
	#/A	bu/A	%	#/A	T/A			
Control	-	182.9	71.0	113.9	3.20	4.41	0.57	8.18
Cu	5	186.7	70.7	114.9	3.23	4.31	0.58	8.11
B	2	185.0	70.4	116.5	3.42	4.40	0.59	8.41
S	25	182.2	70.6	114.9	3.43	4.48	0.61	8.50
Mg	75	189.1	70.5	119.5	3.08	4.18	0.56	7.83
Zn	10	182.5	70.8	113.6	3.59	4.41	0.59	8.59
Mn	3	185.2	70.2	114.2	3.42	4.47	0.59	8.49
Significance		NS	NS	NS	*	NS	NS	*
BLSD(.05)		-	-	-	0.31	-	-	0.52

Table 3. Influence of micronutrient fertilization (also Mg and S) on the elemental concentration of silage stover, silage grain and the leaf opposite and below the ear at silking.

		Elemental Concentration											
		Silage Stover											
Treatment	rate/A	N	P	K	Ca	Mg	Al	Fe	Na	MN	Zn	Cu	Bu
	#/A	%					ppm						
Control	-	0.65	0.06	2.29	0.36	0.14	148	149	66	62	8	7	7
Cu	5	0.56	0.04	2.36	0.28	0.13	139	128	50	47	7	7	6
B	2	0.56	0.05	2.39	0.34	0.12	136	123	57	65	8	6	10
S	25	0.58	0.04	2.42	0.36	0.14	156	146	59	59	7	6	8
Mg	75	0.54	0.04	2.37	0.30	0.14	147	134	52	54	7	6	8
Zn	10	0.60	0.04	2.40	0.36	0.14	154	139	56	52	21	6	7
Mn	3	0.56	0.04	2.58	0.30	0.11	130	120	54	51	7	6	8
Significance		NS	NS	NS	NS	NS	NS	NS	*	NS	**	NS	**
BLSD (.05)		-	-	-	-	-	-	-	11	-	3	-	2
		Silage Grain											
Control	-	1.34	0.28	0.37	0.002	0.13	1	21	8	6	18	2	2
Cu	5	1.32	0.27	0.37	0.002	0.13	2	20	11	6	17	2	2
B	2	1.35	0.28	0.38	0.002	0.13	1	21	9	6	18	2	3
S	25	1.33	0.28	0.38	0.002	0.13	1	21	8	6	18	2	2
Mg	75	1.35	0.29	0.39	0.002	0.14	2	22	10	6	19	2	2
Zn	10	1.30	0.28	0.38	0.002	0.14	1	23	8	6	25	2	2
Mn	3	1.34	0.28	0.38	0.002	0.13	1	21	9	6	18	2	2
Significance		NS	NS	NS	NS	NS	NS	*	NS	NS	**	NS	**
BLSD (.05)		-	-	-	-	-	-	2	-	-	1	-	1
		Leaf											
Control	-	2.96	0.38	2.82	0.62	0.29	55	136	72	112	23	11	6
Cu	5	2.96	0.37	2.78	0.55	0.27	50	126	72	108	22	13	6
B	2	2.84	0.37	2.86	0.56	0.25	50	129	74	112	23	10	7
S	25	3.00	0.38	2.79	0.60	0.27	59	139	74	113	23	10	6
Mg	75	2.81	0.37	2.83	0.53	0.30	56	132	87	109	24	10	6
Zn	10	2.99	0.37	2.75	0.58	0.29	54	133	81	96	43	11	6
Mn	3	2.95	0.38	2.82	0.60	0.27	56	137	77	115	24	11	6
Significance		NS	NS	NS	+	NS	NS	NS	NS	NS	**	**	*
BLSD (.05)		-	-	-	0.06	-	-	-	-	-	2	1	1

Table 4. Influence of microutrient fertilization (also Mg and S) on the total elemental removal of silage stover, and silage grain at physiological maturity.

		TOTAL ELEMENTAL REMOVAL											
		Silage Stover											
Treatment	rate/A	N	P	K	Ca	Mg	Al	Fe	Na	Mn	Zn	Cu	B
	#/A	lbs/A											
Control	-	48.6	4.1	174	26.8	10.4	1.1	1.1	0.49	0.47	0.06	0.05	0.05
Cu	5	42.6	3.3	180	21.4	9.7	1.1	1.0	0.38	0.36	0.05	0.05	0.05
B	2	44.6	4.0	192	27.0	9.8	1.1	1.0	0.46	0.52	0.06	0.05	0.08
S	25	46.6	3.6	196	29.0	11.0	1.2	1.2	0.47	0.48	0.06	0.05	0.06
Mg	75	39.4	3.0	173	22.1	10.3	1.1	1.0	0.38	0.39	0.05	0.04	0.06
Zn	10	51.0	3.6	204	29.8	11.8	1.3	1.2	0.46	0.44	0.18	0.05	0.06
Mn	3	45.4	3.2	208	23.6	9.0	1.0	1.0	0.43	0.41	0.06	0.05	0.06
Significance		+	NS	NS	*	NS	NS	NS	*	NS	**	NS	**
BLSD(.05)		7.9	-	-	6.6	-	-	-	0.08	-	0.03	-	0.02
		Silage Grain											
Control	-	117.8	24.3	33	0.14	11.6	0.01	0.18	0.07	0.05	0.16	0.02	0.02
Cu	5	113.9	23.2	32	0.14	11.0	0.02	0.17	0.09	0.05	0.15	0.02	0.02
B	2	118.7	24.4	33	0.16	11.4	0.01	0.19	0.08	0.05	0.16	0.02	0.03
S	25	119.1	25.0	34	0.17	11.8	0.01	0.19	0.07	0.05	0.16	0.02	0.03
Mg	75	112.9	24.1	33	0.15	11.8	0.01	0.18	0.08	0.05	0.16	0.02	0.02
Zn	10	115.0	25.0	34	0.17	12.1	0.01	0.20	0.07	0.05	0.22	0.02	0.02
Mg	3	120.0	25.1	34	0.16	11.8	0.01	0.18	0.08	0.05	0.16	0.02	0.02
Significance		NS	NS	NS	NS	NS	NS	**	NS	NS	**	NS	**
BLSD(.05)		-	-	-	-	-	-	0.02	-	-	0.01	-	0.01
		TOTAL											
Control	-	166.4	28.5	206	27.0	22.0	1.12	1.30	0.57	0.52	0.22	0.07	0.07
Cu	5	156.5	26.4	212	21.6	20.7	1.09	1.16	0.47	0.41	0.20	0.07	0.07
B	2	163.3	28.4	226	27.2	21.2	1.10	1.17	0.53	0.57	0.22	0.07	0.10
S	25	165.7	28.7	230	29.2	22.8	1.27	1.37	0.54	0.53	0.22	0.07	0.08
Mg	75	152.3	27.1	206	22.2	22.1	1.10	1.17	0.46	0.44	0.22	0.06	0.08
Zn	10	166.0	28.7	238	30.0	23.9	1.31	1.37	0.53	0.49	0.40	0.07	0.08
Mn	3	165.4	28.3	242	23.8	20.8	1.06	1.15	0.51	0.46	0.22	0.06	0.08
Significance		NS	NS	NS	*	NS	NS	NS	NS	NS	**	NS	**
BLSD(.05)		-	-	-	6.6	-	-	-	-	-	0.03	-	0.02

CORN AND SUNFLOWER YIELDS WITH VARYING LEVELS OF SOIL TEST K

C. J. Overdahl and Michael O'Leary

Relatively low soil test K has produced surprisingly high crop yields when under irrigation. This has been demonstrated with aflalfa at Staples as well as with corn and sunflowers at Becker.

Sunflowers were grown at Becker in 1979. In 1980 corn was planted on this site and a sunflower plot was established at an adjacent area previously in rye. In 1981 crops were reversed at these 2 sites.

Potash treatments of 0, 60, 120, 180, 240 and 300 were used in 1979 and the 300 pound treatment was increased to 480 pounds of K_2O for 1980 and 1981 on both experimental areas.

In table 1 the area labelled "B plots" was the initial area where sunflowers were grown in 1979 and the "A plots" was the area established in 1980. This table shows the effect of potash treatments on yields of two crops. Most years the first 60 pounds per acre of K_2O was sufficient for best yields.

Table 2 shows the effect by years on the K soil test level. Soil tests as low as 54 gave good yields. Soil tests down to 3 feet were very low. Evident in table 2 is that soil test increases are very slow. At the highest K rate of 1260 pounds over three years the test increased to 232 and 201 pounds in the two plot areas respectively.

At the Staples irrigation farm alfalfa yielded over 5 tons per acre with a soil test of less than 50 pounds per acre of exchangeable K. The subsoil K was also very low. The irrigation water has no appreciable amounts of potassium.

Plant analysis data in table 3 show that the first 60 pounds of K_2O come close to bringing the plant tissue to the sufficiency levels of 3% for sunflowers and 1.7% for corn.

The evidence from the two irrigation farms point to what could be an interesting student thesis project.

Table 1. Corn and sunflower yields rotated on two adjacent plots Becker, Minnesota, 1979, 1980 and 1981.

K_2O lbs/acre[1]			Yields of Sunflowers and Corn					
			A plots (South)			B plots (North)		
1979	1980	1981	1979 rye	1980 flowers lbs.	1981 corn bu	1979 flowers lbs.	1980 corn bu	1981 flowers lbs.
0	0	0	-	1292	164	1277	161	1416
60	60	60	-	1588	186	1965	190	1814
120	120	120	-	1765	182	2017	198	2022
180	180	180	-	1866	187	2082	195	1990
240	240	240	-	1725	191	2172	193	1914
300	480	480	-	1906	182	2033	197	1904
Significance				*	*	**	**	**
BLSD (.05)				345	14	220	18	200
C.V.				12.6	4.9	7.6	6.4	7.4

[1]Additional fertilizer for corn annually
0 + 50 + 0 broadcast (plow down)
18 - 46 - 0 at 160#/acre as starter
75 + 0 + 0 side dressed at 8 leaf stage
100 + 0 + 0 side dressed at 12 leaf stage

Additional fertilizer for sunflowers annually
60 + 40 + 0 preplant
60 + 0 + 0 July 1
18 - 46 - 0 at 160#/acre in row

Table 2. Soil test K for corn and sunflower plots from two adjacent sites. Becker, Minnesota, 1979, 1980 and 1981.

K_2O lbs/acre			Soil Test K, lbs/acre					
			A plots (South)			B plots (North)		
1979	1980	1981	1979 rye	1980 flowers	1981 corn	1979 flowers	1980 corn	1981 flowers
0	0	0	-	42	63	63	36	71
60	60	60	-	54	85	69	44	94
120	120	120	-	60	97	76	58	85
180	180	180	-	72	107	86	80	108
240	240	240	-	67	142	87	109	128
300	480	480	-	104	232	91	142	201

Table 3. Potassium plant analysis from corn and sunflower rotation on two adjacent plots. Becker, Minnesota, 1979, 1980 and 1981.

			%K in plants[1]					
			A plots (South)			B plots (North)		
1979	1980	1981	1979 rye	1980 flowers	1981 corn	1979 flowers	1980 corn	1981 flowers
0	0	0	-	2.76	1.27	2.60	1.05	2.50
60	60	60	-	2.94	1.67	2.77	1.54	3.14
120	120	120	-	3.19	1.96	2.90	1.93	3.51
180	180	180	-	3.43	2.13	3.01	2.28	3.56
240	240	240	-	3.74	2.27	3.27	2.98	4.05
300	480	480	-	4.28	2.64	3.28	2.41	4.70
Significance				**	**	**	**	**
BLSD (.05)				.37	.27	.30	.27	.68
C.V.				7.7	9.8	6.8	9.9	13.0

[1]Corn-leaf opposition and below ear
Sunflower - 5th leaf

SOIL TEST LAB COMPARISON ON IRRIGATED CORN - BECKER, 1981

W. E. Jokela and M. O'Leary

Several commerical laboratories test soils and make fertilizer recommendations in Minnesota. Substantial differences have sometimes been observed in the recommendations from different labs. This experiment was established to compare soil test results, recommended fertilizer rates and costs, and yields of irrigated corn fertilized according to the recommendations of five soil testing labs. Similar experiments are being conducted on corn at Waseca and on corn and wheat in rotation at Morris.

Experimental Procedures

The experiment was established on a Hubbard loamy sand at the Sand Plains Irrigation Farm at Becker, MN. A composite sample was taken in the fall on 1979. The samples were dried, thoroughly mixed, and divided into five subsamples which were sent to five soil testing labs, including the University of Minnesota. A fertilizer recommendation was requested for a 200 bu/acre yield of corn under irrigation. Fertilizer as recommended by each of the five labs was applied in the spring before plowing. The sixth treatment was a no-fertilizer check. Experimental design is randomized complete block with four replications.

After harvest of the 1980 crop, separate samples were taken from each treatment (soil testing lab) and sent to the corresponding soil testing lab for analysis and fertilizer recommendations. The same procedure was followed as in the previous year. In 1981 Pioneer 3901 variety was planted at a population of 30,700 on May 5. Earleaf samples were taken at early silking and two twenty foot rows per plot were harvested for grain at maturity.

Results and Discussion

Soil test results and fertilizer recommendations are shown in Table 1 and 2. Recommended N rates were quite similar, but there were substantial differences in amounts of P and K and in which secondary and micronutrients were recommended.

Elemental analysis of earleaf are given in Table 3. K and Zn shown some variation between lab treatments, but for other elements only the check was significantly different.

Grain yield, grain moisture, and an economic comparison are shown in Table 4. Grain yields varied from 158 to 171 bu/acre, compared to 86 bu/acre on the check. The cost of fertilizer recommended by the various labs ranged from $95 to $127/acre, a considerably smaller range than in 1980 ($81 to $144/acre). The return over cost for the five fertilizer programs varied by only about $19, and all were substantially higher than the no fertilizer check.

Table 1. Soil test results after one year fertilization and cropping. Becker, MN Fall, 1980.

Test	Soil Test Results[1] Lab A	Lab B	Lab C	Lab D	Lab E (U.M.)	Check
pH	6.5	6.2	7.0	6.7	6.4	6.6
Buffer Index	---	6.9	---	7.1	---	---
Phosphorus (Bray 1)	20	26 H	20 VH		8	12
Potassium	10	77 M	68 M	70 L	23	28
Calcium	1100	850 M	2200 M	1000		
Magnesium	220	149 VH	370 M	250		
Sulfur	11	5 L	19 Adq.	19.2	1	8
Iron	25.5	27 VH	17 H	8+		
Manganese	5.5	9 M	4.4 M	2+		
Zinc	3.9	1.8 M	1 VL	2.0	1.1	.6
Copper	.6	.8 L	0.5 H	.4+		
Boron	.3	.8 L		.6 L		
Nitrate-N (0-6")	4		3			
Organic Matter (%)	1.7	1.7 L	ML	1.6	2.0	1.9
C.E.C. (meg/100g)	7.5	6.5		7.3		

[1]All soil test results are in ppm unless noted otherwise.

Table 2. Fertilizer recommendations from 5 soil testing labs for 200 bu/acre irrigated corn following corn. Becker, MN 1981.

Nutrient	Fertilizer Recommended Lab A	Lab B	Lab C	Lab D	Lab E (U.M.)
	----------lb/acre----------				
Nitrogen[1]	265	280	243	240	220
Phosphorus (P_2O_5)	110[2]	65	139	87	110
Potassium (K_2O)	285[2]	190	364	352	240
Sulfur	30	25			20
Zinc		2.5	10		
Manganese		2			
Copper		1.5			
Boron	1.5	1		0.5	
Lime (CCE)		900			

[1]N was split into 3 applications - ¼ preplant, ¼ at 8-leaf, ½ at 12-leaf.

[2]Includes maintenance plus ½ of suggested build rate.

Table 3. Elemental analysis of earleaf at early silking as influenced by fertilization programs from different labs. Becker, MN 1981.

Elemental Analysis of Earleaf

Lab	N	P	K	Ca	Mg	Al	Fe	Na	Mn	Zn	Cu	B
	----------%----------					----------ppm----------						
A	3.10	.33	2.46	.46	.30	28	104	53	44	23.6	8.5	6.6
B	3.08	.30	2.44	.45	.33	28	101	52	46	28.0	10.1	9.2
C	3.05	.33	2.66	.43	.25	28	103	49	41	21.1	8.8	7.9
D	3.07	.33	2.64	.42	.28	28	104	52	42	21.3	8.0	7.2
E (UM)	3.17	.31	2.34	.47	.32	28	107	48	46	22.3	8.9	8.4
Check	1.96	.29	2.11	.44	.38	30	78	38	32	17.4	7.0	10.5
Signif.	**	**	**	ns	**	ns	**	+	**	**	ns	ns
BLSD (.05)	.22	.02	.12	-	.06	-	6	10	7	2.7	-	-
C.V.	5.3	4.9	3.6	8.4	11.6	7.0	4.4	14.4	10.0	8.6	6.9	31.8

Table 4. Corn grain yield, grain moisture at harvest, and economic return over fertilizer costs for six fertilization programs. Becker, MN 1981.

Lab	Grain Yield	Grain Moisture	Crop Value @ $2.40/bu	Fertilizer[1] Cost	Return Over Fertilizer Cost
	-----bu/acre---------		----------$/acre----------		
A	158.2	32.5	379.68	112.55	267.13
B	162.6	32.0	390.24	104.61	285.63
C	171.2	32.1	410.88	127.42	283.46
D	159.8	32.8	383.52	104.46	279.06
E (UM)	158.9	31.8	381.36	95.30	286.06
Check	86.4	38.2	207.36	0	207.36
Signif.	**	**			
BLSD (.05)	12.6	2.81			
C.V.	6.0	5.6			

[1]Fertilizer prices used (5/1/81, $/lb): N = .15, P_2O_5 = .25, K_2O = .13, S = .18, Zn = .89, Mn = 1.04, Cu = 2.80, B = 1.90.

1981 WEATHER

1981 was the second warmest year in the past 92-year history of climatological data for Crookston. Above normal precipitation combined with the warm temperatures produced excellent crop yields for 1981. Following a very mild winter, spring arrived early in the Red River Valley. The shallow snow pack began thawing in mid-February with 40 degree temperatures and was completely melted by mid-March. Field preparation for the 1981 growing season commenced the first part of April although there were some reports of farmers seeding as early as March 20. The last spring frost was recorded on May 10 (22°F) which initiated a 141-day growing season ending September 28 (28°F) when the first fall frost occurred. The normal frost-free period for Crookston (temperature 32°F) is 125 days. Nine daily maximum temperature records were set in 1981 and two records were equaled. Four daily precipitation records were also surpassed in 1981. The new weather records are listed in the tables below.

Table 1.

New Record High Temps.		Previous Record High Temps.	
1-24-81	48°	1-24-44	45°
2-14-81	42°	2-14-35	40°
2-16-81	49°	2-16-31	46°
2-17-81	47°	2-17-71	41°
2-18-81	42°*	2-18-30	42°*
2-21-81	47°*	2-21-30	47°*
3-11-81	46°	3-11-02	53°
3-14-81	58°	3-14-35	52°
3-16-81	59°	3-16-10	57°
11-12-81	61°	11-12-34	58°
11-13-81	60°	11-13-73	55°

*Previous year with the same temperature.

Table 2. Average Annual Mean Temperature

1981	1931	90-Yr Average
43.6°	45.0°	39.4°

Table 3.

New Record Daily Precip.		Previous Record Daily Precip.	
5-24-81	1.01"	5-24-43	0.80"
9-06-81	1.81"	9-06-69	1.27"
9-23-81	1.07"	9-23-64	0.90"
10-12-81	0.90"	10-12-30	0.61"

The precipitation for 1981 totaled 24.85 inches of which 23.59 inches were recorded as rain and 1.26 inches of precipitation were contained in 23.1 inches of snow. The water equivalent of the snow for 1981 was .05 inches/1 inch of snow. 65% of the total precipitation (15.87 inches) was recorded during the growing season April 1-Sept. 30. As indicated in Table 4, January, March, April, November and December had slightly below normal precipitation while the remaining months had above normal precipitation. June through October precipitations were 2/3 inches to 1½ inches above normal. For the year, Crookston was 4.18 inches above normal in regard to total precipitation. The 1981 precipitation patterns were very erratic with the Red Lake Falls reporting station located 18 miles northeast of Crookston recording 25.86 inches for the months June through September (12.11 inches above normal) and 36.40 inches for the year (14.11 inches above normal).

Table 4 also lists the mean monthly and annual temperatures for Crookston. June, October, and December were the only months recording mean temperatures lower than normal. January, February, March and November averaged about 10 degrees warmer than normal which account for 1981 being the second warmest year since the weather records were initiated in 1890. The mean yearly temperature for 1981 was 43.6°F which is 4.2°F warmer than the 90-year average of 39.4°F. The only other warmer year since 1890 was 1931 with a mean annual temperature of 45.0°F.

Table 4. Weather summary for 1981 with averages for precipitation and mean temperatures - 1890-1979.

	Precipitation (Inches)					Mean Temperatures (°F)	
Month	Snow	Precip.	Rain	Total	1890-1979	1981	1890-1979
January	5.1	.20	--	.20	.56	13.6	3.7
February	7.0	.56	.09	.65	.59	19.8	8.1
March	0.2	T	.63	.63	.84	33.3	22.9
April	--	--	1.26	1.26	1.57	46.1	41.4
May	--	--	2.63	2.63	2.59	56.0	54.6
June	--	--	4.95	4.95	3.56	62.7	64.4
July	--	--	3.72	3.72	3.09	69.9	69.6
August	--	--	3.69	3.69	2.90	69.7	67.4
September	--	--	3.60	3.60	2.16	58.4	51.5
October	0.5	.02	2.71	2.73	1.43	44.9	45.3
November	3.1	.21	.31	.52	.78	36.7	26.7
December	7.2	.27	--	.27	.60	10.9	11.5
Total	23.1	1.26	23.59	24.85	20.67	43.6	39.4

STARTER FERTILIZER STUDY--SPRING WHEAT

G.E. Varvel and H. Meredith

Objective of Study: To compare commercially available starter fertilizer materials with experimental urea phosphates prepared by TVA on a highly calcareous soil.

Location: University of Minnesota, Northwest Experiment Station, Crookston, MN.

Carriers: 1) urea phosphate (17-44-0), 2) diammonium phosphate (18-46-0), 3) cogranulated-urea-urea phosphate (38-13-0) + superphosphate (0-44-0) to give (25-50-0), 4) urea phosphate (17-44-0) + UAN solution (28-0-0) to give (13-28-0), and 5) ammoniated phosphoric acid (10-34-0) + UAN solution (28-0-0) to give (13-28-0).

P Rate: 50 and 100 lb P_2O_5/A.

Methods: All treatments were applied with the seed. The test variety was era and all treatments (seeding + fertilizer) were applied on May 1, 1981. Emergence (stand counts) were taken on May 21, 1981. Whole plant samples were taken at late tillering (June 16, 1981) and maturity (July 27, 1981). Grain harvest was taken August 10, 1981. Soil test data for the study which was located on a Wheatville loam were: O.M.-3.6, pH-7.9, $NaHCO_3$ P-20 lb/A, exchangeable K-322 lb/A, and NO_3-N.-160 lb/A-2'.

Results:
Early plant and forage analyses as affected by the treatments are shown in Table 1. Phosphorus (early plant) and N (forage) were significantly increased as the P rate increased.

Table 1. The effect of starter fertilizer on elemental analyses of spring wheat at late tillering and maturity.

	Elemental Analyses					
	Early Plant (Late Tillering)			Forage (Maturity)		
Carrier	N	P	K	N	P	K
	%			%		
1 (18-44-0)	4.30	.44	4.56	1.48	.21	1.33
2 (18-46-0)	4.37	.44	4.45	1.55	.23	1.27
3 (25-50-0)	4.16	.45	4.49	1.43	.20	1.36
4 (13-28-0)	4.31	.44	4.38	1.47	.20	1.32
5 (13-28-0)	4.28	.45	4.47	1.48	.21	1.45
Significance	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
C.V. (%)	5.0	3.4	6.1	9.1	18.1	16.7
P Rate lb/A						
50	4.22	.43	4.43	1.44	.20	1.36
100	4.35	.45	4.51	1.52	.22	1.34
Significance	N.S.	**	N.S.	*	N.S.	N.S.
B.L.S.D. (.05)						
C.V. (%)	5.0	3.4	6.1	9.1	18.1	16.7

Forage yield, N and P uptake, grain yield, protein, bushel weight, and plant population (early stand counts) as affected by the treatments are shown in Table 2. Grain yield was significantly reduced as P rate increased and plant population was significantly different between carriers. A significant interaction between carrier and P rate was obtained with respect to forage yield (Table 2).

Table 2. The effect of starter fertilizer on forage yield, P and N uptake, grain yield, protein, test weight, and plant population.

Carrier	Rate P_2O_5	Rate N	Forage T.D.M. Yield	Forage P	Forage N	Grain Yield	Grain Protein	Grain Test Weight	Plant Population
	- - - - - - -		lb/A - - - - - - -			Bu/A	%	lb/Bu	Plants/A
18-44-0	50	20	7184	14.7	105	41.8	13.1	56.4	1,071,600
	100	40	6851	14.8	102	39.4	12.9	56.4	1,050,700
18-46-0	50	20	6514	15.3	100	44.3	12.8	56.4	1,006,300
	100	40	6926	16.4	110	40.6	13.0	55.7	1,035,900
25-50-0	50	25	6841	13.6	97	40.9	13.0	56.3	1,110,000
	100	50	7067	13.6	101	39.6	12.8	56.7	1,121,300
13-28-0	50	24	7453	13.4	101	42.6	13.0	56.2	1,095,200
	100	48	6641	14.4	105	38.7	13.4	55.5	1,095,200
13-28-0	50	24	7502	15.0	107	42.0	13.0	56.8	1,161,400
	100	48	6572	14.8	100	39.1	13.2	55.2	1,078,600
Significance			**	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
C.V. (%)			6.0	19.1	10.6	7.7	2.3	2.2	6.6
Carrier									
1			7018	14.7	104	40.6	13.0	56.4	1,061,200
2			6720	15.8	105	42.4	12.9	56.0	1,021,100
3			6954	13.6	99	40.2	12.9	56.5	1,115,600
4			7047	13.9	103	40.6	13.2	55.8	1,095,200
5			7037	14.9	103	40.6	13.1	56.0	1,120,000
Significance			--	N.S.	N.S.	N.S.	N.S.	N.S.	*
B.L.S.D. (.05)									83,200
P Rate lb/A									
50			7099	14.4	102	42.3	13.0	56.4	1,088,900
100			6811	14.8	104	39.5	13.1	55.9	1,076,300
Significance			--	N.S.	N.S.	**	N.S.	N.S.	N.S.
B.L.S.D. (.05)									

Discussion: The interaction between carrier and P rate was obtained because with carriers 1, 4 and 5 forage yield was reduced as P rate increased, while with carriers 2 and 3 forage yield increased with P rate. Generally, N levels were too high for optimum production which may have caused some lodging at the higher P rates which had higher N rates, but this should have occurred with all carriers. The cause of the interaction is unclear. The significant increase of N in the forage was caused by the additional N in the treatments, not the P.

The significant difference in plant population between carriers did not cause any differences in yield. No reduction in plant population was obtained, even though N levels in excess of 40 lb/A were applied with the seed. Excellent soil moisture at planting probably negated the effect of the high N levels. Further studies will be used to evaluate these carriers.

BROADCAST FERTILIZER STUDY--SPRING WHEAT

G.E. Varvel and H. Meredith

Objective: To evaluate experimental N carriers on a highly calcareous soil.

Location: University of Minnesota, Northwest Experiment Station, Crookston, MN.

Carriers: 1) cogranulated urea-urea phosphate (38-13-0), 2) cogranulated urea-urea phosphate (34-17-0), 3) urea-ammonium phosphate (28-28-0), 4) urea phosphate (18-44-0), and 5) urea phosphate (18-44-0) + UAN (28-0-0) to give (15-28-0).

N Rate: 30 and 60 lb N/A.

Methods: The treatments were applied May 1, 1981 on a Wheatville loam soil and incorporated with a field cultivator. Phosphorus rates were equalized between treatments with super phosphate (0-44-0). Era wheat was planted that same day. Stand counts (plant population) were taken May 21, 1981. Whole plant samples were taken at late tillering (June 16, 1981) and maturity (July 27, 1981) to measure the relative N efficiency of the carriers. Grain was harvested August 10, 1981. Soil test data for the study were: O.M.-3.6, pH-7.9, NO_3-N.-160 lb/A, $NaHCO_3$ P-20 lb/A, and exchangeable K-322 lb/A.

Results: Early plant and forage analyses as affected by the treatments are shown in Table 1. Nitrogen and phosphorus (early plant) were significantly increased as N rate increased. No significant differences were obtained between carriers.

Table 1. The effect of broadcast N from different carriers on analyses of spring wheat at late tillering and maturity.

	Elemental Analyses					
	Early Plant (Late Tillering)			Forage (Maturity)		
Carrier	N	P	K	N	P	K
	%			%		
1 (38-13-0)	3.88	.48	5.09	1.40	.19	1.50
2 (34-17-0)	4.09	.47	5.08	1.52	.21	1.45
3 (28-28-0)	4.07	.46	4.75	1.54	.22	1.40
4 (18-44-0)	3.96	.48	5.03	1.52	.21	1.41
5 (15-28-0	3.93	.49	5.15	1.46	.20	1.59
Significance	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
C.V. (%)	6.2	10.0	10.0	9.5	15.1	18.7
N Rate lb/A						
30	3.91	.46	4.92	1.47	.21	1.42
60	4.05	.49	5.12	1.51	.20	1.52
Significance	*	*	N.S.	N.S.	N.S.	N.S.
B.L.S.D. (.05)	.14	.03				
C.V. (%)	6.2	10.0	10.0	9.5	15.1	18.7

Forage yield, N and P uptake, grain yield, protein, test weight, and plant population (stand count) as affected by the treatments are shown in Table 2. Forage yields were significantly different between carriers and additional N significantly increased protein. A significant interaction between carrier and N rate was obtained with respect to N uptake.

Table 2. The effect of broadcast N from different carriers on forage yield, N and P uptake, grain yield, protein, test weight, and plant population.

Carrier	N Rate	P_2O_5 Rate	Forage D.M. Yield	Forage Uptake N	Forage Uptake P	Grain Yield	Grain Protein	Grain Test Weight	Plant Population
	- - - - - - - - - -		lb/A - - - - - - - - - -			Bu/A	- % -	- lb -	Plants/A
38-13-0	30	76	6072	89	13	38.7	12.3	57.6	1,136,045
	60	152	6183	83	11	40.9	12.8	57.2	1,109,560
34-17-0	30	76	6670	98	14	43.8	12.5	57.5	1,067,743
	60	152	6306	99	12	40.3	12.7	56.6	1,104,682
28-28-0	30	76	6410	96	13	42.2	12.3	57.8	1,140,924
	60	152	6423	101	15	40.5	12.9	56.7	1,090,045
18-44-0	30	76	5840	81	13	41.5	12.4	57.2	1,166,711
	60	152	6462	105	13	41.5	13.1	56.9	1,196,680
15-28-0	30	76	6582	98	13	43.9	12.4	57.8	1,103,288
	60	152	6969	99	13	44.8	13.0	58.1	1,170,196
Significance			N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
C.V. (%)			7.9	10.2	16.7	7.9	2.2	1.5	7.0
Carrier									
1			6127	86	12	39.8	12.6	57.4	1,122,803
2			6488	98	13	42.0	12.6	57.1	1,086,212
3			6417	99	14	41.4	12.6	57.3	1,115,484
4			6151	93	13	41.5	12.7	57.1	1,181,696
5			6776	99	13	44.3	12.7	57.9	1,136,742
Significance			*	--	N.S.	N.S.	N.S.	N.S.	N.S.
B.L.S.D. (.05)			512						
N Rate lb/A									
30			6315	93	13	54.0	12.4	57.6	1,122,942
60			6469	97	13	53.5	12.9	57.1	1,134,233
Significance			N.S.	--	N.S.	N.S.	**	N.S.	N.S.
B.L.S.D. (.05)							.2		

Discussion: Effective evaluation of the N carriers in this study were not obtained. Nitrogen levels in the soil were sufficient for optimum production before any of the treatments were applied, which created an unfavorable environment for N response. The absence of a N response made it difficult to compare the efficiency of the N carriers.

Some differences were obtained between carriers, but these may be actually artificial due to the high N soil levels. Nitrogen did significantly increase early plant N and protein content of the grain, but these would be expected. Significant differences in forage yields between carriers were also obtained, but not in grain yields. An interaction between carrier and N rate was obtained with respect to N uptake, but no explanation is apparent. Additional studies under a N responsive situation will be used to further evaluate the carriers.

HIGH PHOSPHORUS AND POTASSIUM RATES ON CONTINUOUS SPRING WHEAT

G.E. Varvel 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 are designed to provide response curves for both elements and to estimate their "maintenance" rates.

Experimental Procedure:

The ten P and K treatments for the first two years are shown in Table 1. The P and K treatments in the fall of 1980 were broadcast and plowed down. No additional N was applied because the 0-2' soil test showed 140 lb N/A. Era wheat was planted on April 8, 1981 and harvested August 5, 1981. Whole plant samples were taken at late-tillering (June 5, 1981) and soft-dough (July 16, 1981) to determine early plant nutrient concentrations and forage yield and nutrient uptake respectively. Soil samples taken August 18, 1981 were split and sent to the North Dakota State University and University of Minnesota soil testing laboratories for P and K analyses.

Table 1. Phosphorus and potassium treatments applied at Crookston in the high P and K study.

Treatment	Application Date: Spring 1980	Application Date: Fall 1980
	- - - - - P_2O_5 + K_2O	- - - - -
1	0 + 0	0 + 0
2	0 + 100	0 + 100
3	50 + 100	50 + 100
4	100 + 100	100 + 100
5	150 + 100	0 + 100
6	100 + 0	100 + 0
7	100 + 50	100 + 50
8	100 + 150	100 + 0
9	150 + 100	0 + 0
10	100 + 150	0 + 0

Results:

Analyses of the early plant samples are shown in Table 2. The addition of P significantly increased P levels and decreased Zn levels while K levels in the plant increased with added K. Significant differences in B levels were obtained, but they appear to bear no relationship to the treatments.

Table 2. Effect of high P and K rates on the elemental analyses of whole plant samples of spring wheat at late-tillering.

Treatment No.	P_2O_5	K_2O 1/	N	P	K	Ca	Mg	Mn	Zn	Cu	B
	- - lb/A	- -	- - - - - - - - - %					- - - - - - ppm			- - - - - -
1	0	0	4.10	.34	4.08	.40	.37	60	24	6.4	1.8
2	0	100	4.14	.36	4.32	.42	.33	57	24	5.9	1.8
3	50	100	4.08	.43	4.48	.40	.36	58	21	5.8	1.8
4	100	100	3.92	.46	4.50	.37	.36	58	20	6.1	1.8
5	0	100	4.07	.44	4.30	.43	.36	57	22	6.6	1.8
6	100	0	3.94	.44	4.16	.38	.39	62	20	6.0	2.0
7	100	50	4.15	.47	4.27	.43	.38	61	21	5.8	1.9
8	100	0	4.04	.46	4.34	.44	.36	58	21	6.3	1.8
9	0	0	4.07	.44	4.21	.41	.37	60	21	6.0	1.8
10	0	0	4.12	.43	4.34	.40	.37	62	22	5.9	2.1
Significance			N.S.	**	*	N.S.	N.S.	N.S.	**	N.S.	*
B.L.S.D. (.05)				.02	.27				2		0.2
C.V. (%)			4.1	4.3	3.7	10.5	5.8	5.1	5.7	9.0	5.9

1/ Treatments applied in the fall of 1980.