1995 Research and Cropping Results

Twelfth Annual Progress Report

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Ardell Halvorson, LD, Soil Scientist
Donald Tanaka, Soil Scientist
Joseph Krupinsky, Plant Pathologist
Stephen Merrill, Soil Scientist
Beverly Dow, Geneticist (Trees)
John Berdahl, Geneticist (Grasses)
David Franzen, Ext. Soil Specialist
Vern Hofman, Ext. Agric. Engineer

Field Support Staff: James Harms, Marvin Hatzenbuhler, Larry Renner, Jason Gross, Dawn Wetch, Delmer Schlenker, Chuck Flakker, Gordon Jensen, Becky Wald, Mary Kay Tokach, Louie Zachmeier, and Ron Vredenburg.

NOTICE

Contents Relate to Cooperative Agreement between USDA-ARS and Area IV Soil Conservation Districts represented by the Area IV SCD Research Advisory Committee. The preliminary results of this report cannot be used for publication or reproduction without permission of the research scientists involved.

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RESEARCH REPORTS (CONTINUED)

INTRODUCTION TO AREA IV RESEARCH FARM

The Area IV Research Farm is the result of a specific cooperative agreement between USDA-ARS and the twelve soil conservation districts (SCD) that make up Area IV. This agreement was put in place in 1984. Through this agreement, the Area IV SCD's lease cropland from the Nelson estate for USDA-ARS to perform cooperative research projects with the Area IV SCD's. Total cropland leased by AREA IV SCD is 382 acres. In addition, USDA-ARS has leased 55 acres in Sec. 17 and Sec. 18 for soil and water conservation research for many years and another 30 acres in Sec. 8 for tree breeding since 1989. Total acreage leased for research purposes is 467 acres. See Figure 1 for location of Area IV Research Farm in relation to the location of the USDA-ARS Northern Great Plains Research Laboratory facilities. Figure 2 shows the 1995 cropping plans for the four field areas designated as F, G, H, and I.

REPORT OF ACTIVITIES FOR AREA F. NW 1/4 Section 17 (see Figure 2)

Field F1. Conservation Bench Terrace Area - This hay producing area has been excluded from the total acreage leased by AREA IV SCD since 1987.

Field F2. The previous crop was sunflower in 1994 that yielded 1682 lb/a. Sunflower stubble (12-15 inches high) was left standing over winter to augment snow trapping and soil water storage. On May 17, 1995, 40 lb N/a as Urea was broadcast on the soil surface by Cenex. The fertilizer was immediately incorporated with one pass with the JD Mulch Master on May 17th. Butte86 spring wheat was seeded with a JD 750 disk drill with 7.5" row spacing on May 18, 1995. Starter fertilizer, 50 lb/a of 18-46-0, was applied with the seed at planting. The wheat emerged about May 26th. The field was sprayed with Tiller (7.3 oz ai/a) on June 20th. The spring wheat was destroyed by hail on July 20th with a 100% loss. The field was swathed and the spring wheat baled (121 bales of about 400 lb each). On September 20th, the field was sprayed with Roundup RT at 9 oz ai/a. Roughrider winter wheat was planted on September 21, 1995 with JD 750 drill with 7.5" row spacing. Starter fertilizer, 50 lb of 11-52-0, was applied with the seed and 20 lb N/a was also applied at seeding between the rows.

Field F3. The previous crop was Stark spring barley in 1994 that yielded 52 bu/a. The field was sprayed after barley harvest to control volunteer grain and weeds with Roundup (8.25 oz ai/a) on September 26, 1994. Winter wheat, Roughrider, was no-till seeded into standing barley stubble (8 to 10-inch height) on September 29, 1994 using the Haybuster 8000 narrow-point hoe drill, single seed opener, in 10-inch row spacing at a seeding rate of about 1-million viable seeds/a. Nitrogen fertilizer (46-0-0) was broadcast at a rate of 50 lb N/a on May 17, 1995 by Cenex dealer. The winter wheat was not sprayed for broadleaf weed in 1995. A hail storm on July 20, 1995 destroyed most (95%) of the winter wheat. The field was swathed as close to the ground as

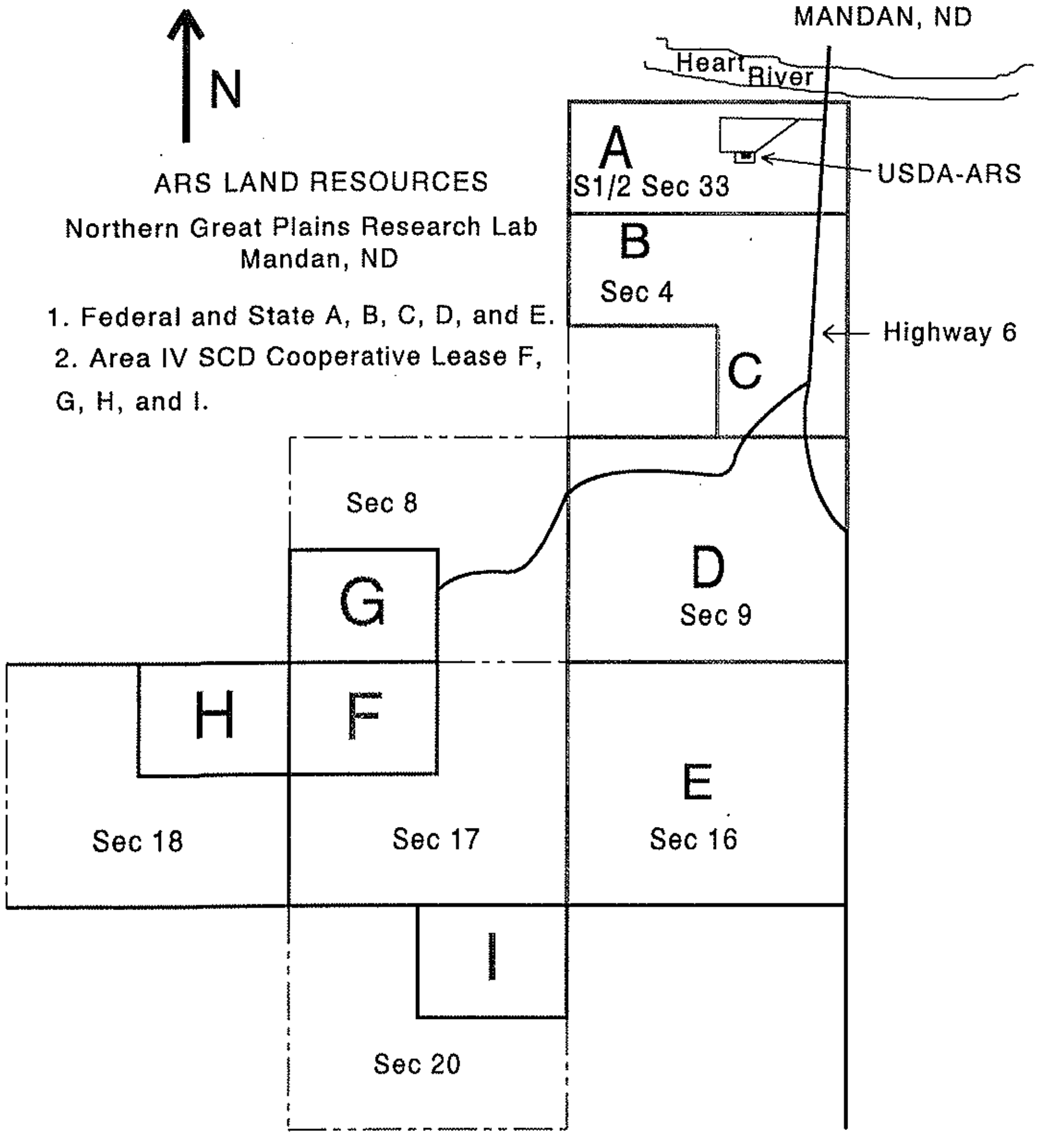
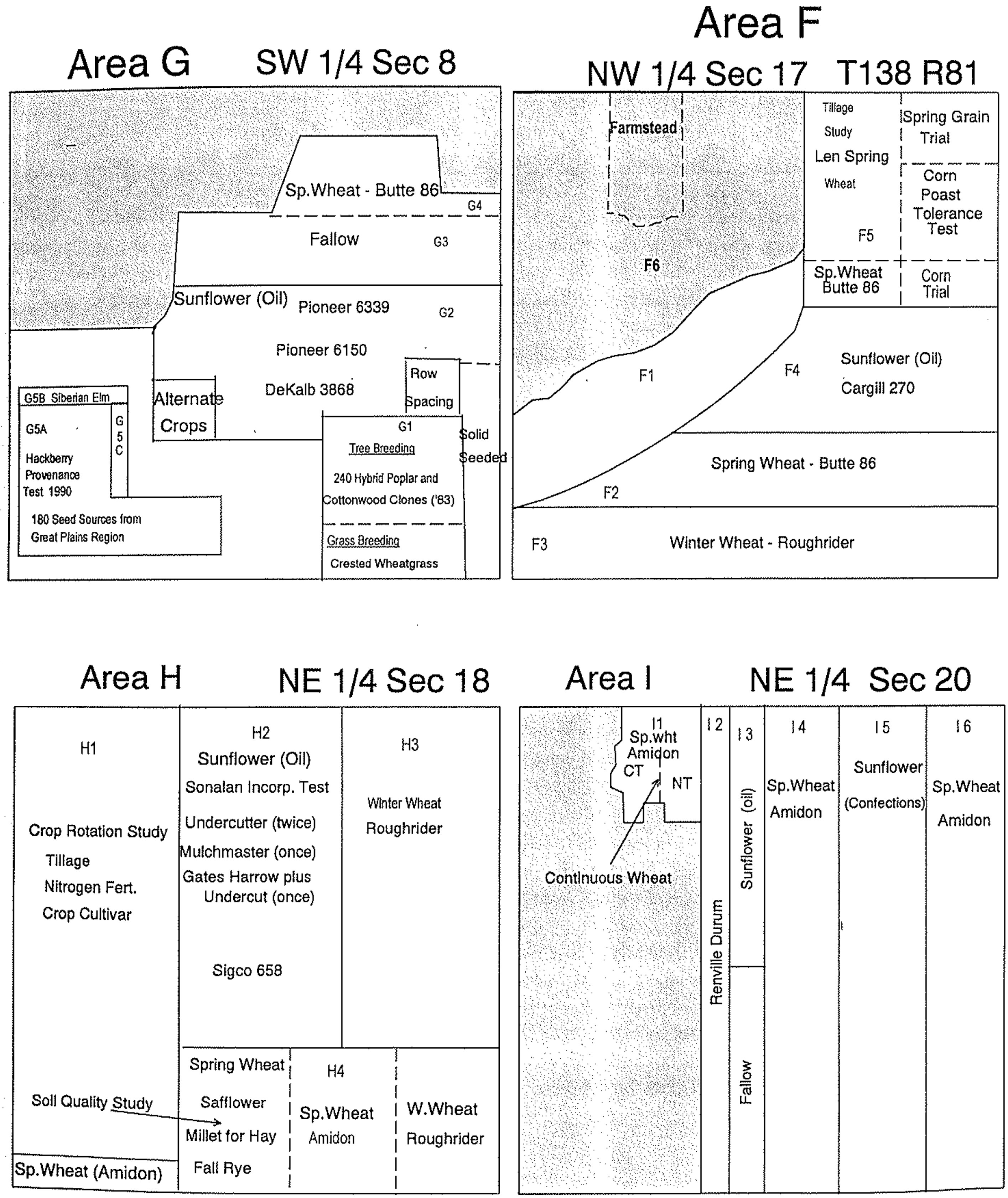


Figure 1. Map of the land associated with the USDA-ARS, Northern Great Plains Research Laboratory and the Area IV SCD-ARS Research Farm.

Fig. 2. Area G, F, H, and I field layouts - 1995.



possible to salvage what winter wheat we could on July 30, 1995 and combined August 8-10, 1995. The winter wheat yielded about 21.2 bu/a after the hail with a test weight of 59 lb/bu and a protein content of 11.3%. The field was sprayed after winter wheat harvest on September 20, 1995 with Roundup (8 oz ai/a) to control weeds and volunteer grain.

Field F4. The previous crop was winter wheat in 1994 that yielded 57 bu/ac. Winter wheat stubble (8-10 inches high) was left standing over winter to augment snow trapping and soil water storage. The field was sprayed with Roundup RT (8.25 oz ai/a) on September 29, 1994. We applied Sonalan G-10 granules May 30, 1995 at a rate of 1.0 lb ai/a with a Gandy granular applicator mounted on the front of the Haybuster undercutter while making the first undercutter tillage pass at a 2-inch depth. The field was undercut again June 2, 1995 at a depth of 2-inches to accomplish the second incorporation. We seeded this field to sunflower 'Cargill 270', June 3rd with the IH 800 Cyclo unit row planter (36" row spacing) at a seeding rate of 25,000 seeds/a with 45 lb N/a banded beside the row using 46-0-0 as a source of N. Depth of seeding was about 1.5 inches after passage of the packer wheel. The sunflowers emerged about June 12th. On July 20th, hail severely damaged the sunflowers in this field (estimated 40% loss). We contract sprayed for insect control with Asana XL (0.4 oz ai/a) on July 31, 1995. The sunflowers were harvested October 10-16, 1995, yielding about 1531 lb/acre with a test weight of 32.8 lb/bu and an oil content of 49.6 %.

Field F5. Several corn hybrids were planted no-till in field F5 in 1995. The field was sprayed with Roundup RT (9 oz ai/a) on May 17th. Fertilizer, 90 lb N/a (34-0-0) was broadcast about May 24th. Atrazine was applied at a rate of 8 oz ai/a on May 30th to the area planted to Pioneer corn hybrids. On May 31, 1995, Pioneer hybrids 3732 (103 day corn), 3893 (89 day corn), and 3921(86 day corn) were planted in addition to DeKalb 404SR (Poast resistant, 86 day corn) and DK381 with IHC 800 Cyclo planter with 36 inch row spacing and a plant population of about 11000 seeds/a. The DeKalb hybrids were part of a Poast resistant corn demonstration. The Poast herbicide was sprayed on the DeKalb hybrids on June 26, 1995. The Poast applied on June 26th to the DeKalb hybrids totally eliminated the DK381 hybrid but had little effect on the DK404SR hybrid. On June 30th, Accent (0.67 oz ai/a) was applied to the NDSU corn trial to control grassy weeds and to part of the DeKalb corn study. On July 18th, the remainder of the DeKalb study was sprayed with Accent (which was a little late to get good weed control). Excellent weed control was achieved with the atrazine and fair weed control with the early application of Accent. The corn plots were harvested on October 17, 1995. The grain moisture content at harvest ranged from 20 to 29%, but the corn was drying slowly and rain and snow were predicted. Due to the late planting, the corn did not get to black layer before frost in September. This resulted in slow drying of the corn in the field and loss of grain test weight. Grain yields and test weights are reported in the following Table 1.

Table 1. Corn hybrid grain yields (15% moisture) and grain test weight in Field F5.				
Hybrid	Maturity Length	Harvest Moisture	Test Weight	Grain Yield
Pioneer 3732	103 day	29.3%	48.3 lb/bu	58.5 bu/a
Pioneer 3893	89 day	24.6%	52.5 lb/bu	62.1 bu/a
Pioneer 3921	86 day	19.7%	48.1 lb/bu	66.2 bu/a
DeKalb 404SR (early Accent)	86 day	26.1%	43.4 lb/bu	54.6 bu/a
DeKalb 404SR (late Accent)	86 day	25.4%	43.5 lb/bu	43.1 bu/a

Field F6. A comparison tillage study for studying wheat diseases was started in 1993. This study included five tillage treatments (continuous wheat no-till, continuous wheat maximum till, continuous wheat minimum till, and a wheat-fallow rotation with maximum tillage). In 1994, the second year that plots were rated for leaf spot diseases. No consistent differences among tillage treatments or fungicide treatments were detected for leaf spot diseases in 1994. Due to wet soil conditions during the spring of 1995, tillage treatments could not be uniformly established. Therefore, the study was abandoned in 1995. The field was sprayed with Roundup RT (9 oz ai/a) on those areas that were not tilled on May 17, 1995. On May 30th, Len spring wheat was seeded in the dry parts of the field with the Haybuster 107 disk drill. The remainder of the field was seeded on June 14th. The early seeded wheat was sprayed with Tiller (7.3 oz ai/a) plus Banvel (1 oz ai/a) on June 19th. The late seeded wheat was mowed down because of weeds. Wheat yields were about 21.9 bu/a. Some hail damage was present in this field.

REPORT OF ACTIVITIES FOR AREA G. SW 1/4 Section 8 - Research Activities (see Figure 2)

Field G1. Hybrid Poplar Clonal Test - Dr. Beverly Dow

See research report by Dr. Dow.

Field G1. Forage Grass Breeding and Genetics - Dr. John Berdahl

See research report by Dr. Berdahl.

Field G2. This field has been in a spring barley-winter wheat-sunflower rotation since 1983 using minimum or no-till production systems. The spring barley has averaged 40 bu/ac; winter wheat, 35 bu/ac; and sunflower about 1500 lbs/ac over the 10-year period. The previous crop in 1994 was winter wheat (a mixture of Roughrider and Norstar) that yielded about 42 bu/a. Following the winter wheat harvest in 1994, the field was sprayed with Roundup RT on 9/29/94 (8.25 oz ai/a). On May 30, 1995, Sonalan 10G granules were applied with undercutter at a rate of 1 lb ai/a. A second incorporation with the undercutter occurred on June 2, 1995. On June 5, 1995, sunflower 'Pioneer 6339' was seeded on the north 8 acres of the field, Pioneer 6150 on the center 7 acres of the field, and DeKalb 3868 on 3 acres on the south side of the field at a seeding rate of 25,000 seeds/a. At seeding, 45 lb N/a was applied as 46-0-0 (urea). The sunflower was planted with the IHC 800 Cyclo unit row planter, 36 inch row spacing. The sunflowers emerged about June 14th. On October 9th, the P6150 and DK3868 were harvested, yielding 1697 and 1652 lb/a, respectively, with grain test weights of 29.5 and 33.7 lb/bu and oil contents of 47.2 and 52.9%. On October 16th, the P6339 was harvested with a yield of 1743 lb/a, oil content of 49.6% and a test weight of 28.4 lb/bu. The sunflowers were sprayed with Asana XL on July 31, 1995 to control sunflower insects. The sunflowers were relatively weed free until August when a second flush of weeds established, which will create a concern for weed control in future crops.

On June 9th, DeKalb 3790 and Pioneer 6150 were solid seeded with a Haybuster 1000 disk drill, 7 inch row spacing. With this drill, we were unable to accurately control the seeding rate of sunflowers. A plant population of 30-40,000 plants per acre was our goal, however, the Pioneer 6150 had a plant population at harvest of 203,236 plants/a and the DK3790 a population of 69,696 plants/a. On October 16th, the solid seeded sunflowers were harvested with small grain straight head on the combine, without sunflower pans. The DK3790 combine yields were 1726 lb/a with a test weight of 33.1 lb/bu and an oil content of 49.8% and the P6150 yields were 1273 lb/a with a test weight of 31.2 lb/bu and oil content of 43.9%. Hand samples collected for grain yield from this field showed yields of 4336 lb/a for DK3790 and 1554 lb/a for P6150. An important observation in the solid seeded sunflowers was the clean stubble (free of weeds) at harvest compared to a heavy weed infestation at harvest in the sunflowers planted in the 36 inch rows.

Field G3. This field was summerfallowed in 1995 following spring wheat in 1994. The summerfallow was sprayed with Roundup RT (9 oz ai/a) in June, and Fallowmaster (6.3 oz ai/a) on July, 10 and on August 22, 1995.

Field G4. This field was summerfallowed in 1994. The field was tilled with a John Deere Mulch Master on May 16, 1995 before spring wheat planting. The field was seeded on May 18, 1995 to Butte 86 spring wheat using a John Deere 750 no-till drill, 7.5" row spacing. The drill was provided by Letvin Equipment Company of Dickinson and the mulch master by Central Dakota Equipment of Bismarck. At seeding, 40 lb N/a was applied plus 50 lb/a of 18-46-0 with the seed. Tiller (5.7 oz ai/a) plus Banvel (1 oz ai/a) was applied on June 20, 1995 for pigeon grass and broadleaf weed control. The spring wheat was swathed on August 16, 1995 and combined on August 21-22, 1995. The spring wheat yielded 32.8 bu/a with a test weight of 61 lb/bu. Grain protein was 13.7%.

Field G5. USDA-ARS Leased Land - Tree Breeding Activities - Dr. Beverly Dow

5a. **Hackberry Provenance Test** - This area serves as the site for a seed source trial of hackberry accessions collected from 180 native stands throughout the Great Plains.

5b. **Siberian Elm Provenance Test** - Seedlings form 18 seed sources from Russia were planted in 10 replications in the spring of 1992.

5c. **Siberian Elm Clonal Test** - Fifty-five trees, from windbreaks in North and South Dakota, selected for possible disease and insect resistance were planted in four replications in 1990.

REPORT OF ACTIVITIES FOR AREA H. NE 1/4 Section 18 - Research Activities (see Figure 2)

Field H1. This large field is dedicated to the cropping systems--conservation tillage and nitrogen study initiated in 1984. The study involves two cropping systems (spring wheat-fallow and spring wheat-winter wheat-sunflower), three tillage systems (conventional-till (CT), minimum-till (MT) and no-till (NT)) plus a no-residue spring wheat-fallow treatment to serve as a check plot for assessing wind erodibility and plant diseases, three nitrogen (N) fertilizer levels (0, 20, 40 lb N/A for spring wheat-fallow, and 30, 60 and 90 lb N/A for the 3-yr annual crop rotation, spring wheat-winter wheat-sunflower) and two varieties of each crop. See the research report by Dr. Halvorson for details.

Field H2. This field was seeded to winter wheat in 1994 that yielded about 37.6 bu/a. Roundup RT (8.25 oz ai/a) was applied after winter wheat harvest on September 28, 1994. In 1995, this field was divided into 4 sections to compare methods of Sonalan incorporation for sunflower production. Incorporation methods included: Haybuster undercutter (2 passes); JD Mulch Master (1 pass); Gates Harrow plus undercutter; and Gates Harrow plus Mulch Master. Sonalan 10G granules were applied on May 25, 1995. The first incorporation with the Mulch Master was performed on May 26th. Due to rain on May 26th, the first Gates Harrow incorporation was attempted on June 1st. The Gates Harrow did not work very well because of the wet conditions. The straw residue would not flow through the tines. The second incorporation with the undercutter or Mulch Master was performed on June 2nd. Sunflowers, Sigco 658, was planted with the IHC 800 Cyclo planter (36 inch rows) on June 2nd at a rate of 25000 seeds/a. Nitrogen, 45 lb N/a as 46-0-0 was applied at seeding. The field was sprayed with Asana XL on July 30th. The field was harvested on October 11, 1995 with the sunflower yield being determined for each incorporation method. The oil content was 51.4% with seed yield results as follows:

Undercutter, 2 passes	1474 lb/a
Mulch Master, 1 pass	1394 lb/a
Gates Harrow plus undercutter	1387 lb/a
Gates Harrow plus Mulch Master	1361 lb/a

At harvest, weed pressure was least for the 2 pass undercutter treatment followed by the 1 pass Mulch Master and then the Gates Harrow plus undercutter or Mulch Master treatments. Due to the extremely wet conditions in the spring of 1995, herbicide incorporation and planting conditions were less than ideal. Weed control was fair for the 2 pass undercutter and 1 pass Mulch Master treatments until August when a second flush of weeds developed. At harvest, the 2 pass undercutter operation was the most weed free treatment. Sunflower grain yields were not greatly different for the various incorporation methods.

Field H3. This field was in spring wheat in 1994 that yielded 39.6 bu/a. The spring wheat stubble was sprayed with Roundup (8.25 oz ai/a) on September 28, 1994. Winter wheat, 'Roughrider', was no-till seeded into the 8-10 inch barley stubble Sept. 30, 1994 using the Haybuster 8000 hoe drill. Cenex broadcast 50 lb N/a on May 17, 1995, using urea (46-0-0) as the source of N. The late N application was the result of wet soil conditions which prohibited an earlier application of N. The field was not sprayed for weeds in 1995. A hail storm on July 20th heavily damaged the south part of the field. The field was swathed on August 1, 1995 and combined on August 9, 1995. The winter wheat yielded about 33.1 bu/a. The grain test weight was 59 lb/bu with a protein content of 11.9 to 12.5%. Approximately one-third of the field was under water most of the season. The field was sprayed with Fallowmaster (4.5 oz ai/a) on August 31, 1995.

Field H4. Soil Quality Study - Drs. Don Tanaka and Steve Merrill

A long-term study was initiated in the spring of 1993 to evaluate the influence of tillage and crop rotations on soil quality factors. See research report by Drs. Tanaka and Merrill.

Field H4. East Bulk Area. The east part of the field that was in barley in 1994 was sprayed with Roundup RT (8.25 oz ai/a) on September 26, 1994. Winter wheat, Roughrider, was seeded with the Haybuster 8000 hoe drill on September 27, 1994. Cenex bulk spread 20 lb N/a as urea on the winter wheat on May 17, 1995. The winter wheat was not sprayed for broadleaf weeds in 1995. A hail storm on July 20th destroyed the crop nearly 100%. The field was swathed as close to the ground as possible on August 1st to try and recover as much of the downed wheat as possible. The field was combined on August 11th. The winter wheat yielded 24.2 bu/a with a test weight of 59 lb/bu and a protein content of 11.5%.

Field H4. Center Bulk Area. This area was in safflower and sunflower studies in 1994. This area was planted to Amidon spring wheat in 1995. Cenex bulk spread 50 lb N/a as urea on May 17, 1995. Before planting, the field was tilled once with the JD Mulch Master. The spring wheat was seeded on May 30, 1995 with the Haybuster 1000 disk drill (7" row spacing) with 50 lb/a of 18-46-0 applied with the seed. The spring wheat was sprayed on June 20th with Tiller (7.3 oz ai/a) plus Banvel (1 oz ai/a). The spring wheat was severely damaged by hail on July 20th. The spring wheat was harvested August 30th and yielded 25 bu/a.

The field was sprayed with Roundup RT on September 20, 1995. Roughrider winter wheat was seeded into the spring wheat stubble on September 21, 1995 with a JD 750 disk drill (7.5" row spacing). Fertilizer, 50 lb/a of 11-52-0 was applied with the seed and 20 lb N/a side banded at seeding.

REPORT OF ACTIVITIES IN AREA I. NE 1/4 Section 20 (see Figure 2)

Field I1. Root and Leaf Disease Work - Dr. Joe Krupinsky

LEAF SPOT DISEASES in Long-Term Continuous Wheat. Investigations of spring wheat root rot diseases and leaf spot disease observations were continued in this field in 1995. For the last 11 years two residue treatments, no-till (high residue with standing stubble, >60% surface cover) and maximum till (low residue, disking before planting, <30% surface cover) were applied to the same spring wheat field located south of Mandan. This provides an opportunity to investigate plant disease development in a continuous wheat monoculture. 'Amidon' spring wheat was seeded with a Haybuster 107 disk drill on May 26, 1995 with 40 lb N/a plus 50 lb/a of 18-46-0 with the seed. Both the conventional till strip and the no-till strip were sprayed with Tiller (7.3 oz ai/a) on June 20th. Other details are as follows:

Conventional Till: Mowed stubble on May 18, 1995 prior to seeding wheat followed by tillage with JD Mulch Master on May 19th. The wheat yielded 29.7 bu/a.

No-till: Seeding was started on May 26th and finished on May 30th. The field was sprayed with Roundup RT (9 oz ai/a) on May 30th, immediately after planting. The spring wheat yielded 26.3 bu/a.

See research report by Dr. Krupinsky for more details.

Fields I2. This field was summerfallowed in 1994. The field was tilled on May 18, 1995 with the JD Mulch Master prior to seeding Renville durum on May 25th with the Haybuster 1000 disk drill with 7" row spacing. Fertilizer, 40 lb N/a was applied at seeding. The durum emerged about June 3rd. The field was sprayed with LV 2,4-D (8 oz ai/a) on June 30, 1995. The durum was swathed on August 21 and combined on August 30. The durum yielded 24.1 bu/a, but was of low quality [low test weight (54 lb/bu) and poor color] due to rain after maturity.

The field was sprayed with Roundup RT on September 20th. Winter wheat (Roughrider) was seeded in this field on September 22, 1995 with JD 750 no-till drill with a row spacing of 7.5". Fertilizer, 50 lb/a of 11-52-0 and 20 lb N/a, were applied at seeding.

Field I3. This field was planted to Amidon spring wheat in 1994. The spring wheat stubble was left standing over winter to trap snow. The field was divided in half in Spring of 1995 with the south half of the field fallowed and the north half planted to sunflowers (oil).

South Half: Tilled with JD Mulch Master on May 19, 1995. Sprayed with Roundup RT (9 oz ai/a) on June 10th and Fallowmaster (6.3 oz ai/a) on August 23rd.

North Half: Sonalan 10G granules (1 lb ai/a) were applied with undercutter on May 20, 1995. The second incorporation was with the JD Mulch Master on June 1, 1995. The field was planted to DeKalb 3868 sunflowers (25,000 seeds/a) on June 1st. Fertilizer, 45 lb N/a as 46-0-0, was applied at planting. IHC 800 Cyclo row planter was used to plant the sunflowers which emerged about June 7, 1995. The field was sprayed with Asana XL on June 30th to control insects. The field was harvested in late October and yielded 1819 lb/a with an oil content of 52.9%.

Field I4. This field was summerfallowed in 1994. The field was tilled on May 19, 1995 with the JD Mulch Master prior to seeding Amidon spring wheat on May 25th with the Haybuster 1000 and 107 disk drills with 7" row spacing. Fertilizer, 40 lb N/a and 50 lb/a of 18-46-0, was applied at seeding. The spring wheat emerged about June 1st. The field was sprayed with LV 2,4-D (8 oz ai/a) on June 30, 1995. The spring wheat was swathed on August 21st and combined on August 31, 1995. The spring wheat yielded 25.3 bu/a but quality was poor due to rain. Grain protein was 13.2%.

Field I5. This field was in spring wheat in 1994. The field was planted to confection sunflower in 1995. Sonalan 10G granules (1 lb ai/a) were applied with undercutter on May 20, 1995. The second incorporation was with the JD Mulch Master on June 1, 1995. The field was planted to Red River Commodities confection sunflowers (15,000 seeds/a) on June 1st. Fertilizer, 45 lb N/a as 46-0-0, was applied at planting. IHC 800 Cyclo row planter was used to plant the sunflowers which emerged about June 7, 1995. The field was sprayed with Asana XL on June 30th to control insects. The field was harvested in late October 1995 and yielded 1190 lb/a. The average overall price received was $13/cwt.

Field I6. This field was summerfallowed in 1994. The field was tilled on May 19, 1995 with the JD Mulch Master prior to seeding Amidon spring wheat on May 25th and 26th with the Haybuster 1000 and 107 disk drills with 7" row spacing. Fertilizer, 40 lb N/a and 50 lb/a of 18-46-0, was applied at seeding. The spring wheat emerged about June 1st. The field was sprayed with LV 2,4-D (8 oz ai/a) on June 30, 1995. The spring wheat was swathed on August 21st and combined on September 1, 1995. The spring wheat yielded 24.5 bu/a but quality was poor due to rain. Grain protein was 13%.

See the research report by Drs. Franzen, Hofman, and Halvorson on site-specific farming project for details on this research project which is using fields I4, I5, and I6.

CROPPING SYSTEM, TILLAGE, AND NITROGEN FERTILITY STUDY

Drs. Ardell Halvorson, Joe Krupinsky, Steve Merrill, and Don Tanaka

Field H1. This large field is dedicated to the cropping systems--conservation tillage and nitrogen study initiated in 1984. The study involves two cropping systems (spring wheat-fallow (SW-F) and spring wheat-winter wheat-sunflower (SW-WW-SUN)), three tillage systems (conventional-till (CT), minimum-till (MT) and no-till (NT)) plus a no-residue spring wheat-fallow treatment to serve as a check plot for assessing wind erodibility and plant diseases, three nitrogen (N) fertilizer levels (0, 20, and 40 lb N/A for spring wheat-fallow, and 30, 60, and 90 lb N/A for the 3-yr annual crop rotation, spring wheat-winter wheat-sunflower) and two varieties of each crop. The following Tables (A1 through D3) report field operations and grain yields for the spring wheat, winter wheat, and sunflower crops for each rotation.

Spring Wheat-Fallow Results (Table A3): Spring wheat yields were low in 1995 due to heat stress at the 4 to 5.5 leaf growth stage in early June. Precipitation was more than adequate to produce a high yielding crop. In addition, hail on July 20th severely damaged the 3rd replication of the SW-F rotation. Hail also affected the other plots in this study, but not as severely as the SW-F plots in rep 3. In 1995, there was a significant difference between spring wheat varieties with Butte86 out yielding Stoa. There was a significant response to N fertilization and tillage system. There was a significant tillage x N interaction. In 1995, the CT plots had the highest grain yields with NT being the lowest. Weed pressure in 1995 was heavy due to the wet season, but particularly worse in the NT plots. The 1995 SW-F yield expressed on an annual basis averaged 11.8 bu/a. The 11-year average yield data for SW-F are reported in Table A4 with an average annual yield of 16.0 bu/a.

Spring Wheat in SW-WW-SUN System (Table B2): In 1995, there was a significant difference between spring wheat varieties in the annual cropping system (SW-WW-SUN). There was a significant response to N fertilization and to tillage system. The CT and MT system had significantly higher yields than NT. The 1995 average spring wheat yield (22.4 bu/a) in the SW-WW-SUN system was nearly double the annual spring wheat yield in the SW-F system. The 11-year average spring wheat yield data are reported in Table B3 with an 11-yr average annual yield of 22.1 bu/a.

Winter Wheat in SW-WW-SUN System (Table C2): In 1995, tillage system had no significant effect on winter wheat yields in the annual cropping system, however, downy brome infestations were very severe in the NT plots, particularly in rep 1 nearest the fence row. There was a significant difference between winter wheat varieties with Roughrider yielding more than Norstar. Both varieties responded positively to N fertilization. The 1995 average winter wheat yield was 33 bu/a. The 11-year average yield data are presented in Table C3 with an average annual yield of 28.6 bu/a.

Sunflower in SW-WW-SUN System (Table D2): In 1995, tillage system, N fertilization, and cultivar had a significant effect on sunflower yield. The Sigco 651 (early maturity, short variety) yielded significantly more than the Sigco 658 (medium maturity, tall variety). Sunflower yields in the NT plots were lower than CT and MT due to poor weed control in the NT plots. In 1995, glyphosate was not applied at planting time in the NT plots. Poast herbicide was applied post emergence in the NT plots, but did not control all of the weeds (downy brome was particularly bad). Sunflower yields were excellent in 1995 with an average yield of 1534 lb/a in this annual cropping system. The 11-year average annual grain yields are reported in Table D3, with an average yield of 1310 lb/a.

Table A1. Fallow-Spring wheat plots, 1995 schedule of operations for each tillage system for the 1995 fallow series of plots.

Date	Conventional-till		Minimum-till	No-till
mo/day/yr	No residue	<30% Cover	30-60% Cover	>60% Cover
5/16/95	Deep disked	-----	*Roundup RT	Roundup RT
6/6/95	-----	undercut	-----	-----
6/14/95	Disked	-----	-----	-----
6/27/95	undercut	undercut	undercut	Roundup RT
7/20/95	-----	-----	Roundup RT	Roundup RT
7/24/95	Mulch Master	Mulch Master	-----	-----
9/19-20/95	Disked	undercut	Roundup RT	Roundup RT

*Roundup (9.0 oz ai/a) with ammonium sulfate and surfactant.

Table A2. Spring wheat-fallow plots, 1995 schedule of operations for each tillage system following 1994 fallow.

Date	Conventional-till		Minimum-till	No-till
mo/day/yr	No residue	<30% Cover	30-60% Cover	>60% Cover
5/15/95	Applied N-fertilizer (34-0-0) treatments, 0, 20, and 40 lb N/a			
5/16/95	disked	disked	JD Mulch Master	------
5/17/95	Gates harrow	Gates harrow	------	Roundup RT (9 oz ai/a)
5/17-18/95	Seeded Butte 86 and Stoa spring wheat with Haybuster 1000 disk drill at a rate of 1.4 million seeds/a (Vitavax treated seed)			
6/14/95	Sprayed all plots with Tiller (7.3 oz ai/a) plus Banvel (1 oz ai/a)			
8/21/95	Swathed grain for plot harvest (10 ft cut across each plot) from Butte 86 plots			
9/1/95	Biomass harvest samples obtained using bundle cutter from Butte 86 plots			
9/1/95	Swathed grain for plot harvest (10 ft cut across each plot) from Stoa plots			
9/11/95	Biomass harvest samples obtained using bundle cutter from Stoa plots			
8/31/95	Combined Butte 86 plots for yield			
9/12/95	Combine Stoa plots for yield			
9/12/95	Cleaned up plots with large combine			
9/19-20/95	undercut	undercut	Roundup RT	Roundup RT

Table A3. 1995 Spring wheat grain yields in sp.wheat-fallow rotation as a function of tillage system, N-fertilizer level, and cultivar.						
Cultivar	N Rate	Tillage System				Average (excluding No Residue Treatment)
		CT	CT	MT	NT	
		No residue	<30% Cover	30-60% Cover	>60% Cover	
	lb N/a	--------------------------bu/a------------------------------				
Butte 86	0	20.9	28.3	28.5	11.4	22.7
	20	24.1	31.9	28.1	22.32	27.4
	40	23.7	32.5	24.5	25.2	27.4
Butte 86 Average		22.9	30.9	27.0	19.7	25.9
Stoa	0	19.7	21.5	21.1	14.9	19.2
	20	21.2	21.3	22.7	20.2	21.4
	40	21.6	23.8	24.6	23.8	24.1
Stoa Average		20.9	22.2	22.8	19.7	21.5
Tillage Average		21.9	26.5	24.9	19.7	23.7

Table A4. Eleven-year average (1985-1995) spring wheat yields in the spring wheat-fallow cropping system as a function of tillage system, N-fertilizer level, and cultivar.						
Cultivar	N Rate	Tillage System				Average (excludes no residue)
		CT	CT	MT	NT	
		No residue (9-yr avg)	<30% Cover	30-60% Cover	>60% Cover	
	lb N/a	---bu/a---				
Butte 86	0	29.6	33.7	31.4	28.9	31.3
	20	31.6	34.2	32.2	30.7	32.4
	40	30.5	31.9	33.0	32.5	33.4
Butte 86 Average		30.6	34.2	32.2	30.7	32.4
Stoa	0	28.8	31.0	31.6	30.4	31.0
	20	29.8	32.2	31.5	30.3	31.3
	40	29.3	31.9	32.4	31.7	32.0
Stoa Average		29.3	31.7	31.8	30.8	31.4
Tillage Average		29.9	32.9	32.0	30.7	31.9

Table B1. Spring wheat, 1995 schedule of operations in sp.wheat-w.wheat-sunflower rotation.			
Date	Conventional-till	Minimum-till	No-till
mo/day/yr	<30% Cover	30-60% Cover	>60% Cover
5/15/95	Broadcast 34-0-0 N-fertilizer treatments, 30, 60, and 90 lb N/a		
5/16-17/95	disked, Gates harrow	Mulch Master	Roundup RT
5/17-18/95	Seeded Butte 86 and Stoa sp.wheat with Haybuster 1000 disk drill at 1.4 mill seeds/a		
6/14/95	Sprayed Tiller (7.3 oz ai/a) plus Banvel (1 oz ai/a)		
8/21/95	Swathed grain for plot harvest (10 ft cut across each plot) from Butte 86 plots		
9/1/95	Biomass harvest samples obtained using bundle cutter from Butte 86 plots		
9/1/95	Swathed grain for plot harvest (10 ft cut across each plot) from Stoa plots		
9/11/95	Biomass harvest samples obtained using bundle cutter from Stoa plots		
8/31/95	Combined Butte 86 plots for yield		
9/12/95	Combine Stoa plots for yield		
9/12/95	Cleaned up plots with large combine		
9/19-20/95	undercut	undercut	Roundup RT(9 oz ai/a)
9/21-22/95	Seeded w.wheat with Haybuster 8000 hoe drill, 10 inch row spacing, at 1.3 mill seeds/a with 50 lb/a of 11-52-0 with seed and 25 lb N broadcast (total 30 lb N/a)		

Table B2. 1995 Spring wheat grain yields in sp.wheat-w.wheat-sunflower rotation as a function of tillage system, N-fertilizer level, and cultivar.

Cultivar	N Rate	Tillage System			
		CT	MT	NT	Average
	lb N/a	--------------------------bu/a------------------------------			
Butte 86	30	25.1	25.9	20.9	24.0
	60	27.6	27.3	25.6	26.8
	90	27.7	28.8	25.6	27.4
Butte 86 Average		26.8	27.3	24.0	26.1
Stoa	30	20.1	18.0	12.9	17.0
	60	24.4	20.9	16.5	20.6
	90	21.8	19.4	14.8	18.7
Stoa Average		22.1	19.4	14.7	18.8
Tillage Average		24.5	23.4	19.4	22.4

Table B3. Eleven-year (1985-1995) average annual spring wheat yields in sp.wheat-w.wheat-sunflower rotation as a function of tillage system, N-fertilizer level, and cultivar.

Cultivar	N Rate	Tillage System			
		CT	MT	NT	Average
	lb N/a	--------------------------bu/a------------------------------			
Butte 86	30	21.2	22.8	21.0	21.5
	60	23.0	24.3	23.9	23.4
	90	23.4	25.5	26.5	24.9
Butte 86 Average		22.5	24.2	23.8	23.5
Stoa	30	17.9	20.4	18.2	19.0
	60	20.8	22.0	20.0	20.9
	90	20.7	23.6	23.0	22.8
Stoa Average		19.8	22.0	20.4	20.7
Tillage Average		21.1	23.1	22.1	22.1

Table C1. Winter wheat crop plots, 1995 schedule of operations for each tillage system following spring wheat in the sp.wheat-w.wheat-sunflower rotation.			
Date	Conventional-till	Minimum-till	No-till
mo/day/yr	<30% Cover	30-60% Cover	>60% Cover
8/23/94	Combined spring wheat, cleaned up plots		
9/27-28/94	disked	undercut	Roundup RT
9/29/94	Seeded Roughrider and Norstar winter wheat with Haybuster 8000 hoe drill, 10" spacing, at a rate of 1.3 mill seeds/a		
5/12/95	Topdressed N-fertilizer (34-0-0) at 30, 60, and 90 lb N/a		
8/1/95	Swathed winter wheat plots for grain harvest		
8/3-7/95	Collected biomass samples and head counts		
8/2-4/95	Combined plots for yield		
8/14/95	Cleaned up plots with large combine		
9/20/95	undercut	Roundup	Roundup
10/26/95	----	----	Broadcast Sonalan 10G (1.25 lb ai/a)

Table C2. 1995 winter wheat grain yields in sp.wheat-w.wheat-sunflower rotation as a function of tillage system, N-fertilizer level, and cultivar.					
Cultivar	N Rate	Tillage System			Average
		CT	MT	NT	
	lb N/a	---------------------------bu/a------------------------------			
Roughrider	30	33.7	30.3	28.8	29.4
	60	38.0	36.9	32.1	35.7
	90	39.0	35.4	33.0	35.0
Roughrider Average		36.9	34.2	31.3	34.1
Norstar	30	29.1	31.0	26.3	26.9
	60	33.4	34.5	32.6	32.1
	90	30.3	35.6	33.3	31.4
Norstar Average		30.9	33.7	30.7	31.8
Tillage Average		33.9	34.0	31.0	33.0

Table C3. Eleven-year (1985-1995) average annual winter wheat grain yields in sp.wheat-w.wheat-sunflower rotation as a function of tillage system, N-fertilizer level, and cultivar.					
Cultivar	N Rate	Tillage System			
		CT	MT	NT	Average
	lb N/a	---------------------------bu/a-------------------------------			
Roughrider	30	26.0	27.3	27.7	27.0
	60	27.4	29.2	30.9	29.2
	90	27.4	30.0	30.5	29.3
Roughrider Average		27.0	28.8	29.7	28.5
Norstar	30	26.3	28.2	27.6	27.4
	60	26.7	30.4	30.3	29.1
	90	27.7	29.6	31.4	29.6
Norstar Average		26.9	29.4	29.8	28.7
Tillage Average		26.9	29.1	29.7	28.6

Table D1. Sunflower plots, 1995 schedule of operations for each tillage system following spring wheat in the sp.wheat-w.wheat-sunflower rotation.			
Date	Conventional-till	Minimum-till	No-till
mo/day/yr	<30% Cover	30-60% Cover	>60% Cover
9/27/94	undercut	Roundup RT (9 oz ai/a)	Roundup RT (9 oz ai/a)
10/31/94	-----	-----	Broadcast Sonalan 10G (1.3 lb ai/a) soil surface
5/15/95	Broadcast applied N-fertilizer (34-0-0) at 30, 60, and 90 lb N/a		
5/16/95	*undercut, applied Sonalan 10G granules	*undercut, applied Sonalan 10G granules	-----
6/1/95	disked, Gates harrow	undercut	-----
6/2/95	Seeded all plots to Sigco 651 and 658 with IHC 800 Cyclo seeder at 25,000 seeds/a		
6/12/95	-----	-----	Poast (4.5 oz ai/a) plus oil
7/31/95	Aerial sprayed all plots with Asana XL insecticide (5.8 oz material/a)		
9/27/95	Hand harvested plots for yield, 2 rows 9 ft. long at 2 locations		
10/10/95	Bulk combined plot area		

*Sonalan was applied using a Haybuster undercutter with a front mounted Gandy granular applicator. This was the first tillage operation for incorporation of Sonalan G-10 granules.

Table D2. 1995 sunflower grain yields in sp.wheat-w.wheat-sunflower rotation as a function of tillage system, N-fertilizer level, and cultivar.

Cultivar	N Rate	Tillage System			Average
		CT	MT	NT	
	lb N/a	---------------------------lb/a-----------------------------			
Sigco 651	30	1585	1789	850	1408
	60	1787	1665	1126	1526
	90	1818	1941	1599	1786
Sigco 651 Average		1730	1798	1192	1573
Sigco 658	30	1529	1620	656	1269
	60	1591	1767	1021	1459
	90	1824	1981	1465	1756
Sigco 658 Average		1648	1789	1048	1495
Tillage Average		1689	1794	1120	1534

Table D3. Eleven-year (1985-1995) annual sunflower grain yields in sp.wheat-w.wheat-sunflower rotation as a function of tillage system, N-fertilizer level, and cultivar.

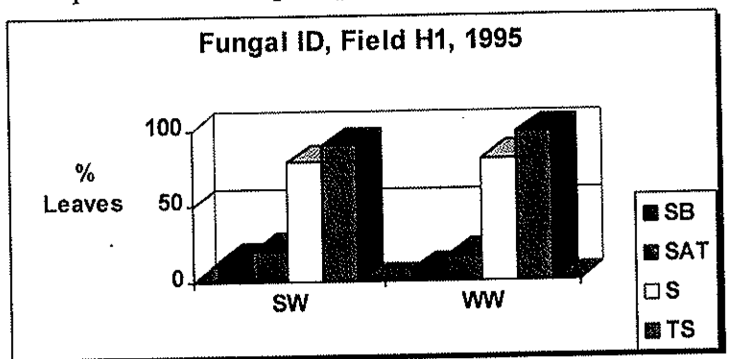
Cultivar	N Rate	Tillage System			
		CT	MT	NT	Average
	lb N/a	---------------------------lb/a-----------------------------			
Early Maturing Cultivar	30	1248	1292	1217	1252
	60	1301	1412	1244	1319
	90	1345	1412	1465	1408
Cultivar Average		1298	1372	1308	1326
Medium Maturing Cultivar	30	1200	1303	1096	1200
	60	1270	1369	1263	1301
	90	1302	1430	1408	1380
Cultivar Average		1257	1367	1256	1294
Tillage Average		1278	1370	1282	1310

PLANT DISEASES

Dr. Joe Krupinsky

LEAF SPOT DISEASE COMPLEX

Field H1. Long-term cropping systems study. Spring wheat and winter wheat leaves from the experimental plots were analyzed for plant pathogens present. Septoria nodorum blotch (*Septoria nodorum* or *Stagonospora nodorum*), tan spot (*Pyrenophora tritici-repentis* or *Drechslera tritici-repenits*), spot blotch (*Helminthosporium sativum* or *Bipolaris sorokiniana*) and Septoria avenae blotch (*Septoria avenae* f. sp. *triticea*) made up the leaf spot disease complex present on wheat.



SB = Spot Blotch, SAT= *S. avenae*, SN = *S. nodorum*, TS = Tan spot

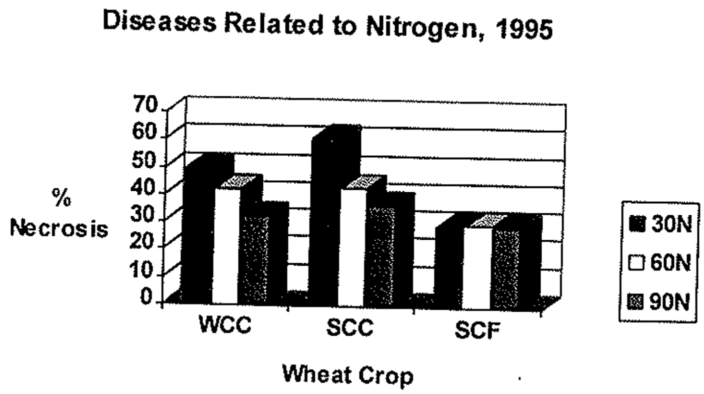
Tan spot was found on 90% of the spring wheat and 98% of the winter wheat leaves tested. Septoria nodorum blotch was detected on 79% of the spring wheat and 81% of the winter wheat leaves tested. Thus, tan spot and Septoria nodorum blotch were the most common diseases on spring wheat and winter wheat and the two main components of a leaf spot complex present on wheat in this area. Spot blotch and Septoria avenae blotch were also detected but at lower levels. This again indicates that leaf spot diseases on wheat are not caused by one pathogen but rather a complex of fungi.

DISEASE LEVELS RELATED TO FIELD MANAGEMENT

Field I1. Long-term continuous wheat. For the last 10 years two residue treatments, no-till (high residue with standing stubble, >60% surface cover) and maximum till (low residue, disking before planting, <30% surface cover) were applied to the same spring wheat field located south of Mandan. This provides an opportunity to investigate plant disease development in a continuous wheat monoculture.

In 1995, a significantly higher level of leaf spot disease damage caused by tan spot and Septoria nodorum blotch was present on wheat grown on the high residue area (no-till) in 50% of the ratings (3 out of 6 total) compared to wheat grown on the low residue area. This difference was less dramatic than expected. Ordinarily disease levels are higher for all the ratings in the high residue plots in a continuous wheat monoculture.

Field H1. Long-term cropping systems study. A higher level of leaf spot disease was associated with the lowest nitrogen levels with spring wheat (SCC) and winter wheat (WCC) in the continuous cropping system.



This would indicate that nitrogen levels had an influence on disease levels. It also points out the importance of providing adequate nitrogen in a continuous cropping system. Nitrogen levels did not have an effect on leaf spot diseases with spring wheat (SCF) in the crop-fallow system. Residue treatments also had a significant effect on leaf spot diseases in spring wheat in the crop-fallow system and with spring wheat and winter wheat in the continuous cropping system. A higher level of leaf spot disease damage was associated with the high residue treatment (no-till) in 1995, a good year for leaf spot diseases because of above normal precipitation.

COLLECTION OF FUNGAL SPORES

Field H1. Long-term cropping systems study. Rotorod samplers with a retracting head were used to collect air-borne spores that cause tan spot (*Drechslera tritici-repentis*). When the motor starts, two collecting rods move into sampling position through centrifugal force and remained exposed until the motor stops. The rods rotate at a high speed (2400 rpm) impacting air-borne spores and retaining them on a sticky substance, silicone grease, which was applied to the leading edge of the rods. Four samplers were in the spring wheat crop-fallow rotation: two in the wheat crop, one with low residue and another with high residue; as well as two in the fallow field with no crop, one in the low residue and one in high residue.

In 1995, average spore numbers were higher in the high residue fallow fields (no crop present) in comparison with the low residue fallow fields. This would be expected because of the higher amount of residue present. In contrast, in the spring wheat crop, higher spore numbers were associated with the low residue area in comparison with the high residue (no-till) area. One can speculate that the tillage operations which were used to obtain the low residue level before planting favored higher tan spot spore production compared to the no-till fields.

WIND ERODIBILITY IN WHEAT-SUMMERFALLOW

Drs. Steve Merrill and Ardell Halvorson

Field H1. Wind erodibility studies have continued at a number of experiments on the Research Farm, including the Soil Quality Experiment and both the three-crop continuous rotation and the spring wheat - summerfallow portions of the 12-year Conservation Tillage Cropping Systems Experiment (all located in section H). The oldest (started in 1988) and most comprehensive of these studies is in wheat - summerfallow, and includes observation of the four principle components of wind erodibility: (1) soil-inherent wind erodibility by measurement of dry aggregate size distribution (ASD) with a rotary sieve; (2) soil surface roughness; (3) standing residue profile; and (4) flat residue cover.

The most important of these measurements for advancing the practical science of wind erosion prediction and control is soil-inherent wind erodibility by rotary sieve as aggregate size distribution (ASD). This is because there is the least amount of information and understanding about ASD for wind erosion. Our report will concentrate on springtime ASD measurements made in May of each year in spring wheat - summerfallow plots under four tillage treatments. This is the time of year when wind erosion problems are likely to be the most severe. The measurements are shown (Table 1) as erodible fraction (EF, the percent of surface soil in aggregates smaller than 0.03 inch diameter) and as average aggregate size. The higher the erodible fraction or the smaller the average aggregate size, the more erodible is the soil. All measurements shown are for the spring after the fallow year of the 2-year crop cycle.

Overwinter conditions are important in determining ASD changes and springtime ASD. We have found that number of days with snowcover and straw production measured at harvest correlate well with ASD change and spring ASD (correlation coefficient values greater than 0.8, where 1.0 is perfect correlation, 0 is none). Thus, these measures are useful for building simple models that predict weather effects on soil-inherent wind erodibility. Data in Table 1 show generally lower snowcover days and straw production values for drought-affected years (1988 to 1990, or springtimes 1989 to 1991). The high EF values for spring 1992 are believed to be an after effect of the severe drought and very low straw production that occurred in 1988.

Tillage treatment doesn't seem to have any consistent effect on ASD values. We have marked the highest EF value each year with an asterisk to make this evident.

Table 1. Aggregate size distributions (ASD) of surface soil as erodible fraction (EF) and average aggregate size, with associated snowcover and straw production values.

Year	Spring Erodible Fraction (EF)					Avg. Aggregate Diameter	Prior Straw Prod.	No. Days Snow-Cover
	Low-Res %	Convent %	Minimal %	No-Till %	Avg. %	inch	lb/A	
1989	51.3*	33.7	41.8	41.5	42.1	0.12	2870	83
1990	49.5	51.0	56.3	64.8*	55.4	0.03	810	42
1991	38.8*	34.9	33.3	31.6	34.7	0.33	2120	53
1992	51.8	55.6	59.2*	56.6	55.8	0.03	3180	60
1993	28.0*	19.7	23.3	23.2	23.5	0.54	4400	100
1994	27.4	30.5	35.9*	31.9	31.4	0.18	4160	121
1995	19.5*	17.2	17.2	13.2	16.8	1.02	3890	112

ROOT GROWTH OF ALTERNATIVE CROPS

Drs. Steve Merrill and Don Tanaka

Field G2. Observations of root growth were made as part of an agronomic study of crops proposed as alternatives to small grains in dryland rotations. Direct observation of the rooting characteristics of crops will enable us to better understand how they use soil water and nitrogen, and thus, will help show us how they would fit into proposed crop rotations. A minirhizotron - microvideo camera system was used to measure root length growth of the crops listed in Table 2. The alternative crops were grown on winter wheat ground, and spring wheat growing nearby was on fallow ground. Root growth observations were made in the undercutter tillage treatment (one of two treatments) of the experiment. For each crop, 6 pressurized-wall and 2 solid-wall type minirhizotrons were installed to depths of 4.5 and 6 feet in 2 out of 3 plot replications.

The crops are listed in Table 2 in order of maximum observed depths of root growth. Data chosen for display in the Table are for observations made in early August, a time near or past flowering of the crops. The crops fall quite well into botanical and functional groups as a result of the root depth rankings shown in Table 2. The legume crops soybean, black bean, and dry pea have the relatively shallowest maximum depths of root growth, about 3.5 feet, with median depths (half of root length growth above, half below) at about 1.5 feet. Next in the list are oilseed crops in the mustard family, crambe and canola, with maximum rooting depths of about 4 feet and median root growth depths of 1.2 to 1.5 feet. Spring wheat follows with maximum depths of 4.2 feet and the second deepest median depth of root growth, 1.9 feet. Finally, the generally deeply rooted oilseed crops sunflower and safflower complete the list, with safflower having the deepest maximum at 5.6 feet and a very deep median at 3.0 feet.

Values of total root length per area often show considerable variation, and relatively cool, wet spring weather in 1995 added to this tendency here. We use a combination of the largest two values plus the median to get a more meaningful measure of total root length growth (Table 2). Black bean and safflower display the two largest overall total root growth values, 14 and 12 mile/sq. yd. Spring wheat has the third highest total root growth value, 9 mile/sq. yd. The ratios of total root length to aboveground dryweight vary considerably from crop to crop. For example, dry pea had relatively high seed yield and had the highest final dryweight, but had relatively low total root length.

Table 1. Maximum and median depths of root length growths, total root lengths, and above-ground dry weights of alternative crops. Root measurements shown were made in first part of August, 1995.

Crop	Maximum depth feet	Minimum depth feet	Total Root Length A: Avg 2 largest mile/sq yd	B: Median mile/sq yd	Avg (A+B) mile/sq yd	Total aboveground dryweight lb/acre
Soybean	3.34	1.64	3.29	2.04	2.65	6050
Black bean	3.63	1.49	21.92	6.85	14.39	5210
Dry pea	3.63	1.35	4.46	1.62	3.04	8400
Crambe	3.91	1.15	11.53	1.92	6.73	5750
Canola	4.20	1.48	7.79	6.29	7.04	5610
Spring Wheat	4.20	1.90	16.26	2.18	9.22	----
Sunflower	4.76	1.56	9.62	4.54	7.08	5830
Safflower	5.62	3.00	18.29	5.72	12.01	4480

MANAGEMENT STRATEGIES FOR SOIL QUALITY

Drs. Don Tanaka and Steve Merrill

A long-term study was initiated in the spring of 1993 to evaluate the influences of residue management and crop rotations on soil quality. Tillage, crops, and crop residues were all in the appropriate places in 1994. Treatments for the 1995 crop included minimum- and no-till for the following crop rotations:

1. Continuous spring wheat (CSW+); straw chopped and spread
2. Continuous spring wheat (CSW-); stubble left in place, straw removed
3. Spring wheat - millet for hay (SW-M)
4. Spring wheat - safflower-fallow (SW-S-F)
5. Spring wheat - safflower-rye (partial fallow, cover crop) (SW-S-R)
6. Spring wheat - fallow (SW-F)

Spring wheat was seeded at 1.3 million viable seeds per acre on May 31, 1995. Safflower was seeded at 200,000 viable seeds per acre on May 31, 1995. Rye was seeded on October 3, 1995 at 1.3 million viable seeds per acre. Recrop plots received 60 lb N/a and 10 lb P/a while crops seeded after fallow received 30 lb N/a and 10 lb P/a. May was cool and wet which delayed seeding. Growing season precipitation (May through August) was 15.5 inches compared to a long-term average of 9.9 inches.

Spring wheat grain yields ranged from 900 to 1295 lb/a (Figure 1). There were no differences due to residue management. Hail in July reduced spring wheat grain yields. Safflower seed yields (500 to 600 lb/a) were poor because of poor pollination caused by relative humidity near 75% in August. High relative humidity renders the pollen sterile. Rye produced about 1850 lb/a of dry matter (growth terminated June 19, 1995) for soil and water conservation while millet produced 4660 lb/a of hay and 1240 lb/a of residue for erosion control.

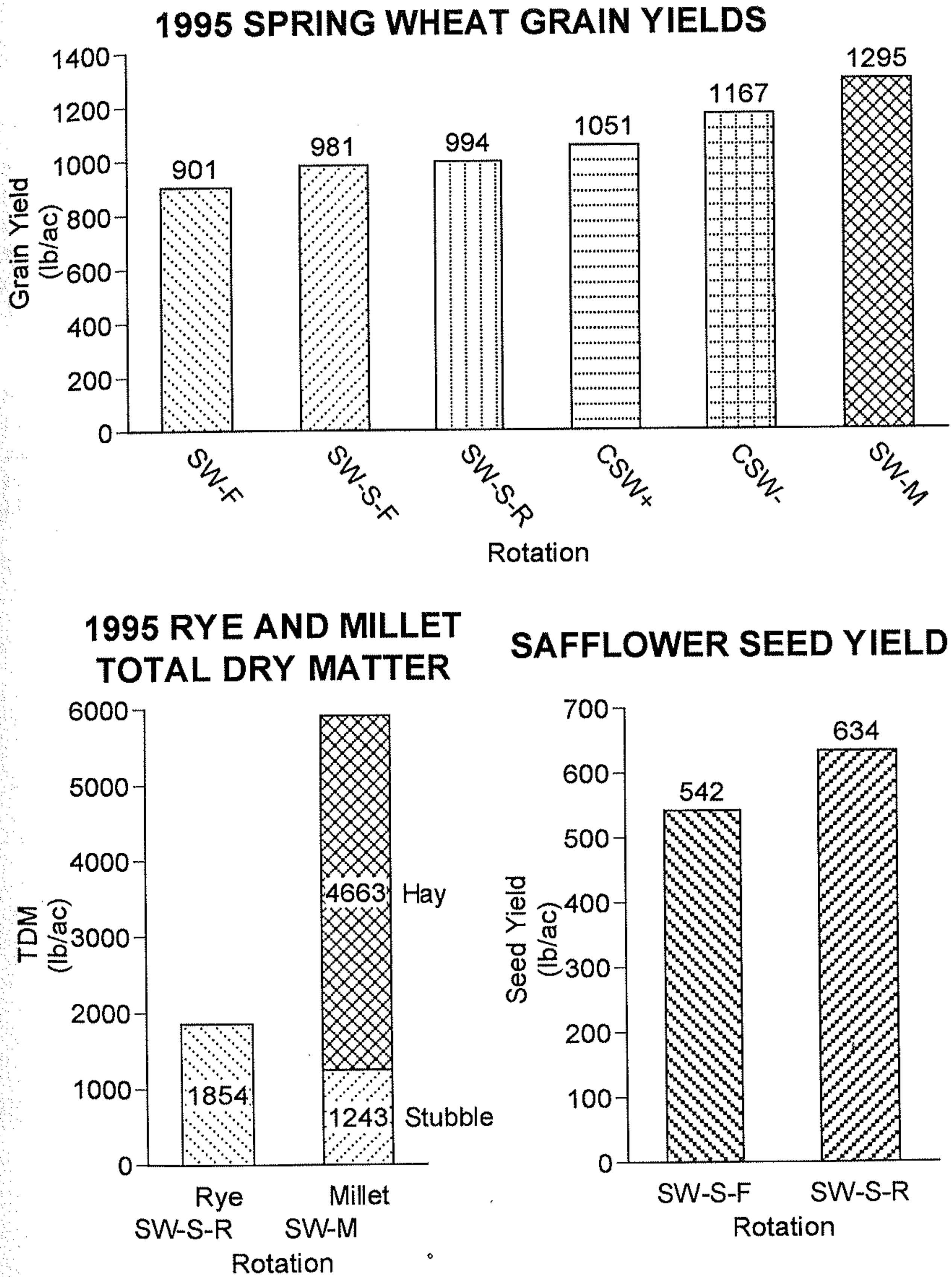


Figure 1 . Spring wheat grain yield, safflower seed yield, and rye and millet total dry matter production as influenced by crop rotation in 1995.

SAFFLOWER PLANT POPULATION

Dr. Don Tanaka

A study was conducted in 1995 to determine the influence of seeding date, variety and plant population on safflower seed yield. The area was previously in winter wheat. Sonalan (1 lb ai/a) was applied on May 16, 1995 and incorporated with an undercutter. Second incorporation was on May 23, 1995 with the JD Mulch Master. Treatments were: seeding dates, May 30 (D_1) and June 9 (D_2); varieties Montola 2000 (V_1) and Centennial (V_2); and target plant populations of 50,000, 100,000, 200,000, 400,000, and 800,000 plants/a (based on 70% viable seeds producing a plant). The 1.5 inches of precipitation in April along with 5.4 inches in May delayed seeding.

Safflower seed production in 1995 was less than expected. Preliminary information suggests that even though adequate growing degree units were accumulated during flowering and seed fill periods, average relative humidity in excess of 75% for July and August resulted in poor pollination. Treatment differences are shown in Figure 1. In general, it takes less seed to reach the target population when seeding late. Centennial needs to be seeded early to get a good seed yield. Field plant populations of 150,000 to 250,000 plants/a produced the best seed yields.

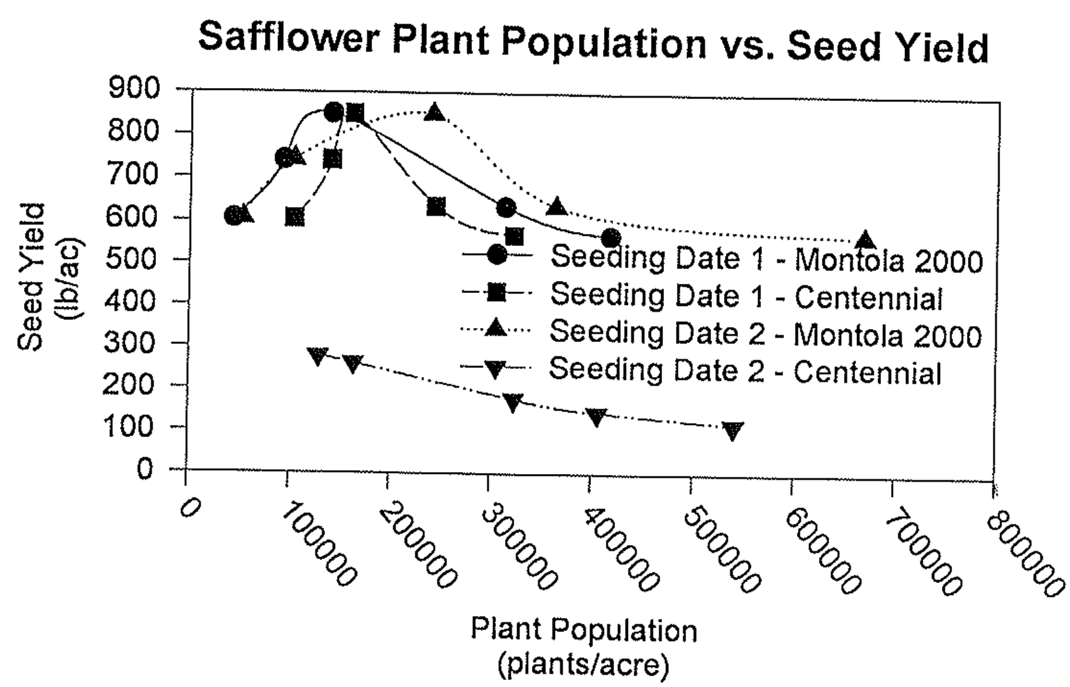


Figure 1. Safflower seeding date, variety, and plant population influences on safflower seed yield in 1995.

ALTERNATE CROPS IN CONSERVATION TILLAGE

Drs. Don Tanaka, Steve Merrill, and Ardell Halvorson

A study was initiated in 1995 to develop high residue cultural practices for the production of crops other than small grains using small grain equipment. Alternate crops included canola, crambe, safflower, dry pea, buckwheat, sunflower, dry beans, and soybeans. Sonalan (1 lb ai/a) was applied and incorporated in a one-pass operation with either an undercutter with 32 inch sweeps or a JD Mulch Master on May 16, 1995. Buckwheat plots were not treated with Sonalan and were seeded in an area that had no history of Sonalan or Treflan application. Canola, crambe, dry peas, safflower, and buckwheat were seeded on May 30, 1995. Sunflower, dry beans, and soybeans were seeded from June 6 to 12, 1995.

Visual observations suggest that canola has seedling establishment and germination problems when the seed is near wheat residue. Other crops did not appear to have this problem. Dry pea produced the greatest seed yield (2474 lb/a) and gross returns ($198/a) (Figure 1). Safflower produced the lowest seed yield (786 lb/a) and gross returns ($98/a). There was not any difference due to herbicide incorporation.

SPRING WHEAT TRIALS

Dr. Don Tanaka

Spring wheat variety trials were initiated in 1979 and have continued with the cooperation of the Williston Research Center. New varieties for 1995 were CDC Teal and Kulm. Varieties were seeded with a 7 foot Kirschmann drill in 6-inch rows on May 25, 1995 at a rate of 1.3 million viable seeds per acre. Seeding depth was 1 inch or less because adequate soil water was present for germination. Wheat plants emerged in less than six days. The field had been chemically fallowed the previous year and weed control prior to seeding was done with a JD Mulch Master at a depth of 1 1/2 inches. Fifty pounds of N per acre and 10 pounds of P per acre were applied at seeding. Weeds in the crop were minimal because of the rapid wheat growth; broadleaf weeds were controlled using Buctril (16 oz/a) on June 19, 1995.

In general, varieties that performed well in 1994, performed well in 1995. Wheat yields ranged from a high of greater than 50 bu/a for Kulm and 2375 to a low of 35 bu/a for Len and Coteau (Table 1) All varieties had a good plant populations with heads per square yard in excess of 400. Heads per square yard was not the only yield determining factor in 1995. Kernels per head also determined yield and ranged from 15 for lower yielding varieties to a high of 24 for higher yielding varieties. Grain protein ranged from a high of 15.7% for CDC Teal to a low of 12.9% for Prospect.

Table 1. Spring wheat agronomic measurements for 1995 at Mandan, ND.

Varieties	Grain			Straw Yield (lbs/ac)	Straw to Grain Ratio	Plant Population (plants/ yard^2)	Heads per Plant (heads/ plant)	Kernel Weight (mg/ kernel)	Heads (heads/ yard^2)	Kernels per Head (kernels/ head)	Plant Height (inches)	Plants per Viable Seed (%)
	Yield (bu/ac)	Protein[1] (%)	Test Weight (lbs/bu)									
Coteau	34	14.3	58	5760	2.9	160	2.58	23.8	407	19	37	59
Len	35	14.9	60	5163	2.5	169	3.00	26.4	483	15	29	63
CDC Teal	40	15.7	59	6042	2.6	205	2.38	28.0	486	16	34	76
Grandin	41	14.5	60	5861	2.4	209	2.78	26.8	579	15	30	78
Vance	42	14.2	58	6321	2.7	163	2.50	26.3	403	22	30	60
Stoa	44	14.0	59	5107	2.1	150	3.13	24.4	464	22	35	56
Butte 86	45	13.3	61	5076	1.9	176	2.73	29.4	473	19	32	65
Amidon	45	14.0	59	7854	3.0	264	2.12	23.8	559	19	37	98
Prospect	46	12.9	60	6667	2.5	166	2.64	25.4	432	24	30	62
Ernest	47	13.9	61	6901	2.5	170	2.83	25.8	479	22	35	63
Kulm	52	13.8	62	6331	2.0	203	2.72	26.1	540	22	34	76
2375	55	13.0	62	5630	1.7	172	2.76	30.9	472	22	31	64
LSD	8	0.6	1	709	0.5	30	0.73	1.4	66	4	1	--

[1]Protein courtesy of Heartland Inc. of Bismarck, ND.

SUNFLOWER ROW SPACING

Dr. Don Tanaka

A study was conducted in 1995 to determine the influence of sunflower row spacing on weed growth and sunflower production. Sonalan (1 lb ai/a) was applied on May 16, 1995 using an undercutter with 32 inch sweeps. Sunflower was planted in 15-, 30-, 7.5 x 30-, and 37.5-inch rows using a JD750 no-till drill on June 12, 1995. The final plant population for all row spacings was 19,000 plants/a. The amount of weed growth was determined by taking weed biomass measurements when sunflower reached the flowering plant development stage (R5) (Figure 1). Weed biomass production for the 15-inch rows was about half the biomass production for the wider rows. Sunflower total dry matter production, seed yield, residue yield, head diameter, and residue to seed ratio was the same for all row spacings (Table 1).

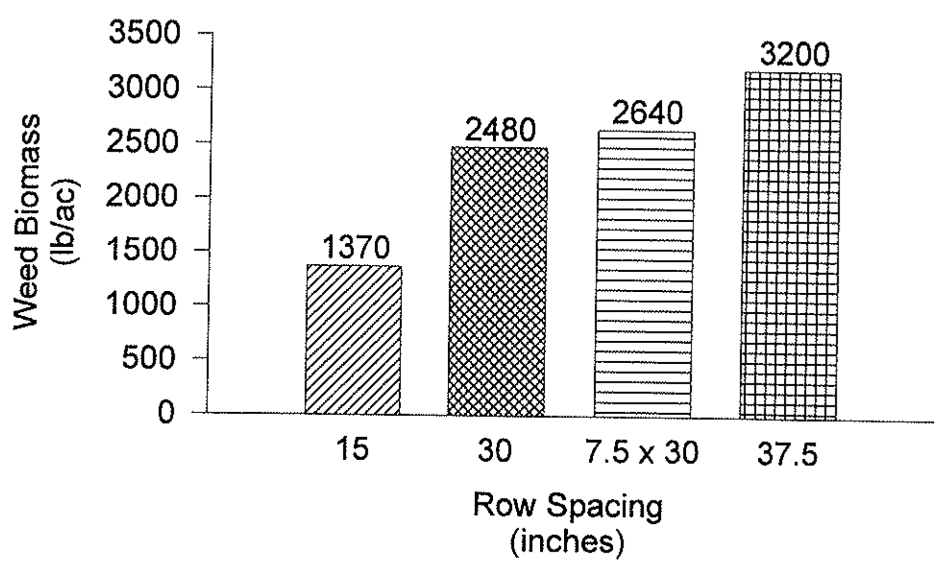


Figure 1. Weed biomass production as influenced by sunflower row spacing.

Table 1. Total dry matter, seed yield, residue yield, head diameter, and residue to seed ratio as influenced by sunflower row spacing.

Treatment	Total Dry Matter (lb/a)	Seed Yield (lb/a)	Residue Yield (lb/a)	Head Diameter (inches)	Residue to Seed Ratio
15 inch row	6680	1370	5310	5.2	3.9
30 inch row	6330	1480	4850	5.6	3.3
7.5 x 30 inch row	6590	1330	5260	5.5	4.0
37.5 inch row	6700	1440	5260	5.5	3.6

SOIL FERTILITY AND SITE-SPECIFIC FARMING STUDY AT AREA IV RESEARCH FARM

Dr. Dave Franzen and Vern Hofman, NDSU Extension Service
Dr. Ardell Halvorson, USDA-ARS

The term site-specific farming means carefully tailoring soil and crop management to fit the different conditions found in each field. Site-specific farming is sometimes called “prescription farming”, “precision farming” or “variable rate technology”. It has caused a focus on the use of three technologies - remote sensing, geographic information systems (GIS) and global positioning systems (GPS). Some people incorrectly use the term “GPS” to imply precision farming. GPS makes use of a series of military satellites that identify the location of farm equipment within a meter of an actual site in the field. The value of knowing a precise location within inches is that 1) location of soil samples and the laboratory results can be compared to a soil map, 2) fertilizer and pesticides can be prescribed to fit soil properties (clay and organic matter content) and soil conditions (relief and drainage), and 3) one can monitor and record yield data as one goes across the field.

In remote sensing, companies are developing systems that involve satellites collecting data, transmitting locational information, or providing data from a variety of sources to farmers. Farmers can analyze this satellite information or they can rely on companies to do this service for them for a fee. In North Dakota little work is being done with satellite imaging outside the Red River Valley.

Using GIS, several "layers" of information can be geo-referenced to locations in fields. Currently, most researchers are able to analyze only a few layers at a time. In the future, more effort will be made to analyze multi-layers of information.

The real value for the farmer is that he can plan more accurate crop protection programs, adjust fertilizer rates from one part of a field to another based upon localized soil tests and know the yield variation within a field. These benefits will enhance the overall cost effectiveness of crop production.

The relevance of site-specific farming to dryland agriculture in the semiarid northern Great Plains needs to be examined. What are the economics and specific benefits of site specific management under dryland in western North and South Dakota and Eastern Montana? In a cooperative effort, the USDA-ARS at Mandan, NDSU Cooperative Extension Service, Area IV Research Farm Advisory Committee, USDA-NRCS, Concord Inc, and other interested participants initiated a site-specific farming demonstration and research site during the summer of 1995 on Field I of the Area IV Research Farm. Yield and disease monitoring began with the 1995 crop. Soil sampling was done after harvest to determine variable fertilizer rates to be applied in the spring of 1996. Annual cropping and minimum tillage systems will be used in the production plan. The objectives of the project are to determine the feasibility of using site-specific farming technology under dryland conditions in the semiarid parts of the Northern Great Plains and to develop management strategies for effectively using this technology in crop production systems.

The work this past summer included obtaining yield data on fields I4, I5 and I6. The information from I4 was questionable due to improper operation of the yield monitor. The yield information from I5, confectionary sunflower (Figure 1), and I6, spring wheat (Figure 2), is included. The original printout of the yield map was in color and when copied in black and white, the clarity is not good. The spring wheat (I6) yielded about 24.5 bushels per acre and the confectionary sunflower (I5) yielded about 1190 pounds per acre.

Figures 3 through 5 show the N, P and K variations across fields I4, I5, and I6. The darker areas show higher levels of the various materials. Figure 3 is the nitrogen level after the crop was harvested and is out of proportion to the others. It should be narrower in width as the tract of land is ½ mile long and about ¼ mile wide. The darker sections of all three drawings is an indication of higher levels of nutrients.

Other work completed this past summer included measuring topographic elevations on fields I4, I5 and I6. Study is being completed to determine if there is a correlation between field elevation and soil fertility. This could be helpful to produce accurate soil tests without the need for grid soil sampling which could help reduce the number of soil samples that need to be taken. Figure 3 also shows a two-dimensional topographic map and Figure 6 is a three-dimensional map of the combined fields of I4, I5, and I6. The differences in elevation from the high point to the low point is about 26 ½ feet. A comparison of first year correlation of topography and 1-2 acre grid estimates with original nitrate-N levels is shown in Table 1.

The project is in an information gathering phase and has been in progress for 6 to 8 months. Very few recommendations can be given at this time. It is felt that at least 2 to 3 more years data is needed to determine if site-specific farming technology can produce an economic benefit to semiarid parts of the northern Great Plains.

Table 1. Comparison of topographic sampling and 1-2 acre grid estimates with original 110-150 ft. grids.

Comparison	r value
1-2 acre grid estimate	0.101
topography	0.755

Acknowledgement

Thanks to Larry Renner of the USDA-ARS lab for his work in producing the yield maps.

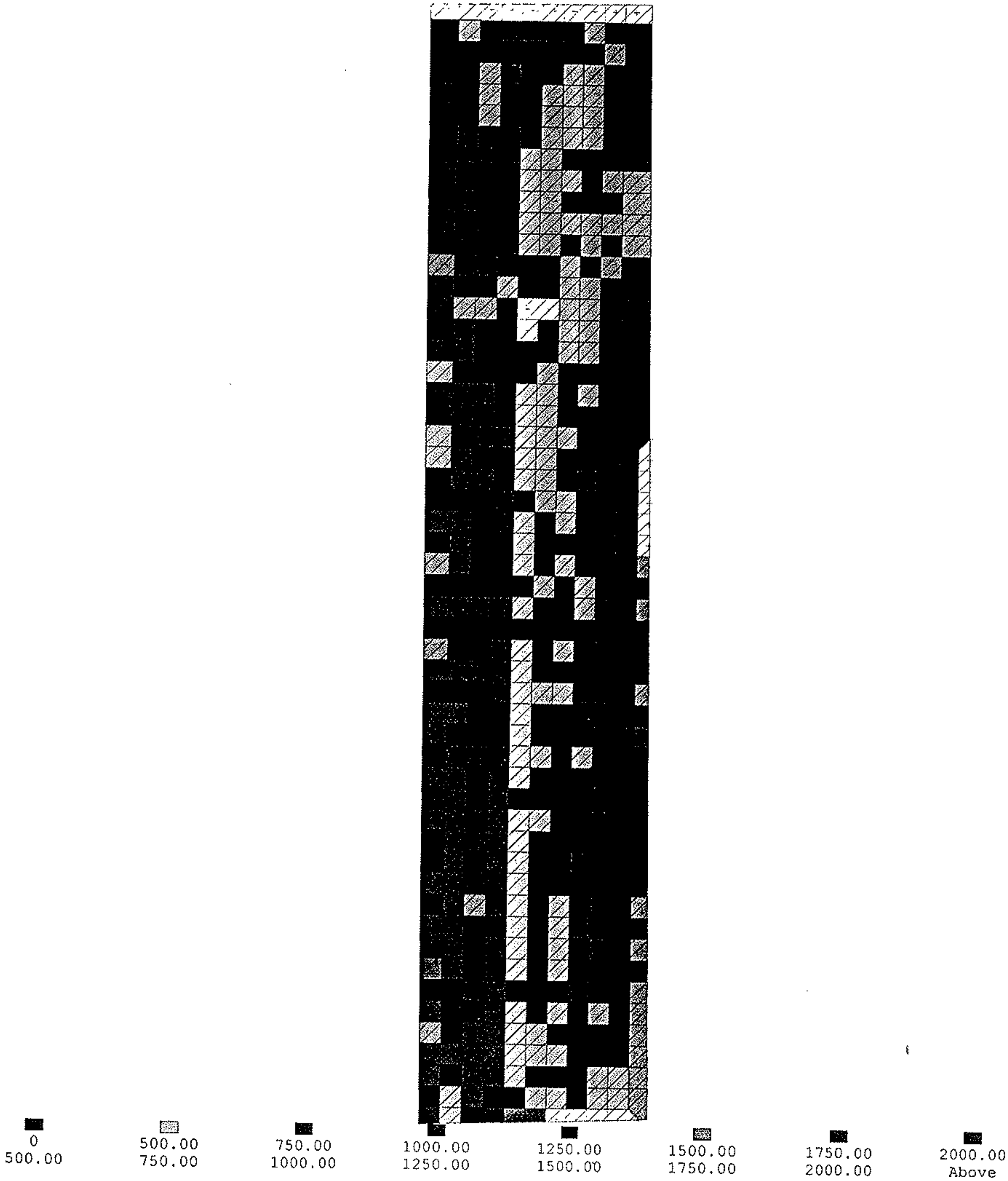


Figure 1. **Field I5 yield map is confectionary sunflower and shows considerable variation in yield.**

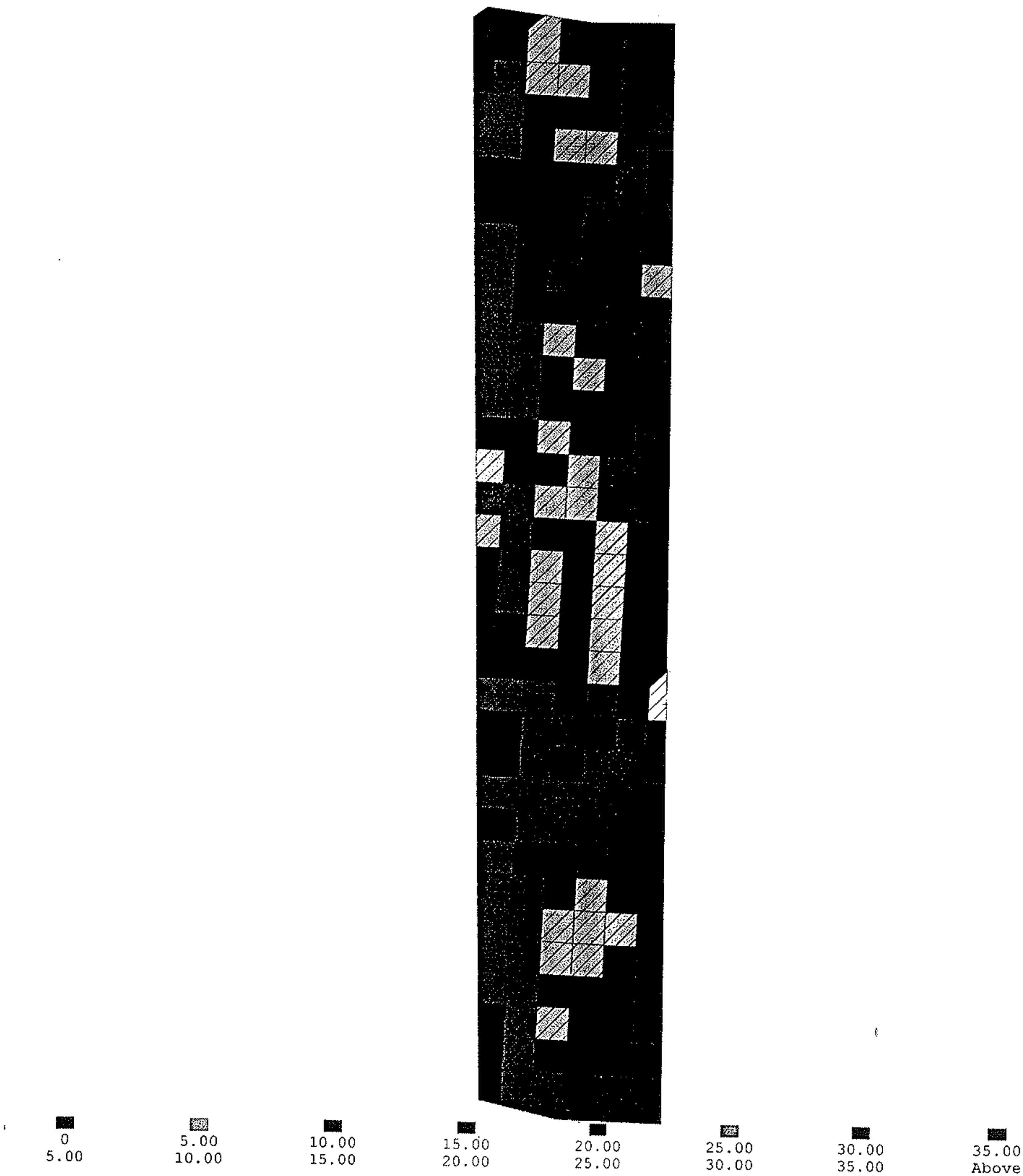


Figure 2. Field I6 yield map of spring wheat shows variation from one area to another.

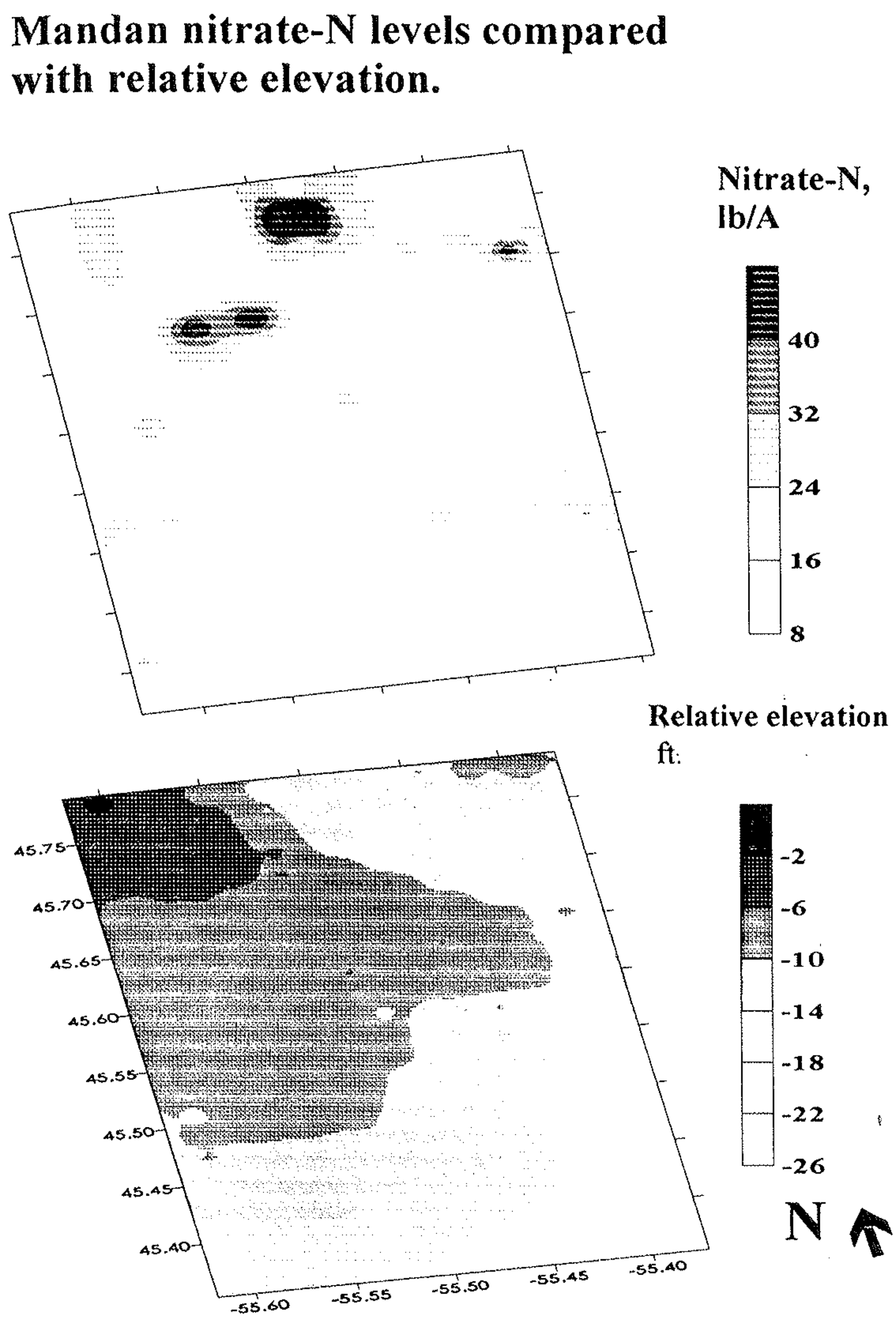


Figure 3. Nitrate levels of fields I4, I5, and I6 (top) and a 2-dimensional topographic map of fields I4, I5, and I6 (bottom).

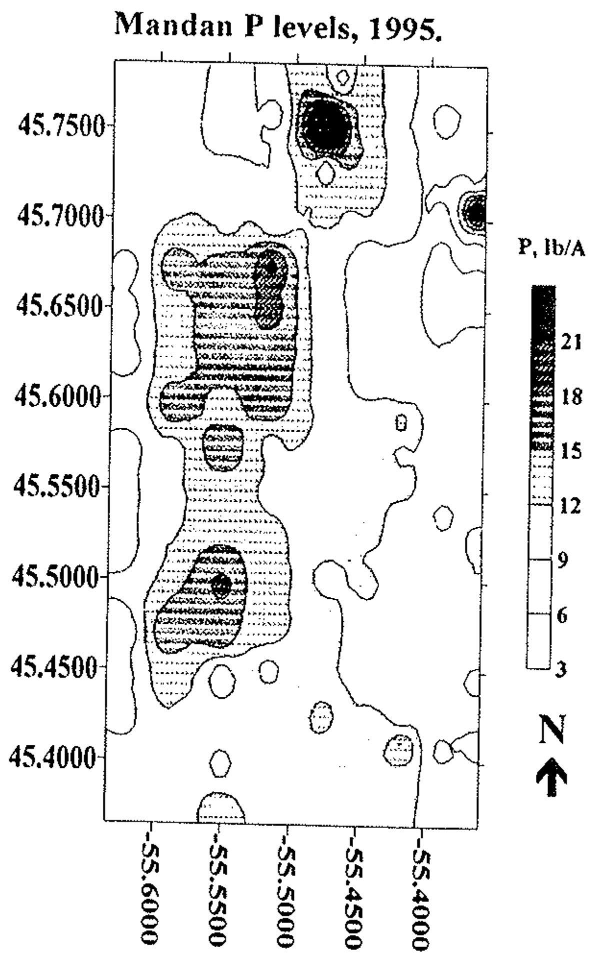


Figure 4. Phosphorus levels of fields I4, I5, and I6.

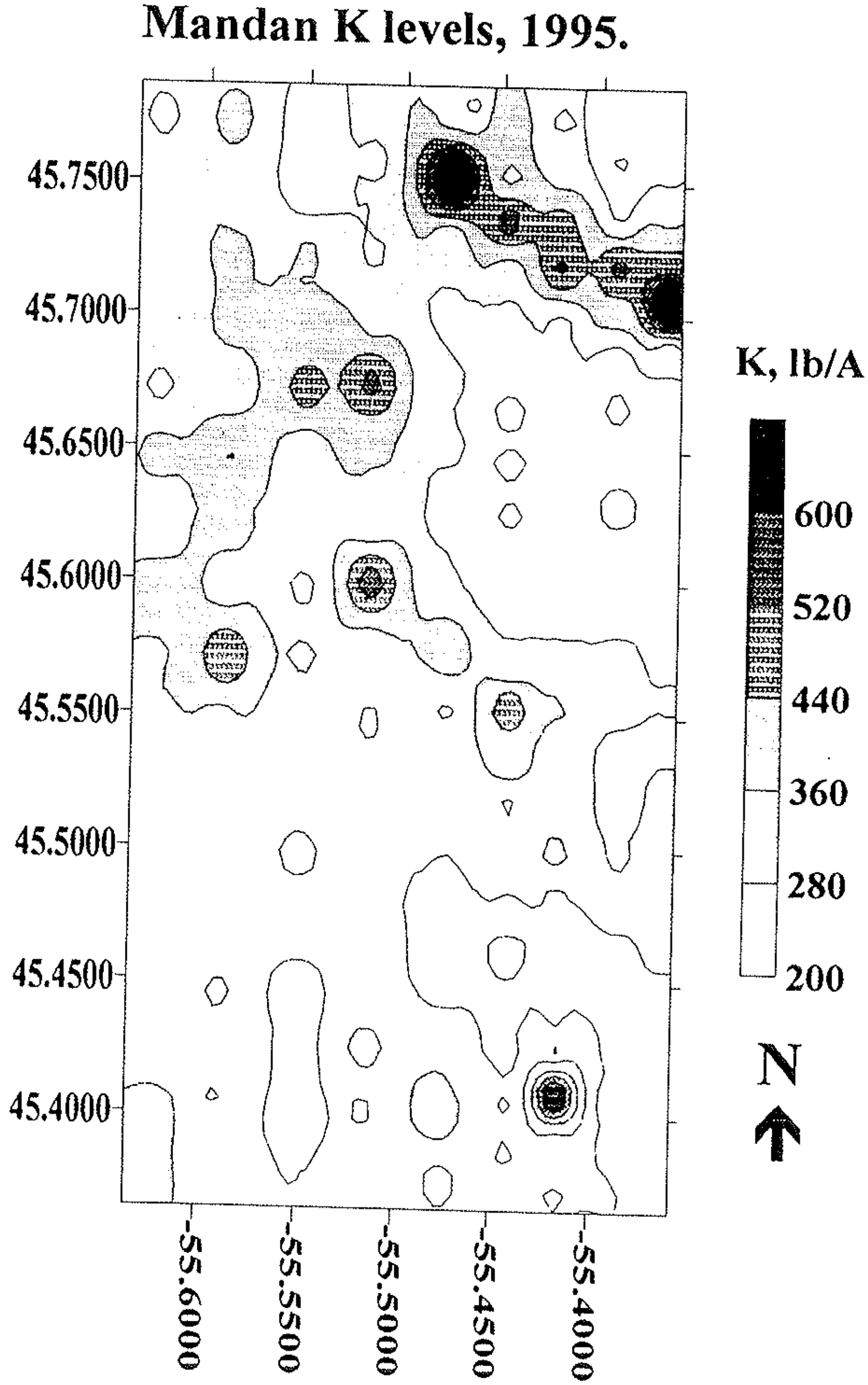


Figure 5. Potassium levels of fields I4, I5, and I6.

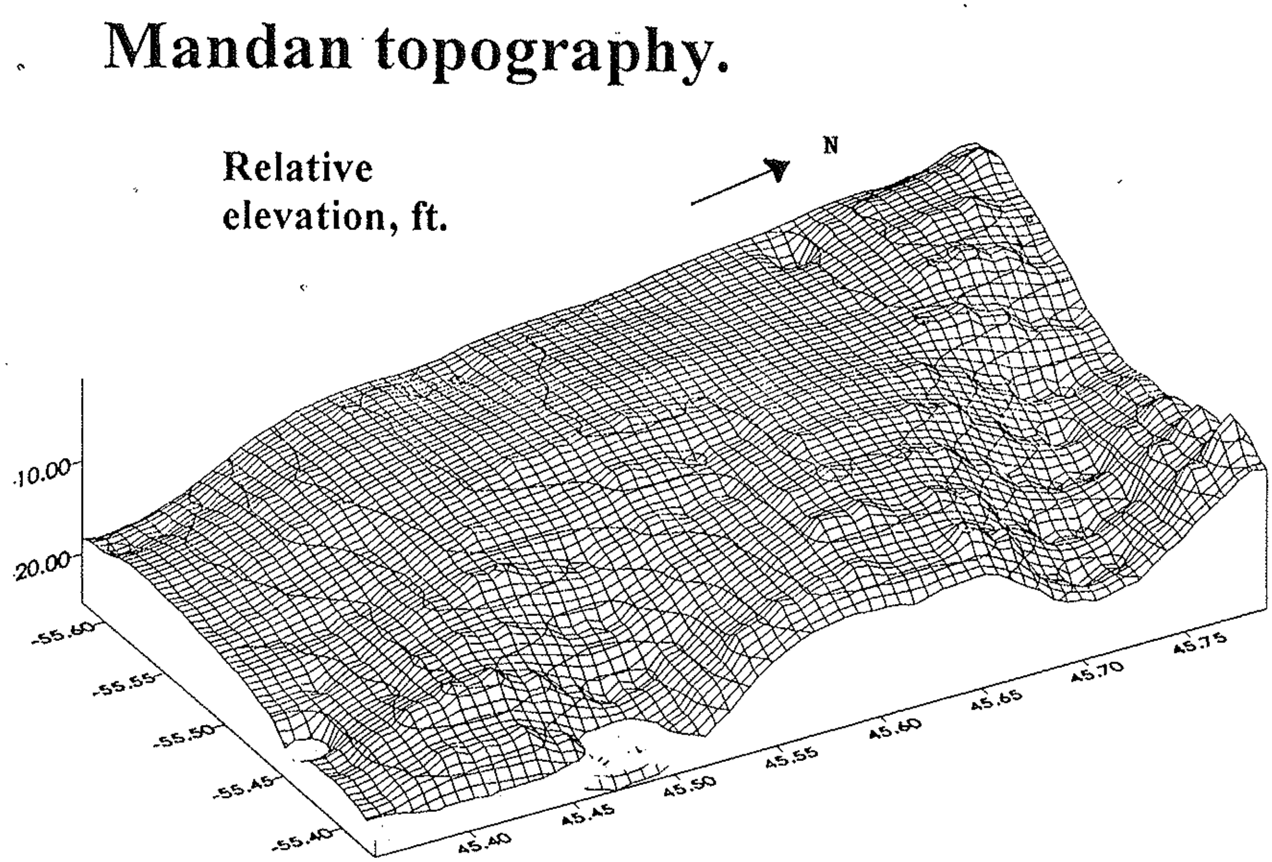


Figure 6. A 3-dimensional topographic map of fields I4, I5, and I6.

CONVERSION OF CRP TO CROP PRODUCTION

Drs. Don Tanaka, Steve Merrill, and Ardell Halvorson

In October 1994, a cooperative study was initiated to determine techniques for conversion of CRP land to crop production. Cooperators included NRCS, Consolidated Farm Service Agency, and the farm cooperator Mr. Keith Boehm. Treatments were: 1) hayed or nonhayed prior to tillage or spray operations; 2) residue management, < 30% surface cover, 30-60% surface cover and > 60% surface cover; and 3) nitrogen fertilizer, 0 and 60 lb N/a. Reference treatments included permanent hay and cover. Plots were hayed on October 11, 1994 and tillage and spray operations were done on October 14, 1994. The cool wet spring of 1995 resulted in poor grass control when an undercutter or tandem disk was used. Herbicides were not as effective because of the slow growth of grass and alfalfa. Amidon spring wheat was seeded on May 25, 1995 but because of the large quantity of volunteer intermediate wheatgrass, all plots were sprayed with Roundup (0.75 lb ai/a) and reseeded on June 12, 1995. Spring wheat was harvested on September 28, 1995. Grain yield was about 20 bu/a with no differences due to haying, residue management, or N fertilizer. Permanent hay plots were harvested on June 28, 1995 and produced about 4000 lb/a of grass-alfalfa mixed hay.

FORAGE GRASS BREEDING AND GENETICS

Dr. John Berdahl

Field G1. Progenies of 107 fairway-type and 196 standard-type crested wheatgrass selections and 240 western wheatgrass selections have been evaluated for forage yield, plant vigor, and nutritive quality. For crested wheatgrass, 11 fairway-type progenies and 22 standard-type progenies averaged greater forage yields than the cultivar Hycrest over a 2-year period. Only 12 of the 240 western wheatgrass progenies averaged greater forage yield than the Rodan and Rosana check cultivars, which were equal in forage yield. New cultivars of crested and western wheatgrass will not have substantial increases (greater than 10%) in forage yield over current cultivars, but preliminary data show good promise for improving forage digestibility and animal performance from these grass species.

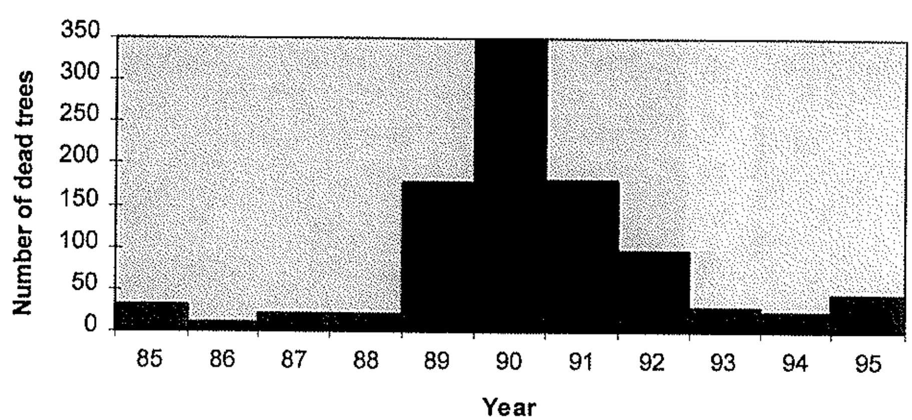
HYBRID POPLAR CLONAL TEST

Dr. Beverly Dow

Field G1. The purpose of this long-term study is to identify clones of hybrid poplars which are drought and cold hardy as well as resistant to damage from insects and diseases. One variety, the CANAM poplar, has been identified from this research and will be available for planting this spring.

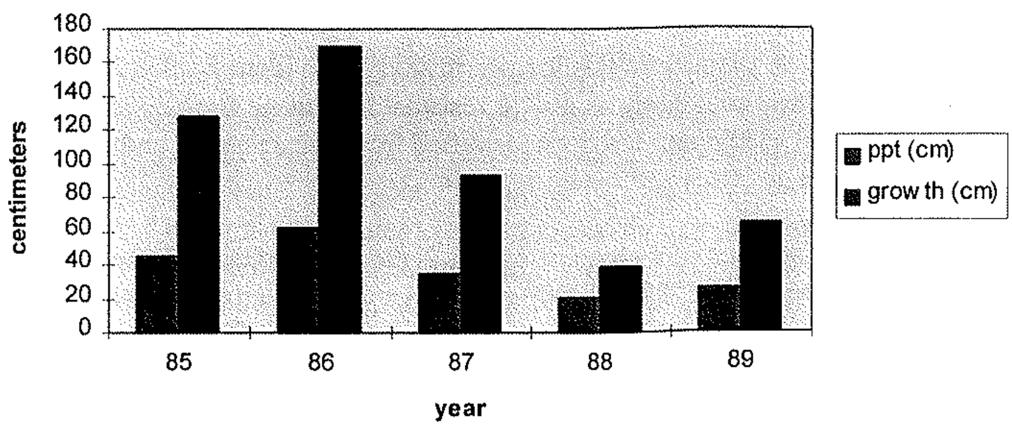
A striking result of these experiments is the effect of drought on poplars. Three years of low rainfall between 1988 and 1990 exerted a strong selective effect on the hybrid clones. Of 1728 trees planted, 983 (57%) have died over 11 years (Figure 1). Of all deaths, only 85 (9%) occurred prior to the drought. Between 1989 and 1991, 707 trees (72%) died, with 350 (37%) of these deaths occurring in 1990. The lag between the onset of drought and increase in deaths is probably because the soil moisture in the first year of drought was sufficient to meet the needs of the trees. It is likely that trees not only died directly from lack of water, but also died because drought stress lowered resistance to pathogens and winter damage. Further analysis will examine these effects. Over the last three years (1993-1995), mortality has again been very low (95 deaths, or 10%), since most susceptible trees have been removed.

Figure 1: Mortality of Populus Trees



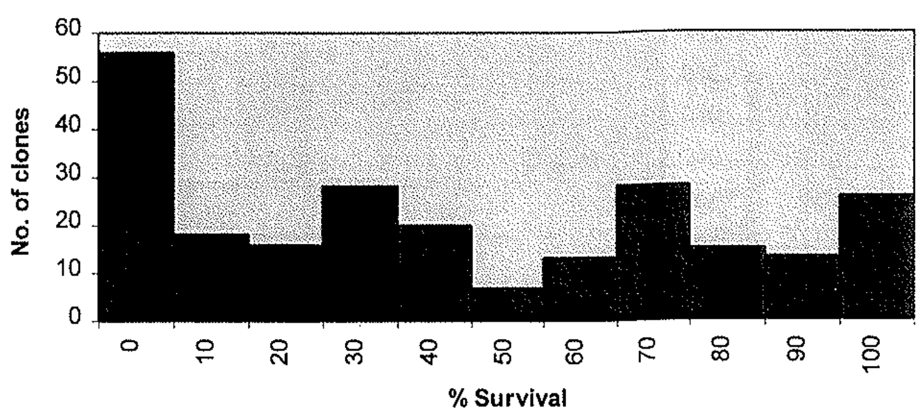
In addition to affecting mortality rates, the drought greatly decreased growth rates of surviving trees (Figure 2). In all years, growth rate paralleled precipitation, with the most average growth (170 cm or 5.6 feet) occurring in 1986, when rainfall was highest (62 cm or 24.5 in). Similarly, growth was lowest in the worst drought year, 1988, when the average growth was only 38 cm (1.2 feet) and precipitation was 20.5 cm (8.1 in). Regression analysis indicates that 51% of the variation in growth among trees can be explained by annual precipitation.

Figure 2: Annual Precipitation and Growth



Most clones showed some susceptibility to the drought and other causes of death. Of 240 clones tested, only 26 (11%) suffered no mortality (Figure 3). Fifty-six clones (23%) had no surviving individuals, and 145 clones (60%) had less than 50% survival.

Figure 3: Survival of Populus Clones



Clones having 100% survival were further analyzed for growth rate and crown size. In addition to the CANAM variety, 13 clones had heights that were at least 110% of the mean for all trees planted at the same time. Many of these trees also had above average crown widths. Further evaluation of these clones will include insect and disease tolerance, crown density, crown die-back, sprouting and dead terminal shoots.