Area IV SCD Cooperative Research Farm

USDA-ARS Northern Great Plains Research Laboratory

2003 Research and Cropping Results

Twentieth Annual Progress Report

January 27, 2004

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ACKNOWLEDGMENTS

The Area IV Soil Conservation Districts and USDA Agricultural Research Service appreciates the contributions of the following cooperators and program sponsors: Agricore United; Agriliance; AgriPro Wheat; AgWeek; AmeriFlax; Arvesta Corporation; BASF; Bayer Crop Science; Bis-Man Ford; CHS, Incorporated; Cloverdale Foods; Cooperative Agronomy Services; Croplan Genetics; DeKalb; D&S Trailer Sales; Dow AgroSciences; Ducks Unlimited; Dupont Ag Products; Encore Technologies; Extreme Sales; FMC; Farm Credit Services of Mandan; Farm and Ranch Guide; Frontier Agriculture; Gartner Seed Farm; Gustafson; Interstate Seeds; KAP Custom Application; Kist Livestock Auction; Legend Seeds; Mandan Tire Center; Minn-Dak Growers, LTD; Mandan Supply & Equipment; Monsanto; Mycogen Seeds; NDSU Agricultural Experiment Stations; NDSU Cooperative Extension Service; North Dakota Barley Council; North Dakota Corn Growers; North Dakota Grain Growers; Northern Canola Grower's Association; North Dakota Dry Pea and Lentil Association; North Dakota Seed Department; North Dakota Soybean Council; National Sunflower Association; Northern Plains Equipment; Pheasants Forever; Philom Bios; Pioneer Hi-Bred/Benchmark Seeds; ProSeed; Pulse USA; RDO Equipment; Red River Commodities; Security First Bank; Seeds 2000; Shelbourne Reynolds; Sygenta; Tesoro Petroleum; Tires Plus; Top Farm Hybrids; Twin City Implement; Triumph Seed; USDA Natural Resources Conservation Service; USDA-ARS Red River Valley Research Center; Valent; Van Seed Hybrids; Wells Fargo Bank; West Central Ag Chemicals; Westward Products; Wolf River Valley Seed

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Dynamic Agriculture - *Rediscovering the Basics*

Area IV SCD Cooperative Research Farm

Research Results & Technology Conference

Cosponsored by the National Sunflower Association

8:30 AM **Registration** - C*offee provided by Stutsman County Soil Conservation District*

9:00 AM **Welcomes:** Marvin Halverson, Area IV SCD Cooperative Research Farm
Dr. Joseph Krupinsky, USDA-ARS Northern Great Plains Research Laboratory
Lloyd Klein, National Sunflower Association

9:10 AM **Crop Sequence Calculator 2.2.5**
Dr. Joseph Krupinsky, Research Plant Pathologist

9:30 AM **Crop Water Use Differences and Potential Effects**
Dr. Steve Merrill, Soil Scientist

9:50 AM **Getting Back to the Basics When Direct Seeding**
Dr. Don Tanaka, Soil Scientist

10:10 AM C*offee break provided by Stutsman County Soil Conservation District*

10:30 AM **Predicting Crop Yield with Remote Sensing**
Vern Hoffman, NDSU Agricultural Engineer

10:50 AM **Management Effects on Soil Quality in Golden Valley County, North Dakota**
Mr. Jason Gross, Soil Scientist

11:10 AM **Glomalin - How Does Scum Hold Your Farm Together?**
Dr. Kris Nichols, Soil Microbiologist

11:30 AM **Carbon sequestration in Northern Plains Croplands and Rangelands**
Dr. Mark Liebig, Soil Scientist

12:00 PM Complementary Lunch and v*isiting with Exhibitors*

1:00 PM **Sunflower Market Dynamics Today and in the Future**
Larry Kleingartner, National Sunflower Association

1:15 PM **New Weed Control Options in Reduced and No-Till Sunflower**
New Label Options for Spartan® Application
Dean Wanner, FMC Corporation
CLEARFIELD® Sunflower: A New Approach to Growing Sunflower
Mike Odegaard, BASF
Dual Magnum, a No-Till Choice for Sunflower Weed Control
Sygenta

2:00 PM **Cattle Are What They Eat:** ***Creating Value-Added Beef***
Dr. Scott Kronberg, Research Animal Scientist

2:20 PM **Status of Improved Grasses and Alfalfa for Grazing**
Dr. John Berdahl, Research Geneticist

2:40 PM **Grazing for Profit Panel**
Gene Govan, McLean County Grass Farmer
Steve Fettig, Fettig Contract Grazing, Wishek, ND
Joe Fritz, Rancher, Beach, ND
Darell Evanson, Rancher, Lisbon, ND
Gabe Brown, Farmer, Menoken, ND

3:30 PM **Door Prize Drawings**

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AREA IV SCD COOPERATIVE RESEARCH FARM

The Area IV SCD Cooperative Research Farm is the result of a specific cooperative agreement between USDA-ARS and twelve Soil Conservation Districts (SCDs) that comprise the North Dakota Area IV Soil Conservation Districts. This agreement was put in place in 1984. Through this agreement, Area IV SCDs lease cropland from the Nelson estate for USDA-ARS Northern Great Plains Research Laboratory scientists to conduct cooperative research projects with the Area IV SCDs. Total cropland leased by Area IV SCDs is 382 acres. In addition, USDA-ARS has leased 55 acres in section 17 and 18 for long-term soil and water conservation research and, since 1989, another 26 acres in section 8 for tree plantings. Total acreage leased for research purposes is 463 acres. The Area IV SCD Cooperative Research Farm is located southwest of the USDA-ARS Northern Great Plains Research Laboratory, Mandan, ND (Figure 1). The general 2003 cropping plans are outlined on maps for the four field areas designated as F, G, H, and I (Figure 2). The precipitation pattern for the 2002 growing season and total precipitation history (1884-2002) for the duration of Area IV cooperative agreement is shown in Figures 3 and 4.

MESSAGE FROM DR. JON HANSON
LABORATORY DIRECTOR
USDA-ARS NORTHERN GREAT PLAINS RESEARCH LABORATORY

This is a year of milestones. The Northern Great Plains Research Laboratory celebrates 90 years of continuous research, supporting farm families in the Northern Plains and the economy of the region. The Agricultural Research Service observes 50 years as a USDA agency. We also celebrate the cooperation between several North Dakota Soil Conservation Districts and a USDA laboratory that twenty years ago created the Area IV SCD Cooperative Research Farm. This unique joint venture continues to allow USDA-ARS scientists to investigate current or potential economically important crops and the soil resource, with the same large-scale implements as the customers we serve. This research farm provides the ability to accomplish scientific natural resources investigation with real world farming practices.

A significant value of the Area IV farm is the credibility this research has with agricultural producers. This large field research is accomplished on fields like yours and in the same environmental conditions you face. This is a 'working farm' which must pay its bills every year. Each year we are able to present this "Research Results and Technology Conference", it means the bills were paid, and the research farm survived by the principles developed and utilized by our scientists. Our reputation with you, our customer, is earned each year through this farm's continued success and yours; by you learning what we have discovered through this research, and incorporating our science into your practices. As you utilize the information in this book, we look forward to hearing of your successes from the ideas you learned today. Your success is our success.

Leadership from the Area IV Soil Conservation Districts has been critical to the research farm's success throughout the past 20 years. We appreciate the extensive commitment and dedication of these groups and their leaders. Meaningful research is focused on today's real needs and tomorrow's opportunities by the input of these Agricultural leaders.

Research at the Area IV SCD Cooperative Research Farm, by USDA-ARS Northern Great Plains Research Laboratory scientists has extensively advanced the understanding of agricultural science and the environment of the Northern Great Plains region. Ongoing research may provide direction for future Agricultural policy decisions as well as help family farmers successfully thrive on the land and improve the resource for future generations, all because 20 years ago, cooperation between a USDA laboratory and twelve North Dakota Soil Conservation Districts made this possible.

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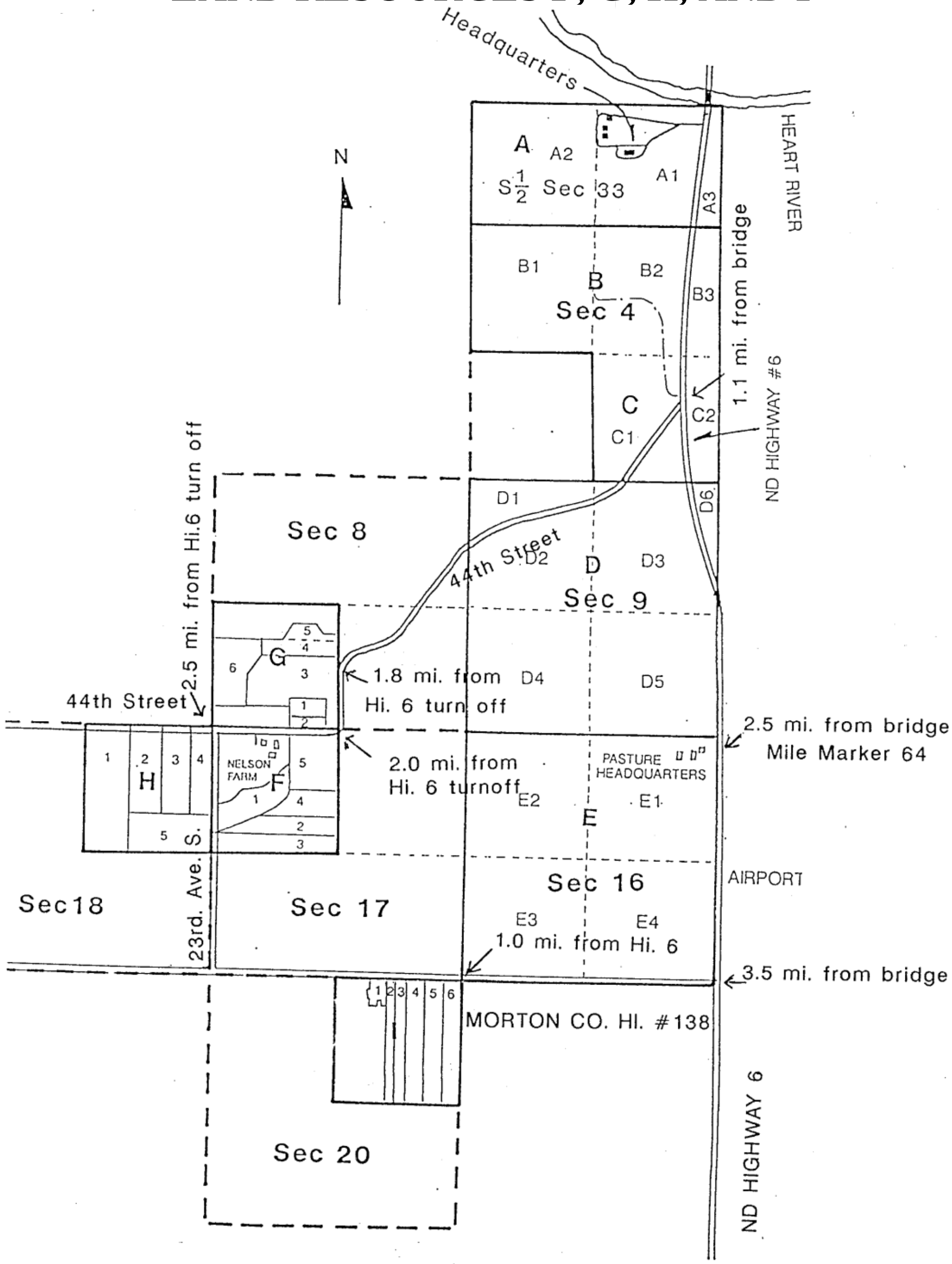
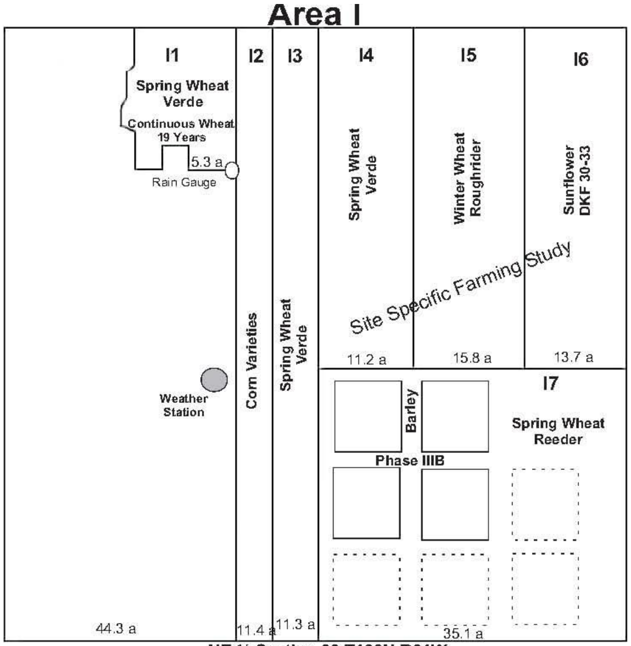
USDA-ARS LAND RESOURCES (FEDERAL & STATE) A, B, C, D, AND E
AREA IV SCD COOPERATIVE RESEARCH FARM
LAND RESOURCES F, G, H, AND I



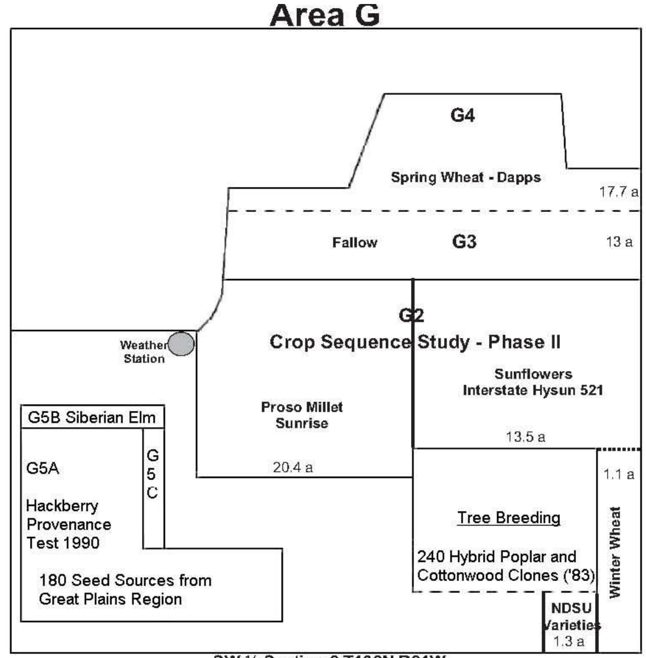
AREA IV SCD COOPERATIVE RESEARCH FARM
2003 CROP PLAN

Area I



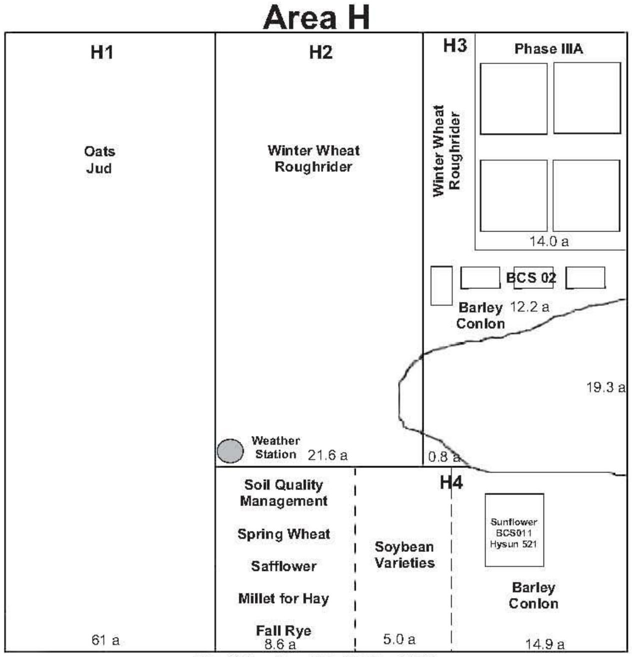
NE ¼ Section 20 T138N R81W

Area G



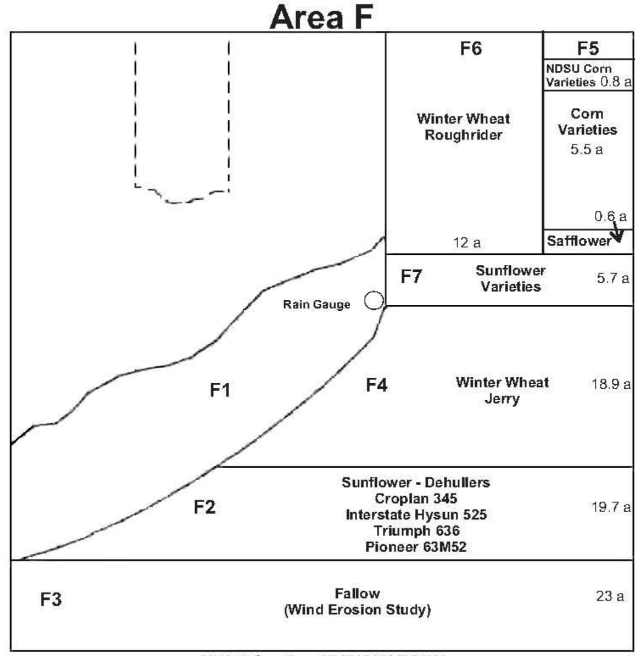
SW ¼ Section 8 T138N R81W

Area H



NE ¼ Section 18 T138N R81W

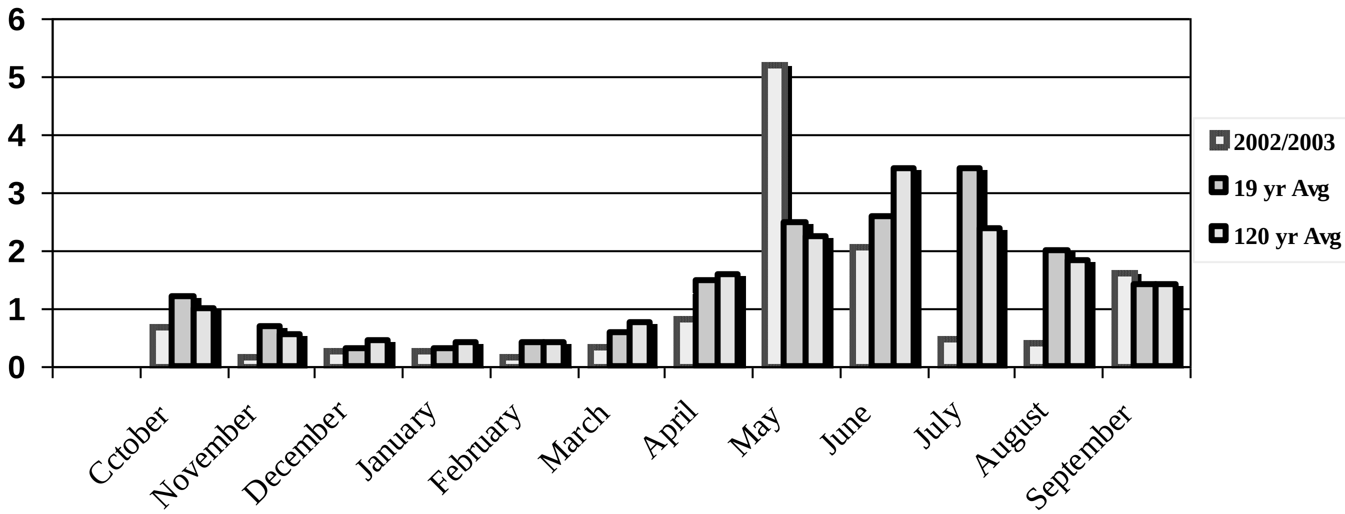
Area F



NW ¼ Section 17 T138N R81W

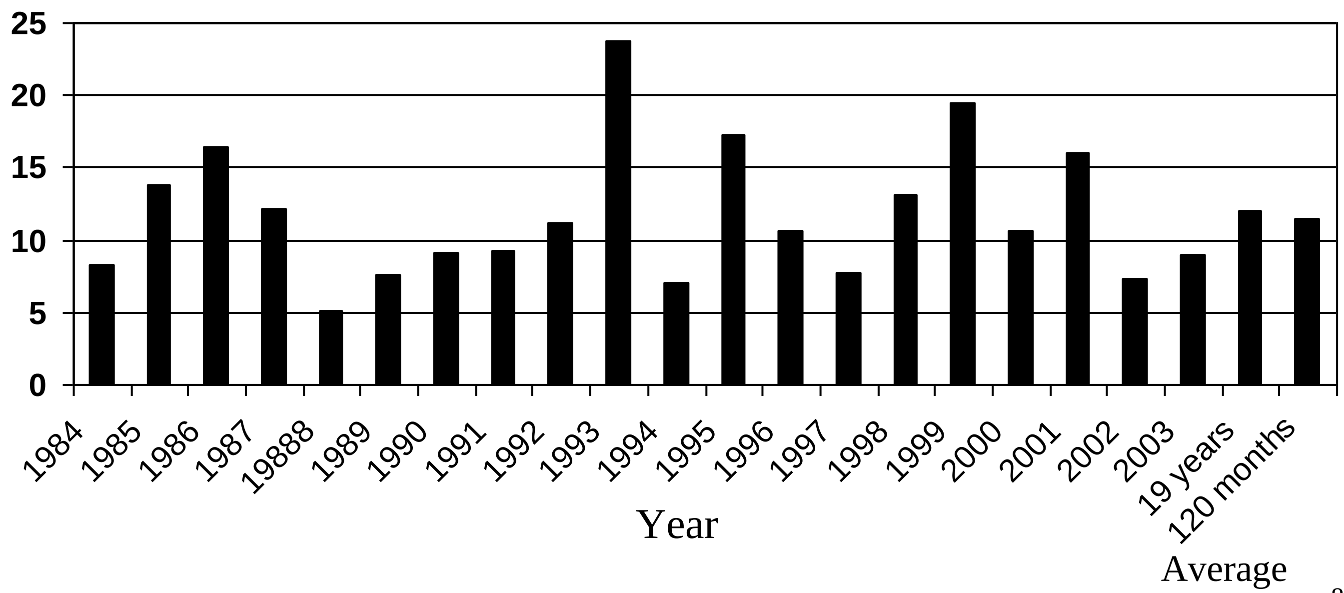
MONTHLY PRECIPITATION (INCHES)
October 2002 – September 2003
Area IV SCD Cooperative Research Farm
Mandan, North Dakota

Figure 3



GROWING SEASON PRECIPITATION (INCHES)
April - August (1984 - 2003)
Area IV SCD Cooperative Research Farm
Mandan, North Dakota

Figure 4



MANAGEMENT PRACTICES, 2003
AREA IV SCD COOPERATIVE RESEARCH FARM

<u>AREA-F FIELD OPERATIONS,</u> NW ¼ Section 17 T138N R81 W

FIELD F1 This conservation bench terrace area has been excluded from the total acreage leased by AREA IV SCDs since 1987.

FIELD F2, SUNFLOWER DEHULLER VARIETIES

4/21/03 Contractor spread Urea at 50 lbs/acre
4/29/03 Sonalan was applied and incorporated at a rate of 1.1 lbs ai/a using a Gandy air applicator mounted to a Haybuster undercutter.
6/11/03 Sprayed field with Glyphomax (20 oz/a), and LV4 (1 pt/a) plus ammonium sulfate.
6/12/03 Seeded sunflower dehuller varieties, from North to South, Pioneer 63M52, Croplan 345, Triumph 636, and Interstate Hysun 525, into winter wheat stubble using a JD Maxemerge II planter (30-inch row space) at a rate of 25,000 seeds per acre.
8/19/03 Contractor sprayed field with Asana XL (5.0 oz/a).
9/27/03 Contractor desiccated field with Gramoxone Max (1.2 pt/a).
10/15/03 Sunflowers were combined with Pioneer 63M52 yielding 1492 lbs/a, Croplan 345 yielding 1446 lbs/a, Triumph 636 yielding 1241 lbs/a, and Interstate Hysun 525 yielding 1418 lbs/a. Sunflowers were sold for $9.75 cwt.

FIELD F3, FALLOW (WIND EROSION PROJECT)

5/1/03 Sprayed field with Roundup Ultra Max (16 oz/a) and Bison (0.75 pt/a) plus ammonium sulfate (5 gal/100 gal H_20).
6/11/03 Sprayed field with Roundup Ultra Max (16 oz/a), and LV4 (1 pt/a) plus ammonium sulfate.
9/16/03 Sprayed field with 2,4-D Ester (16 oz/a), Roundup Ultra Max (16 oz/a) and ammonium sulfate.
9/22/03 Seeded Jerry winter wheat with a Haybuster 8000 hoe drill (10-inch row spacing) at a rate of 1.3 million seeds/a. Seed was treated with Raxil MD and 50 lbs of 11-52-00 was put on at seeding.

FIELD F4, JERRY WINTER WHEAT

9/18/02 Seeded Jerry winter wheat treated with Raxil MD with the Haybuster 8000 hoe drill (10-inch row spacing) at a rate of 1.3 million viable seeds/a. Winter wheat was seeded into barley stubble. Fertilizer in the form of 11-52-00 was applied at seeding at a rate of 50 lbs material/a.
4/21/03 Contractor spread 50 lbs N/a in the form of Urea.
5/15/03 LV4 at a rate of 1 pt/a was applied by contractor.
7/30/03 Winter wheat was combined and had a yield of 40.8 bu/a. The winter wheat had protein of 14.2% and a test weight of 57.8 lbs/bu and was sold for $3.27/bu.
9/23/03 Sprayed field with Glyphomax (20 oz/a), and LV4 (1 pt/a) plus ammonium sulfate.

FIELD F5, MONTOLA 2003 SAFFLOWER

4/21/03 Contractor bulk spread Urea at 80 lbs N/a.
4/30/03 Seeded Montola 2003 safflower treated with Raxil MD and Jumpstart (2 g/bu), into spring wheat stubble at a rate of 200,000 seeds/a. 50 lbs of 0-44-0 was applied at the time of seeding.
6/27/03 Sprayed field with Harmony GT (1/12 oz/a) and then applied Poast (1 pt/a) plus crop oil (1 qt/a).
7/30/03 Sprayed field with Quadris (6.2 oz/a).
9/9/03 Combined field with an estimated yield of 1000 lbs/a (combine yield).

FIELD F5, CORN VARIETIES

4/21/03 Contractor bulk spread Urea at 80 lbs N/a.
4/30/03 Field was sprayed with Roundup Ultra Max (16 oz/a) and Bison (1 pt/a) plus ammonium sulfate.
5/30/03 Corn varieties were planted at a rate of 25,000 seeds/a using a JD Maxemerge II planter with 30-inch row spacing.
6/18/03 Sprayed field with Option (1.5 oz/a), MSO (1.5 pt/a), UAN (1.5 qt/a), and Banvel (8 oz/a).
7/2/03 Sprayed field with Accent (0.33 oz/a), Atrazine (0.75 pt/a) and Destiny (1.5 pt/a).
No yield data due to corn not being harvested.

FIELD F5, NDSU VARIETY TRIALS

NDSU Variety trials by Joel Ransom.

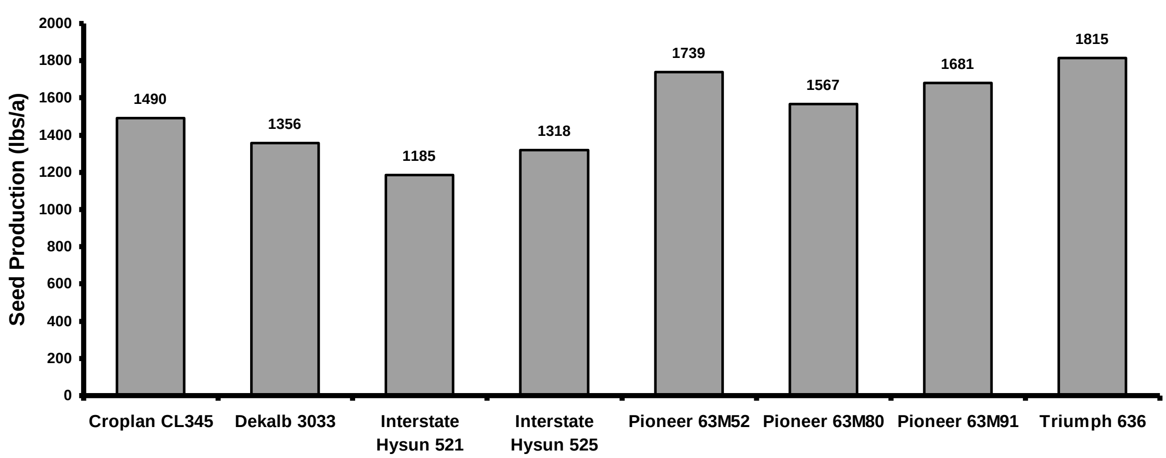
FIELD F6, ROUGHRIDER WINTER WHEAT

9/18/02 Seeded Roughrider winter wheat, treated with Raxil MD, into chemical fallow using a Bourgault air seeder (10-inch row space) at a rate of 1.3 million seeds/a. Fertilized at time of seeding with 70 lbs/a of 11-52-00.
4/21/03 Contractor spread Urea at a rate of 50 lbs N/a.
5/15/03 Contractor sprayed field with LV4 (1 pt/a).
7/30/03 Field was combined and had a yield of 39.2 bu/a (combine yield), a test weight of 60 lbs/a and protein of 12.9%. The winter wheat was kept for seed.
9/23/03 Sprayed field with Glyphomax (20 oz/a), and LV4 (1 pt/a) plus ammonium sulfate.

FIELD F7, SUNFLOWER VARIETIES

4/21/03 Contractor spread 50 lbs N/a in the form of Urea.
4/29/03 Sonalan was applied and incorporated at a rate of 1.1 lbs ai/a using a Gandy air applicator mounted to a Haybuster undercutter.
6/11/03 Sprayed field with Roundup Ultra Max (16 oz/a), and LV4 (1 pt/a) plus ammonium sulfate.
6/13/03 Sunflower varieties were seeded at 25,000 seeds/a using JD Maxemerge II planter (30-inch row spacing).
6/30/03 Applied Poast (1.5 pt/a) and crop oil (1 qt/a).
8/19/03 Contractor sprayed field with Asana XL (5.0 oz/a).
10/21/03 Sunflowers were harvested and sold for $9.75 cwt. See seed yield data below.

2003 Sunflower Varieties (F7)



AREA-G FIELD OPERATIONS, SW ¼ Section 8 T138N R81W

FIELD G2 EAST, INTERSTATE HYSUN 521 SUNFLOWERS

4/23/03 Contractor spread 50 lbs N/a (Urea).
6/5/03 Sprayed field with Spartan (5.0 oz/a).
6/11/03 Seeded Interstate Hysun 521 sunflowers into barley stubble using a JD Maxemerge II planter at a seed rate of 25,000 seeds/a.
6/30/03 Applied Poast (1.5 pt/a) and crop oil (1 qt/a).
7/3/03 Applied Assert (12 oz/a) and Preference (1 pt/100 gal H_2O).
7/22/03 Sprayed Roundup Ultra at 24 oz/a.
8/19/03 Contractor sprayed field with Asana XL (5.0 oz/a).
10/17/03 Sunflowers were combined and yielded 1570 lbs/a and were sold for $9.75 cwt.
10/21/03 Contractor sprayed field with Roundup (2 qt/a).

FIELD G2 WEST, SUNRISE PROSO MILLET

4/23/03 Contractor spread 50 lbs N/a in the form of Urea.
6/4/03 Sprayed field with Roundup Ultra Max (16 oz/a), and Bison (0.75 pt/a) plus ammonium sulfate.
6/17/03- Seeded proso millet into sunflower stubble at a rate of 1.5 million seeds/a using a JD 750 6/18/03
(7.5-inch row spacing) no-till drill. 50 lbs/a of 11-52-00 was applied at seeding time.
9/9/03 Field was swathed using a Versatile 4400.
10/7/03 Proso millet was combined and yielded 1323 lbs/a. Proso millet was sold for $5.75 cwt.

FIELD G3, FALLOW

5/21/03 Field sprayed with Roundup Ultra Max (20 oz/a) and Bison (1.5 pt/a) 6/13/03
Field sprayed with Roundup Ultra Max (20 oz/a) and LV4 (1 pt/a) plus ammonium sulfate.
9/25/03 Sprayed field with Glyphomax (20 oz/a), and LV4 (1 pt/a) plus ammonium sulfate.

FIELD G4, DAPPS SPRING WHEAT

4/22/03 Seeded Dapps spring wheat (treated with Raxil MD) into fallow using a JD 750 no-till drill (7.5-inch row spacing) at a rate of 1.3 million seeds/a. Put down 50 lbs/a 11-52-00 and 40 lbs N/a (urea) at time of seeding.
6/4/03 Contractor sprayed field with Everest (0.6 oz/a) and Bromax (1 pt/a).
8/12/03 Spring wheat was combined and yielded 44.7 bu/a, test weight was 63 lbs/bu and protein was 14.6%.
9/25/03 Sprayed field with Glyphomax (20 oz/a), and LV4 (1 pt/a) plus ammonium sulfate.
10/1/03 Sprayed field with Roundup Ultra Max (16 oz/a), and LV4 (1 pt/a) plus ammonium sulfate.

AREA-H FIELD OPERATIONS, NE ¼ Section 18 T138N R81W

FIELD H1, JUD OATS

4/23/03 Contractor bulk spread 50 lbs N/a (Urea).
5/1/03 Sprayed field with Roundup Ultra Max (16 oz/a) and Bison (0.75 pt/a) plus ammonium sulfate (5 gal/100 gal H_20).
5/16/03- Seeded Jud oats (treated with Raxil MD) into flax stubble with the Bourgault air
5/22/03 seeder (10-inch row spacing) at a seed rate of 80 lbs/a. Fertilized with 60 lbs of 11-52-00.
6/16/03 Sprayed with Stampede (1.4 lbs/a), Bison (0.5 pt/a) plus Prime oil (1 pt/a).
8/21/03 Oats were combined and yielded 29.2 bu/a (combine yield).
9/22/03 Sprayed field with Glyphomax (20 oz/a), and LV4 (1 pt/a) plus ammonium sulfate.
9/24/03 Seeded Roughrider winter wheat, treated with Raxil MD, at a rate of 1.3 million seeds/a along with 50 lbs/a of 11-52-00. The western 1/3 of the field was seeded using a Haybuster 8000 hoe drill (10-inch row spacing) and the rest of the field was seeded with a JD 750 no-till drill (7.5-inch row spacing).

FIELD H2, ROUGHRIDER WINTER WHEAT

9/18/02 Seeded Roughrider winter wheat, treated with Raxil MD, into oat stubble with the JD 750 no-till drill (7.5-inch row spacing) at a rate of 1.3 million seeds/a. 11-52-00 was applied at 50 lbs/a at seeding.
9/19/02 Sprayed with Glyphomax (16 oz/a), LV4 (1 pt/a), and ammonium sulfate.
4/21/03 Contractor bulk spread Urea at 50 lbs N/a.
5/15/03 Contractor sprayed field with LV4 (1 pt/a).
7/29/03 Roughrider winter wheat was combined and had a yield of 41.1 bu/a (combine yield). The winter wheat had 60.1 lbs/bu test weight with protein of 14.3 and was sold for $3.27/bu.
9/25/03 Sprayed field with Glyphomax (20 oz/a), and LV4 (1 pt/a) plus ammonium sulfate.

FIELD H3, ROUGHRIDER WINTER WHEAT

9/19/02 Seeded Roughrider winter wheat, treated with Raxil MD, into barley stubble with the JD 750 no-till drill (7.5-inch row spacing) at a rate of 1.3 million seeds/a. Applied 11-52-00 at this time at a rate of 50 lbs/a.
4/23/03 Contractor bulk spread Urea at 50 lbs N/a.
5/15/03 Contractor sprayed field with LV4 (1 pt/a).
7/29/03 Roughrider winter wheat was combined and had a yield of 41.2 bu/a (combine yield) with a test weight of 60.5 lbs/bu and had protein level of 13.6%. The wheat was sold for $3.27/bu.
9/25/03 Sprayed field with Glyphomax (20 oz/a), and LV4 (1 pt/a) plus ammonium sulfate.

FIELD H3, CROP SEQUENCE PROJECT, PHASE III

See ‘Diverse Cropping Systems – Introduction to Crop Sequence Project’ on pages 15-16.

FIELD H4, SOIL QUALITY MANAGEMENT

See ‘Management Strategies for Soil Quality’ on page 22.

FIELD H4 WEST, SOYBEAN VARIETIES

6/12/03 Seeded soybean varieties (Top Farm 6042RR and 6072RR, Legend 92 RR, and Roughrider 200RR) into corn stubble at a rate of 200,000 seeds/a using a JD 750 no-till drill (7.5-inch row spacing). Nodulator soybean inoculant was put down with the seed. 30 lbs N/a (34-0-0) and 50 lbs 0-44-0 were also put down at seeding.
7/15/03 Sprayed field with Roundup Ultra Max at 24 oz/a plus ammonium sulfate.
No yield data due to soybeans not being harvested.

FIELD H4 EAST, SCLEROTINIA BIOLOGICAL CONTROL STUDIES

See ‘Sclorotinia (White Mold) as Influenced by Crop Sequence and Biological Control, 2003’ on pages 40-41.

FIELD H4 CONLON BARLEY

4/23/03 Contractor bulk spread 50 lbs N/a in the form of Urea.
5/21/03 Sprayed field with Roundup Ultra Max (16 oz/a), and Bison (0.75 pt/a) plus ammonium sulfate.
5/29/03 Seeded Conlon barley treated with Raxil MD into sunflower stubble with Bourgault air seeder (10-inch row space). Fertilized at seeding with 60 lbs/a of 11-52-00.
6/17/03 Sprayed with Puma (0.5 pt/a) and Bison (0.75 pt/a).
8/19/03 Barley was combined and yielded 32 bu/a (combine yield). Sold for $1.87/bu.
9/16/03 Field was sprayed with Roundup Ultra Max (16 oz/a) and LV4 (1 pt/a) plus ammonium sulfate.
9/22/03 Field was seeded to Roughrider winter wheat (treated with Raxil MD) with the JD 750 no-till drill (7.5-inch row spacing). 50 lbs/a of 11-52-00 was also put down at seeding.

AREA-I FIELD OPERATIONS, NE ¼ Section 20 T138N R81W

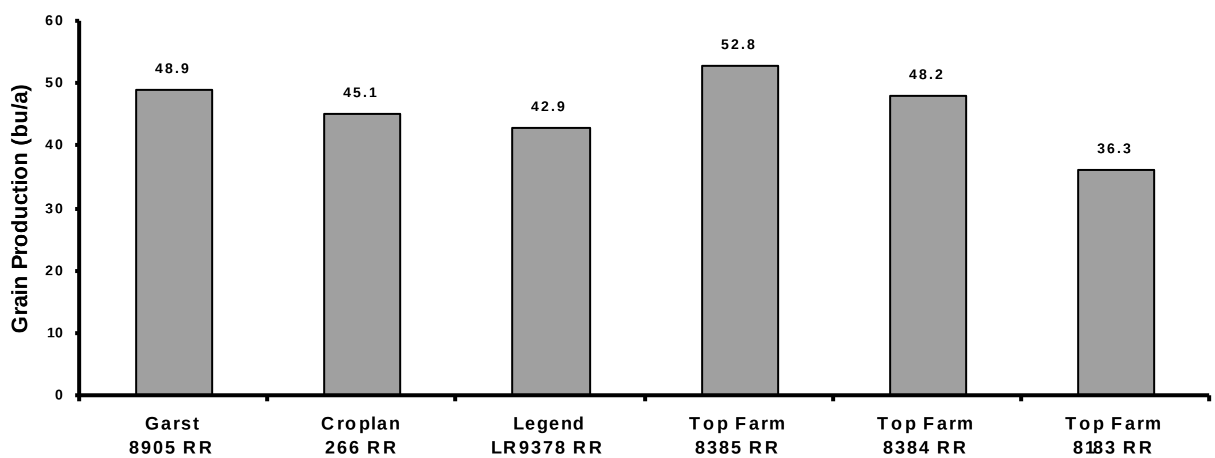
FIELD I1, VERDE SPRING WHEAT

4/29/03 Sprayed field with Roundup Ultra Max (16 oz/a), and Bison (0.75 pt/a) plus ammonium sulfate.
5/22/03 Seeded Verde spring wheat (treated with Raxil MD) into spring wheat stubble with a Concord air seeder with hoe openers and a 10-inch row spacing. Applied 50 lbs N/a (urea) and 60 lbs 11-52-00 at time of seeding.
6/11/03 Sprayed with Puma (0.5 pt/a) and Bison (0.75 pt/a).
8/20/03 Spring wheat was combined and yielded 28.8 bu/a (combine yield) with a test weight of 59.0 lbs/bu and protein of 15%. Sold for $3.48/bu.
10/1/03 Sprayed field with Glyphomax (20 oz/a), and LV4 (1 pt/a) plus ammonium sulfate.

FIELD I2, CORN VARIETIES

4/23/03 Contractor bulk spread 50 lbs N/a (Urea).
5/21/03 Sprayed field with Roundup Ultra Max (16 oz/a), and Bison (0.75 pt/a) plus ammonium sulfate.
6/10/03 Top dressed field with 60 lbs N/a (Ammonium Nitrate) using a Barber fertilizer spreader.
6/10/03 Seeded corn varieties, from west to east, Garst 8905RR, Croplan 266RR, Legend 9378RR, Top Farm 8385RR, Top Farm 8384RR, and Top Farm 8183RR using a JD Maxemerge II planter (30-inch row spacing). Seeding rate was 25,000 seeds/a and corn was seeded into soybean stubble.
6/11/03 Sprayed field with Roundup Ultra Max (16 oz/a), and LV4 (1 pt/a) plus ammonium sulfate.
7/15/03 Field was sprayed with Roundup Ultra Max (16 oz/a) plus ammonium sulfate.
10/22/03 Corn varieties were harvested. See corn yields (combine yield) below.

2003 Corn Varieties (I2)



FIELD I3, VERDE SPRING WHEAT

4/21/03 Contractor bulk spread 50 lbs N/a (Urea).
4/22/03 Went over the field with a JD MulchMaster.
4/29/03 Sprayed field with Roundup Ultra Max (16 oz/a), and Bison (0.75 pt/a) plus ammonium sulfate.
5/21/03 Sprayed field with Roundup Ultra Max (16 oz/a), and Bison (0.75 pt/a) plus ammonium sulfate.
5/21/03 Seeded Verde spring wheat (treated with Raxil MD) into sunflower stubble with Concord air seeder with hoe openers and a 10-inch row spacing. Applied 60 lbs N/a (urea) and 60 lbs 11-52-00 at time of seeding.
6/11/03 Sprayed with Puma (0.5 pt/a) and Bison (0.75 pt/a).
8/13/03 Spring wheat was combined and yielded 29.2 bu/a (combine yield) with a test weight of 58 lbs/bu and 14.6% protein. Sold for $3.48/bu.
10/1/03 Sprayed field with Glyphomax (20 oz/a), and LV4 (1 pt/a) plus ammonium sulfate.

FIELD I4, VERDE SPRING WHEAT

4/22/03 Went over the field with a JD MulchMaster.
4/29/03 Sprayed field with Roundup Ultra Max (16 oz/a), and Bison (0.75 pt/a) plus ammonium sulfate.
5/2/03 Seeded Verde spring wheat (treated with Raxil MD) into sunflower stubble with Concord air seeder with hoe openers and a 10-inch row spacing. Applied 60 lbs 11-52-00 at time of seeding along with 30 lbs N/a (Urea).
6/9/03 Applied 50 lbs N/a (Ammonium sulfate) with a Barber fertilizer spreader.
6/11/03 Sprayed with Puma (0.5 pt/a) and Bison (0.75 pt/a).
8/11/03 Spring wheat was combined and yielded 26.2 bu/a (combine yield) with a test weight of 56 lbs/bu and 16.4% protein. Sold for $3.48/bu.
9/16/03 Sprayed field with Roundup Ultra Max (16 oz/a), and LV4 (1 pt/a) plus ammonium sulfate.
9/22/03 Seeded roughrider winter wheat, treated with Raxil MD, at a rate of 1.3 million seeds/a using seeder (10-inch row spacing). At seeding, 60 lbs/a of 11-52-00 was applied.
9/23/03 Sprayed field with Glyphomax (20 oz/a), and LV4 (1 pt/a) plus ammonium sulfate.

FIELD I5, ROUGHRIDER WINTER WHEAT

9/18/02 Seeded Roughrider winter wheat (treated with Raxil MD) into spring wheat stubble at a rate of 1.3 million seeds/a with a Bourgault air seeder (10-inch row space). Fertilizer was applied at 70 lbs/a 11-52-00.
4/21/03 Contractor bulk spread 50 lbs N/a (Urea).
5/15/03 Contractor sprayed field with LV4 (1 pt/a).
7/28/03 Winter wheat was combined and yielded 36 bu/a (combine yield). Protein was 13.8% and market price was $3.27/bu.
9/23/03 Sprayed field with Glyphomax (20 oz/a), and LV4 (1 pt/a) plus ammonium sulfate.

FIELD I6, DKF 30-33 SUNFLOWER

4/29/03 Sonalan was applied and incorporated at a rate of 1.1 lbs ai/a using a Gandy air applicator mounted to a Haybuster undercutter.
5/28/03 50 lbs N/a in the form of urea was spread using the Concord air seeder.
6/11/03 Seeded Dekalb 30-33 sunflowers into winter wheat stubble, using the JD Maxemerge II planter (30-inch row spacing), at a seed rate of 25,000 seeds/a.
7/22/03 Sprayed Roundup Ultra at 24 oz/a.
8/19/03 Contractor sprayed field with Asana XL (5.0 oz/a).
10/20/03 Sunflowers were combined and yielded 1493 lbs/a (combine yield). They were sold for $9.75 cwt.

FIELD I7, REEDER SPRING WHEAT

4/29/03 Sprayed field with Roundup Ultra Max (16 oz/a), and Bison (0.75 pt/a) plus ammonium sulfate.
5/16/03-5/21/03 Seeded Reeder spring wheat (treated with Raxil MD) into spring wheat stubble at 1.3 million viable seeds/a with a Haybuster 107 no-till drill with a 7-inch row spacing. 60 lbs N/a (urea) and 60 lbs/a 11-52-00 was applied with seed.
6/11/03 Sprayed with Puma (0.5 pt/a) and Bison (0.75 pt/a).
6/17/03 Contractor broadcast 60 lbs N/a (urea) on eastern half of field when spring wheat was at the 4th leaf stage.
8/14/03 Spring wheat was combined and yielded 29.4 bu/a (combine yield) on western side of field and 30.5 bu/a on the eastern side. The eastern spring wheat top, dressed with 60 lbs N/a, had a test weight of 58 lbs/bu and protein of 15.1%. The western spring wheat had a test weight of 58.5 lbs/bu and protein of 15.3%. The wheat was sold for $3.48/bu.
10/1/03 Sprayed field with Glyphomax (20 oz/a), and LV4 (1 pt/a) plus ammonium sulfate.

DIVERSE CROPPING SYSTEMS

INTRODUCTION TO CROP SEQUENCE PROJECT

Contact Information: J.M. Krupinsky krupinskj@mandan.ars.usda.gov (701) 667.3011

A multi-disciplinary team of scientists is conducting a multi-phased project with early- and late-season grass and broad leaf crops to develop diverse cropping systems. The team is evaluating the components of crop production, crop residue, plant disease, weeds, root growth, crop-water use, soil quality, and economics to develop guidelines for long-term diversified crop production systems and to provide producers with management flexibility for developing their own cropping systems.

Phase II of the Crop Sequence Project, Early Season Crops

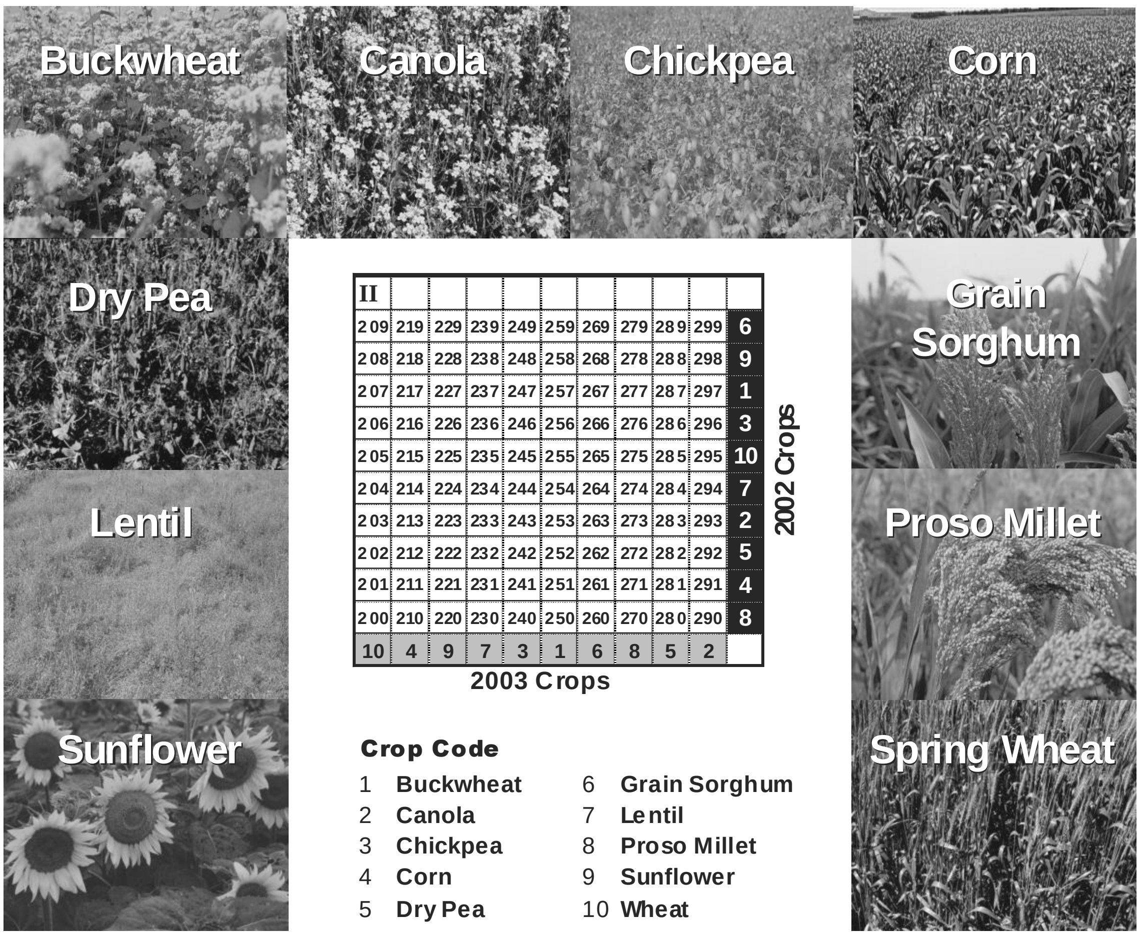
Phase II of the Diverse Cropping Systems Project, was initiated in 1998 to determine the sequence crops should follow to take advantage of the previous crop and crop residues. Ten crops were included (barley, dry bean, canola, crambe, flax, dry pea, safflower, soybean, oil seed sunflower, and hard red spring wheat). A crop by crop residue matrix was evaluated in 1999 and 2000. Following the crop by crop-residue matrix, a uniform wheat crop was grown in 2000 and 2001 over the crop matrix to determine how wheat performs after all crop sequences. A sunflower crop followed the wheat crop in 2001 and 2002. The Crop Sequence Calculator (version 2.2.5) provides an introduction to Phase II of the cropping system project and information on crop production, economics, plant diseases, weeds, insects, water use, and surface soil properties to aid producers in their evaluation of management risks associated with different crop sequences.

Phase III of the Crop Sequence Project, Late Season Crops (Figure 1.)

Phase III of the Diverse Cropping Systems Project, was initiated in 2002 to continue determining the sequence crops should follow to take advantage of the previous crop and crop residues. Field plots were located on the Area IV ARS/SCD Research Farm located near the Northern Great Plains Research Laboratory, southwest of Mandan, ND. For Phase IIIa, ten crops (canola, dry pea, oil seed sunflower, hard red spring wheat, proso millet, grain sorghum, chickpea, lentil, corn, buckwheat) were direct seeded in an east-west direction with a JD 750 no-till drill in strips into wheat stubble in each of four replications in 2002. In 2003 all ten crops were again randomized and direct seeded into stubble from the previous crops in a north-south direction, perpendicular to the 2002 crop. This allowed every crop to be seeded on the residue of all the other crops (100 treatments per replication). At another field site, Phase IIIb, the same ten crops were seeded in an east-west direction in 2003. The same crops will be seeded in a north-south direction in 2004, again allowing every crop to be seeded on the residue of the ten previous crops creating 100 treatment combinations for evaluation.

Figure 1

Crop Sequence Project, Phase III



II										2002 Crops
209	219	229	239	249	259	269	279	289	299	6
208	218	228	238	248	258	268	278	288	298	9
207	217	227	237	247	257	267	277	287	297	1
206	216	226	236	246	256	266	276	286	296	3
205	215	225	235	245	255	265	275	285	295	10
204	214	224	234	244	254	264	274	284	294	7
203	213	223	233	243	253	263	273	283	293	2
202	212	222	232	242	252	262	272	282	292	5
201	211	221	231	241	251	261	271	281	291	4
200	210	220	230	240	250	260	270	280	290	8
10	4	9	7	3	1	6	8	5	2	

2003 Crops

Crop Code

1	**Buckwheat**	6	**Grain Sorghum**
2	**Canola**	7	**Lentil**
3	**Chickpea**	8	**Proso Millet**
4	**Corn**	9	**Sunflower**
5	**Dry Pea**	10	**Wheat**

Design of one replicate of a crop by crop residue matrix used to evaluate the influence of crop sequence. During the first year, ten crops (numbered 1 through 10) were seeded into a uniform crop residue. During the second year, the same crops were no-till seeded perpendicular over the residue of the previous year's crop. Individual plot numbers were assigned for each of the four replications.

CROP SEQUENCE CALCULATOR, VERSION 2.2.5 A REVISED COMPUTER PROGRAM TO ASSIST PRODUCERS

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ARS researchers were challenged by users of ARS research technology to make research results available in timely manner and in a format that could be readily accessed. Researchers took the initiative by producing the "Crop Sequence Calculator" (CSC), an interactive computer software program on a user-friendly CD-ROM. The CSC provides information from the Cropping Sequence Project (Phase II), which is described elsewhere in this report. The CSC provides crop production information and the potential returns of crops in a diverse cropping system, especially the influence of crop sequence (crop rotation). The CSC can calculate the expected yield of ten crops (barley, bean, canola, crambe, flax, pea, safflower, soybean, sunflower, and wheat) grown in any two-year combination. Expected crop prices and expected loan deficiency payments (LDP) can be input to provide rapid calculations of potential returns. Summary statements on crop production, plant diseases, insects, weeds, crop water use, and surface soil properties are automatically provided for each of the 100 possible crop sequence combinations to aid users in their evaluation of management risks associated with different crop sequences. In addition, by selecting the 'More Info' buttons adjacent to each summary statement, numerous photos, graphs, management principles, and internet resources are easily accessed. For example, 'More Info' concerning plant diseases includes graphs and photos of plant disease research results, an introduction to plant diseases, websites for plant disease information, and a gallery of plant disease photographs. The numerous photographs of diseases, weeds, and insects aid producers in identification of possible pests. The user-friendly CSC runs directly from a CD-ROM eliminating the need for additional disk space or installation procedures. The CSC, version 1, was released in January, 2001 and over 2,300 copies of the Crop Sequence Calculator were distributed within nine months. The expanded version 2 of the CSC was released in January, 2002 and over 7,391 copies were requested and distributed.

The Crop Sequence Calculator was revised (version 2.2.5) to provide a more user-friendly computer environment. Although the basic data remains the same in this version, editorial changes were made and numerous websites were added.

Copies of the Crop Sequence Calculator can be obtained from the Northern Great Plains Research Lab website: www.mandan.ars.usda.gov

The underlying data were generated with the supplemental support of the Area IV Soil Conservation District, The National Sunflower Association, The North Dakota Oilseed Council, and the Northern Canola Growers Association.

SOIL BIOLOGICAL CHARACTERISTICS OF CONTRASTING CROPPING SYSTEMS IN THE GREAT PLAINS

M.A. Liebig, L. Carpenter-Boggs, J.M.F. Johnson, S.E. Wright, N.W. Barbour, and B.J. Wienhold

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BACKGROUND

Interest in soil quality has increased emphasis on understanding soil biological contributions to soil function. This emphasis is understandable, as soil biota mediate important ecosystem processes such as energy flow, nutrient cycling, and water infiltration and storage. Enhancement of these processes from improved soil management is expressed through the activities of soil flora and fauna. Examples include decomposition of organic residues, assimilation and release of plant nutrients, creation of biopores, and production of compounds in soil known to enhance aggregate stability. Collectively, soil biota affect both agricultural productivity and environmental quality, and therefore, warrant careful consideration when evaluating the sustainability of cropping systems.

In 1999, a multi-location study was initiated to evaluate a number of soil physical, chemical, and biological properties proposed for assessing soil quality. The objectives of this study were to 1) quantify temporal dynamics of soil quality attributes in established cropping systems, 2) assess soil quality attributes between treatments of contrasting management intensity, and 3) evaluate recently developed methods for assessing soil quality. The study's objectives allowed for the evaluation of management impacts on a consistent set of soil biological properties across multiple locations over time, which to date, has not been conducted in the Great Plains. This report provides a summary of results from the study.

METHODS

Contrasting management treatments within eight long-term cropping system experiments throughout the Great Plains were selected for the study (Table 1; Figure 1). Experiments were located near Akron, CO, Brookings, SD, Bushland, TX, Fargo, ND, Mandan, ND, Mead, NE, Sidney, MT, and Swift Current, SK. Treatments selected within each experiment, referred to as 'conventional' and 'alternative', differed in management intensity as characterized by either type or frequency of tillage, cropping intensity, and/or crop rotation diversity. At four of the locations – Fargo, Mandan, Mead, and Sidney – grass check plots were also evaluated.

Soil samples were collected prior to planting, at peak crop biomass, and after harvest over a period of four years at each location. Samples were collected in the same plots throughout the duration of the study at depths of 0 to 7.5, 7.5 to 15, and 15 to 30 cm. Samples were analyzed for microbial biomass carbon (C) and nitrogen (N), potentially mineralizable nitrogen (PMN), glomalin, water stable aggregates, and fatty acid methyl ester (FAME) profile.

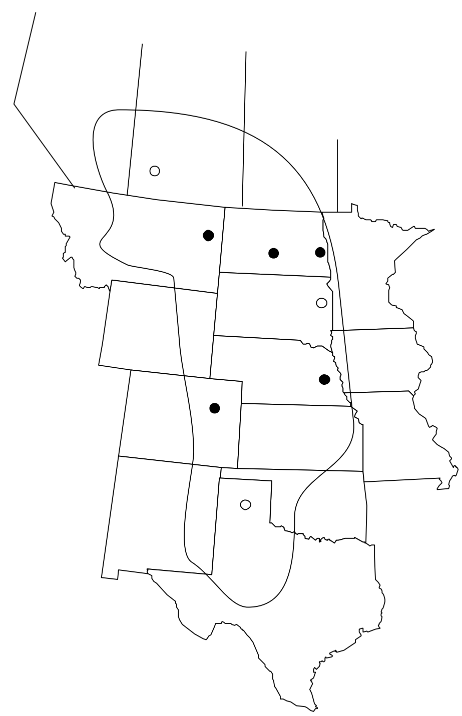

Figure1. Approximate locations of eight long-term experiments included in the study.

Table 1. Treatment descriptions for eight long-term cropping system experiments in the Great Plains.

Location/ MAP;MAT*	Treatment	Tillage	Rotation
Akron	Con	Sweep plow	WW-F
(42 cm; 9ºC)	Alt	No-till	WW-C-M
Brookings	Con	Fall chisel, spring disk	CC
(58 cm; 6ºC)	Alt	Fall chisel, spring disk	C-SB-SW/A-A
Bushland	Con	No-till	WW-SG-F
(47 cm; 13ºC)	Alt	No-till	CWW
Fargo	Con	Moldboard plow, disk, S-tine	FP-D
(54 cm; 5ºC)	Alt	No-till	FP-D
Mandan	Con	Tandem disk, chisel plow	SW-F
(43 cm; 6ºC)	Alt	No till	SW-WW-SF
Mead	Con	Tandem disk, harrow	CC
(77 cm; 11ºC)	Alt	Tandem disk, harrow	C-SB-SG-O/CL
Sidney	Con	Tandem disk	CSW
(31 cm; 9ºC)	Alt	No till	CSW-F
Swift Current	Con	Chisel plow w/sweeps	SW-F
(36 cm; 4ºC)	Alt	Chisel plow w/sweeps	SW-L

*Abbreviations: MAP=Mean annual precipitation, MAT=Mean annual temperature, Con=conventional, Alt=alternative, A=alfalfa, C=corn, CC=continuous corn, CL=clover, CSW=continuous spring wheat, CWW=continuous winter wheat, D=durum wheat, F=fallow, FP=field pea, L=lentil, M=millet, O=oats, SB= soybean, SF=sunflower, SG=sorghum, SW=spring wheat, WW=winter wheat.

RESULTS

Contrasting cropping systems had a significant effect on soil biological properties (Tables 2 and 3). Microbial biomass C and N were greater in alternative cropping systems than conventional cropping systems at all locations in the surface 7.5 cm (Table 2). Differences in microbial biomass C between cropping systems were significant ($P \leq 0.05$) at Fargo, Mandan, Mead, and Swift Current, where the alternative system averaged 182 kg ha^{-1} more biomass C than the conventional system. More ($P \leq 0.05$) microbial biomass N was observed in the alternative cropping system at Brookings, Bushland, Fargo, and Mead, with an average difference between cropping systems of 14 kg ha^{-1}. Additionally, alternative cropping systems at Bushland, Fargo, and Mead had more ($P \leq 0.05$) PMN than conventional cropping systems, though the average difference between treatments was relatively small (10.4 kg ha^{-1}) (Table 2). These results are supported by previous evaluations, where cropping systems with intensive crop sequences and/or reduced tillage possessed greater microbial biomass and PMN than cropping systems characterized by monoculture crop sequences, fallow periods, and/or significant tillage.

Table 2. Mean values of microbial biomass carbon and nitrogen and potentially mineralizable nitrogen (PMN) within conventional and alternative treatments and grass check-plots in eight long-term cropping systems experiments.

	- - - - - - - - - - - - Microbial biomass - - - - - - - - - - - -						- - - - - - PMN - - - - - -		
	kg ha^{-1}						kg ha^{-1}		
	- - - - - - Carbon - - - - - -			- - - - - Nitrogen - - - - -					
Location	Con. [‡]	Alt.	Grass	Con.	Alt.	Grass	Con.	Alt.	Grass
Akron	--[§]	177	--	29.7	31.8	--	25.1	24.9	--
Brookings	331	375	--	34.6	40.4**	--	26.3	34.3**	--
Bushland	209	331	--	26.3	37.1***	--	17.6	31.9***	--
Fargo	243	491***	*645*	42.0	62.6**	*72.1*	14.4	21.2**	*62.2*
Mandan	297	444**	*743*	30.9	49.2**	*90.6*	21.7	35.6*	*67.1*
Mead	195	324**	*812*	29.6	36.7	*100.9*	19.3	29.5***	*70.9*
Sidney	--	154	*677*	24.3	27.6	*80.6*	20.3	20.4	*88.5*
Swift Current	288	491**	--	32.8	45.2	--	23.7	45.8	--

[†] PMN = Potentially mineralizable N.

[‡] Con. = Conventional treatment; Alt. = Alternative treatment; Grass = Grass check plot (Sampling times: Fargo - peak biomass, 2000; Mandan - preplant, 2000; Mead - peak biomass, 2000; Sidney - preplant, peak biomass, and postharvest, 2001 (average of three sampling times presented)).

[§] -- = Not estimated.

*, **, *** Values between conventional and alternative treatments within a property and soil depth significantly different at $P \leq 0.1$, 0.05, and 0.01, respectively.

Unlike microbial biomass and PMN, there was no consistent trend between treatments across locations for glomalin (Table 3). Management effects on glomalin were limited to Mandan, where the alternative cropping system (annual cropping with no-tillage) possessed 27% more glomalin than the conventional cropping system (crop-fallow with conventional tillage). Four of eight locations possessed greater ($P \leq 0.05$) water stable aggregates in the alternative cropping system, with relative differences in stability between treatments ranging from 13 to 133% (Table 3).

Table 3. Means of total glomalin and water stable aggregates at 0 to 7.5 cm depth for conventional and alternative treatments in eight long-term cropping systems experiments.

	Total glomalin		Water stable aggregates	
	- - - - - - mg g^{-1} - - - - - -		- - - - - - g kg^{-1} - - - - - -	
Location	Con.[†]	Alt.	Con.[†]	Alt.
Akron	1.75	1.83	110	124
Brookings	2.61	2.58	491	495
Bushland	2.76	2.96	377***	456
Fargo	4.45	5.46	739**	832
Mandan	2.81**	3.57	218***	507
Mead	3.28	2.65	584	622
Sidney	2.67*	2.23	486***	360
Swift Current	4.72	5.12	485***	609

[†] Con. = Conventional treatment; Alt. = Alternative treatment.
*, **, *** = Difference between conventional and alternative treatments significant at $P \leq 0.1$, 0.05, and 0.01, respectively.

CONCLUSIONS

Collectively, findings from this evaluation indicate there is merit in pursuing alternative management practices to enhance biological indicators of soil quality. Specifically, management systems characterized by increased cropping intensity, greater cropping diversity, and/or reduced tillage enhanced most soil biological properties evaluated in this study. Improved status of soil biological properties can enhance nutrient cycling and residue decomposition. Systems comparisons such as this can play an important role in redefining best management practices for improving soil quality and creating more sustainable cropping systems.

Summary adapted from: Liebig, M., L. Carpenter-Boggs, J.M.-F. Johnson, S. Wright, and N. Barbour. 2003. Soil biological characteristics of contrasting cropping systems in the Great Plains: Summary of preliminary findings. p. 210-214. *In* Proc. Dynamic Cropping Systems: Principles, Processes, and Challenges. 5-7 Aug. 2003, Bismarck, ND.

MANAGEMENT STRATEGIES FOR SOIL QUALITY

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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 residue were all in the appropriate places in 1994. Treatments for the 2003 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 (cv. Parshall) was seeded on April 29 at 1.3 million viable seeds per acre. Safflower (cv. Montola 2003) was seeded on April 30 at 200,000 viable seeds per acre. Millet for hay was seeded at 4 million viable seeds per acre on June 16. Residue from previous crops was uniformly distributed at harvest. All no-till plots were sprayed with Roundup (0.375 lb ai/a) prior to seeding while minimum-till plots were tilled with an undercutter about 3 inches deep prior to seeding. Spring wheat, safflower, and millet were seeded with a JD750 no-till drill with N fertilizer banded at seeding and P applied with the seed at seeding. Recrop plots received 60 lb N/a and 10 lb P/a while fallow or partial fallow plots received 30 lb N/a and 10 lb P/a at seeding. Rye was seeded on September 29, 2003 at 1.3 million viable seeds per acre with a Haybuster 8000.

Precipitation for April through June was 123% of the 19-year average of 6.6 inches. The above-average early growing season precipitation helped to maintain close to average spring wheat grain yields (average 1800 lb/a) for wheat after fallow or partial fallow and rye total dry matter production (average 4000 lb/a) (Figure 1 and 3). Precipitation for July and August was 17% of the 19-year average of 5.41 inches and coupled with above-average July and August temperatures caused low safflower seed yield and low millet hay production (Figure 2 and 3).

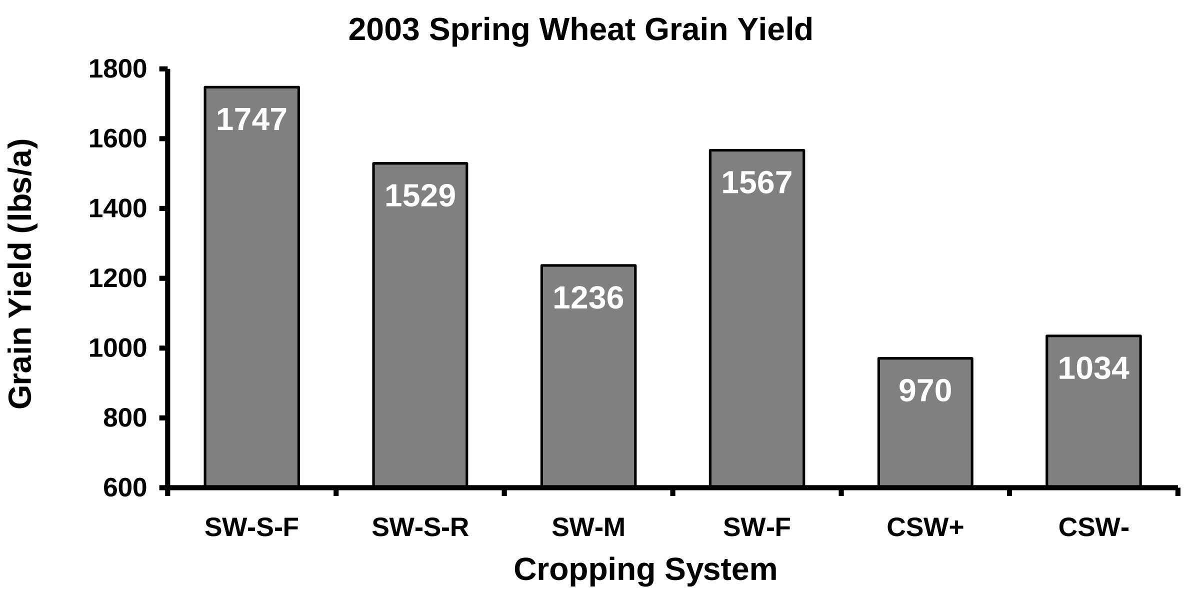

Figure 1. Spring wheat grain yield as influenced by cropping system. Yields are the average of minimum and no-till.

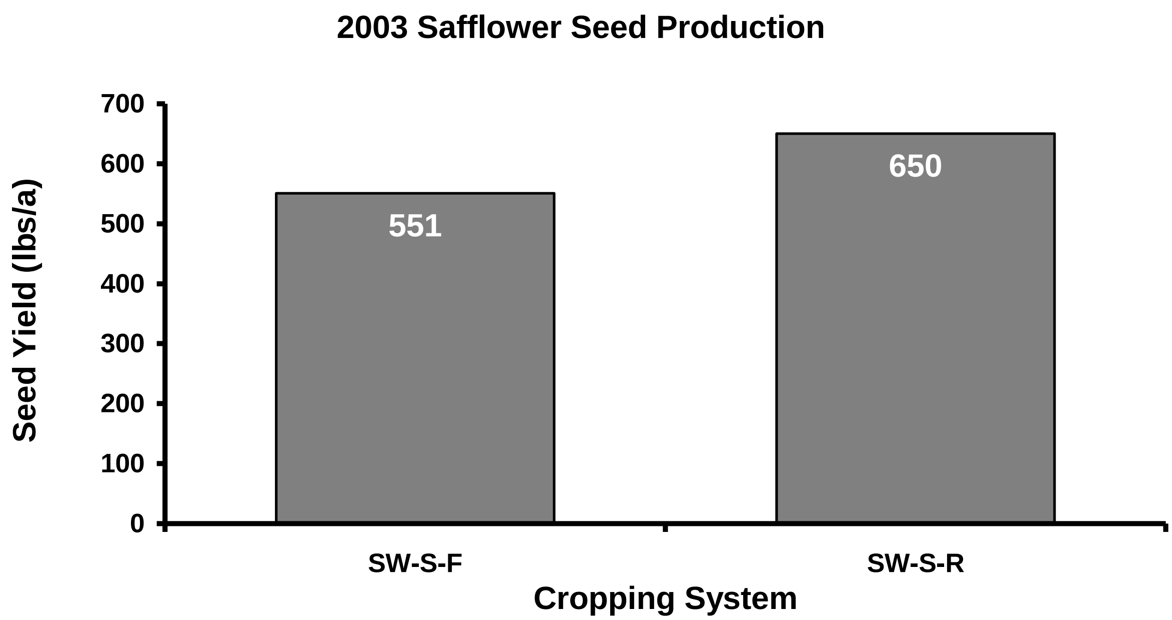

Figure 2. Safflower seed yield as influenced by cropping system. Yields are the average of minimum and no-till.

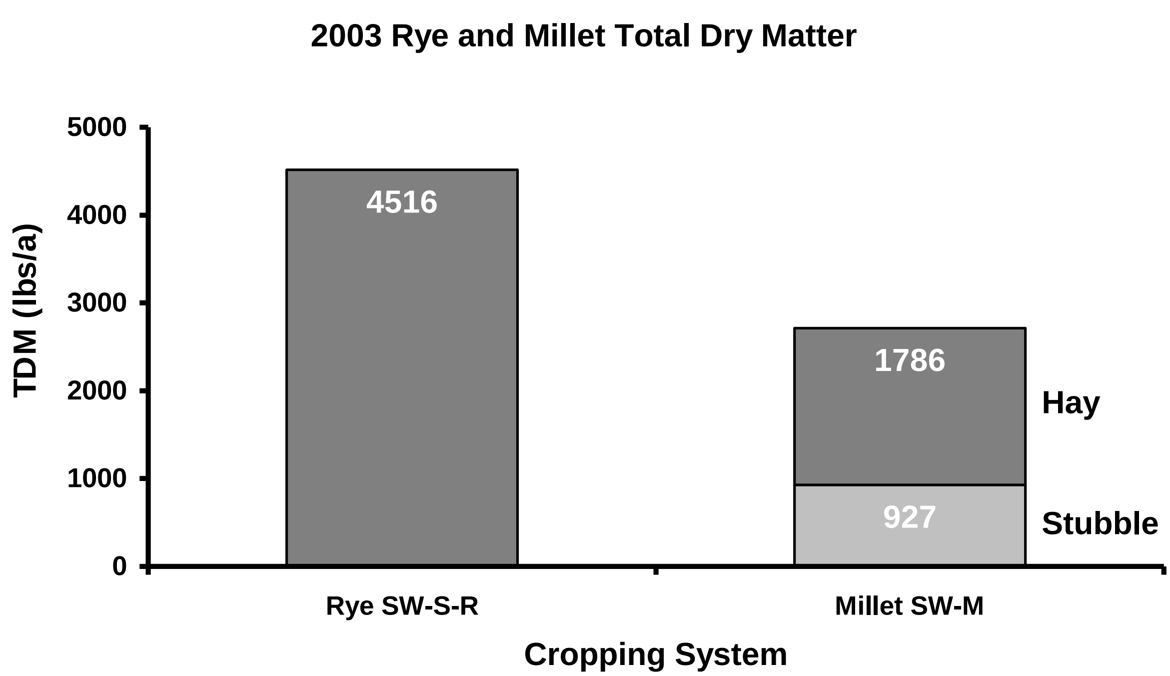

Figure 3. Total dry matter production for rye used as partial fallow and Siberian millet used for hay.

NDSU 2003 Barley Variety Trial - Continuously Cropped - No-till

Variety	Plant Height	Lodging	Test Weight	Protein	------ Grain Yield ----- 2001	2003	2 yr Avg.
	inches	0 - 9**	lbs/bu	%	------------ bu/ac ------------		
Conlon	30	2.5	50.1	13.5	104.9	42.9	73.9
Robust*	31	6.0	48.1	14.2	85.8	43.5	64.6
Stark	30	1.5	50.8	13.9	72.2	45.4	58.8
Legacy*	29	5.5	45.8	13.4		46.8	
Trial Mean	30	3.9	48.2	13.6	87.6	45.2	--
C.V. %	5.6	43.9	1.3	2.3	5.9	11.7	--
LSD .05	NS	2.6	1.0	0.5	11.8	NS	--
LSD .01	NS	3.7	1.3	0.7	19.6	NS	--

**Lodging: 0 = none, 9 = lying flat on ground.
Planting Date: April 23, 2003
Harvest Date: August 11, 2003
Seeding rate: 750,000 live seeds/A (approx. 1.4 bu/A).
Previous Crop: 1999 = rye, 2002 = barley.
NS = no statistical difference between varieties.
* 6 row type.

NDSU 2003 Durum Variety Trial - Continuously Cropped - No-till

Variety	Plant Height	Test Weight	Protein	-------- Grain Yield --------			Average Yield	
				2001	2002	2003	2 year	
	inches	lbs/bu	%	------------------------ bu/ac ------------------				
Mountrail	33	57.9	16.3	66.1	50.3	42.4	46.4	52.9
Ben	36	60.3	16.4	62.0	42.8	44.9	44.4	50.2
Lebsock	33	60.9	15.9	66.4	43.1	40.4	41.8	50.0
Maier	33	59.8	16.9	63.5	37.3	39.4	38.4	46.7
Pierce	35	60.0	16.1		43.4	42.2	42.8	
Dilse	33	59.3	17.1			40.4		
Trial Mean	34	59.7	16.4	61.3	43.4	41.7	--	--
C.V. %	3.9	0.8	2.7	14.4	6.9	2.8	--	--
LSD .05	2	0.7	0.7	NS	5.4	1.7	--	--
LSD .01	NS	0.9	0.9	NS	7.7	2.4	--	--

Planting Date: April 23, 2003
Harvest Date: August 11, 2003
Seeding rate: 1.25 million live seeds/A (approx. 2.2 bu/A).
Previous Crop: 1999 = rye, 2000 & 2002 = barley.
NS = no statistical difference between varieties.

NDSU 2003 Hard Red Spring Wheat - Continuously Cropped - No-till

Variety	Plant Height	Lodging	Test Weight	Protein	2000	2001	2003	Average Yield 2 year	Average Yield 3 year
					-------- Grain Yield --------				
	inches	0 - 9*	lbs/bu	%	----------------------bu/ac----------------				
Oxen	30	0.0	58.6	15.6	59.1	45.0	45.8	45.4	50.0
Reeder	31	0.0	55.8	15.7	60.3	48.6	40.7	44.6	49.9
Parshall	36	0.5	59.7	16.1	54.1	45.6	40.5	43.0	46.7
Alsen	30	0.0	59.3	15.9	50.2	42.9	38.0	40.4	43.7
Keene	36	0.0	59.7	15.8	48.6	40.6	39.2	39.9	42.8
Mercury	27	0.0	57.8	15.7		52.3	42.3	47.3	
Briggs	31	2.5	59.8	15.7			40.8		
Dapps	35	0.0	58.2	16.1			37.5		
Trial Mean	32	0.4	58.7	15.8	52.7	45.9	40.5	--	--
C.V. %	5.1	116	1.4	3.7	9.5	8.3	7.3	--	--
LSD .05	2	1.2	1.2	NS	7.2	6.4	4.3	--	--
LSD .01	3	1.7	1.7	NS	9.6	8.7	NS	--	--

*Lodging: 0 = none, 9 = lying flat on ground.
Planting Date: April 23, 2003
Harvest Date: August 11, 2003
Seeding rate: 1.1 million live seeds/A (approx. 1.6 bu/A).
Previous Crop: 1999 = rye, 2000 & 2002 = barley.
NS = no statistical difference between varieties.

PREDICTING CROP YIELD WITH REMOTE SENSING

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INTRODUCTION

Site-Specific farming work is continuing on the I Fields of the Area IV farm. This is being done in cooperation with USDA-ARS and the NDSU Extension Service.

Remote sensing is becoming of interest to producers. Growers are becoming interested in determining the relationship of a number of items that affect crop yield. Some parameters include the NDVI values of satellite images and aerial photos taken during the growing season and how they relate to yield. Other things include the relationship of soil type and field topography to crop yield.

Figure 1and 2 show the yield map of the I4 field and the Landsat 7 photo taken during June of 2002. The 2002 sunflower field was chosen as it produced a good yield and a good satellite image was available. It produced over 2100 lb./ac. of sunflower seed even though it was a dry year. Figure 3 shows the correlation of the Normalized Difference Vegetative Index (NDVI) for the field to crop yield. It shows an R^2 of 0.4. This is a relatively low correlation to yield but could be considered reasonable as the satellite photo was taken in mid June. At this stage of growth, sunflower plants are not fully developed and a significant amount of bare soil is showing through the plant canopy. Also, the NDVI has a resolution of 30 meters which causes reduced accuracy.

Some aerial photos of the I fields were taken of the crops this past season. We are working to determine a correlation of these photos to crop yield. This has not been completed at this time. Work is also continuing to determine a correlation of satellite images to yield. This work will continue into the next growing season.

This past growing season produced slightly below normal crop yields due to below normal rainfall. The I4 field received less fertilizer (N) due to an application error and produced only 26 bu./ac. The I5 field produced 36 bu./ac. of winter wheat and the I6 field produced slightly less than 1500 lb./ac. of sunflower. Crop inputs are shown in the management practices section in the front of this manual

Previous years work has shown:

1. Variable rate fertilizer application helps improve the environment as only the amount of fertilizer is added to the field for a projected yield. Residual fertilizer is subtracted from the amount needed. This reduces the amount of residual N remaining in the soil that may move through the soil profile and cause possible contamination of underground water supplies.
2. Sunflower is an excellent crop in a rotation to retrieve N that may remain in the soil from a previous crop. Sunflower has a tap root that is able to go below small grain rooting zones down to 3-5 ft.
3. Soil sampling based on topographic zones is able to provide residual fertilizer values similar to intensive grid sampling at a much cheaper cost.
4. Aerial photography is beginning to provide information that can be helpful in identifying areas of pest infestation such as disease and insects. This can be helpful in stepping up pest treatment before major damage occurs. They can also be helpful in predicting crop yield.

Figure 1. I 4 Field Yield

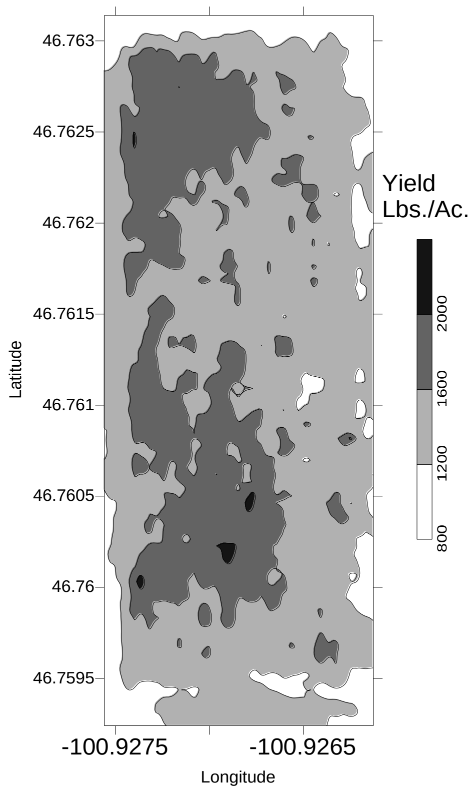


Figure 2. NDVI Field I4 2002 Satellite Image

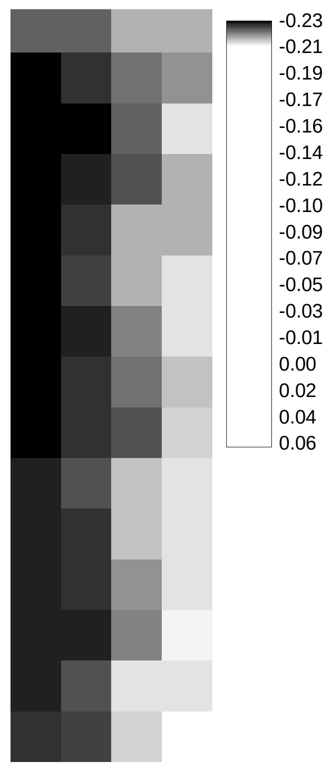
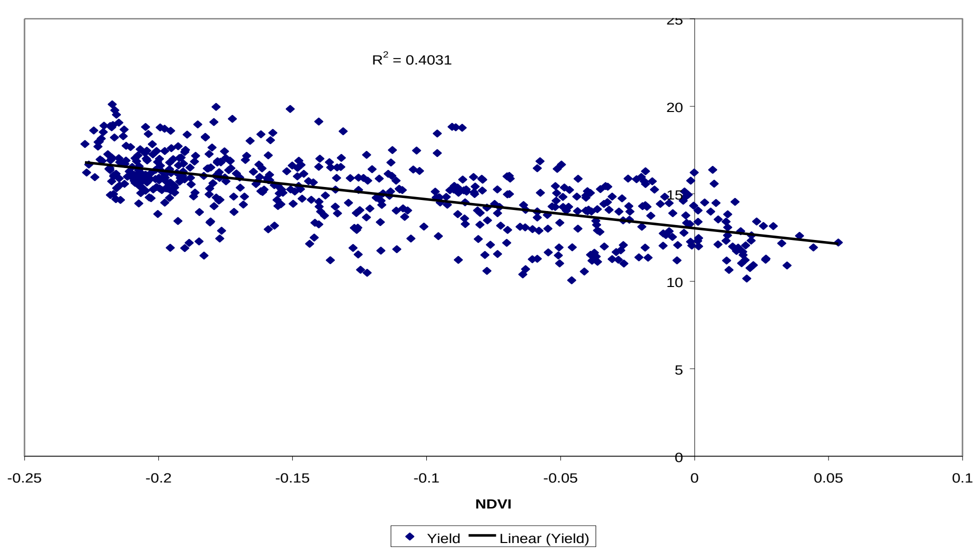


Figure 3. Correlation of NDVI vs Yield

Yield
Cwt./ac.



GLOMALIN – HOW DOES SCUM HOLD YOUR FARM TOGETHER?

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WHAT MAKES GOOD QUALITY SOIL?

Soil quality is "the capacity of a specific kind of soil to function." Basic soil functions are maintaining productivity, regulating and partitioning water and solutes, filtering and buffering against pollutants, and storing and cycling nutrients. Both soil structure and soil fertility contribute to soil quality.

Soil structure is the shape that the soil takes based on its physical and chemical properties. Structure creates pores that allow air and water to move freely through the soil and impacts root growth and penetration. Soil aggregates (clumps of soil particles and debris) and texture (amounts of sand, silt and clay) are components of soil structure.

Soil fertility is the soil's nutrient supplying capacity. The soil environment is complex and its consistency or make-up influences plant growth. Soil is home to a number of organisms that convert nutrients into plant available forms by processes like decomposition and fixation. Organisms, such as arbuscular mycorrhizal (AM) fungi, deliver nutrients to plants in exchange for carbon compounds that the plant produces by photosynthesis.

Arbuscular mycorrhizal fungi form a mutually beneficial relationship with most plants (about 80%). Fungal hyphae (thread-like projections) grow out beyond the depletion zones (areas where roots have removed all the available nutrients) surrounding roots to access more nutrients in the soil, especially immobile nutrients like P (Figure 1). Hyphae are much finer than plant roots and therefore have a greater surface area to volume ratio for more efficient uptake. This is the same reason that roots form fine roots and root hairs to contact more soil.

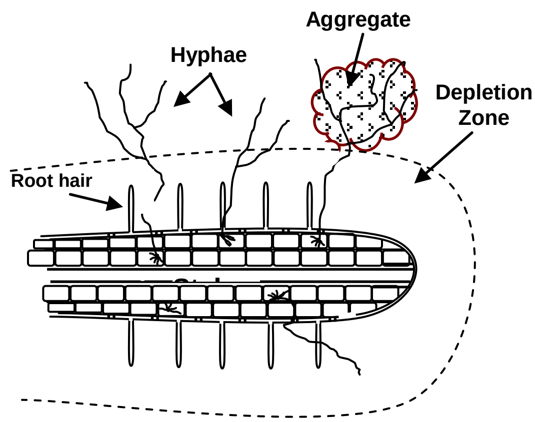

Figure 1. Hyphae of AM fungi may grow several cm beyond nutrient depletion zones found around roots and root hairs to obtain more nutrients than roots alone can uptake.

Mycorrhizal fungi contribute both directly and indirectly to soil structure and soil fertility. Soil structure is improved directly by fungal hyphae actively growing through soil and indirectly by providing a framework or net to capture soil particles and debris to form aggregates. Soil fertility is enhanced directly by efficiently absorbing the maximum amount nutrients available and indirectly by forming and stabilizing soil aggregates.

SOIL AGGREGATION – WHAT IS IT AND WHY DOES IT MATTER?

Soil aggregation is the formation of a conglomeration of sand, silt, clay, organic matter (such as plant debris and microbial byproducts), and inorganic compounds (such as Fe or Al oxides). These constituents are entrapped by root and hyphal 'nets' and are bound together by chemical or physical interactions. Within this conglomeration, a number of microbial communities are actively growing in microenvironments that may or may not contain oxygen and may be very moist to very dry. These communities are transforming organic and inorganic material into plant available nutrients.

Aggregates are important for: (1) increasing stability against wind and water erosion, (2) maintaining soil porosity, which provides aeration and water infiltration rates favorable for plant and microbial growth, (3) improving soil fertility by holding nutrients in protected microsites near plant roots, and (4) storing C by protecting organic matter from microbial decomposition. Nutrient contents (C, N, S, P) are generally higher within aggregates than in the surrounding soil. Soil aggregates influence the interaction of enzymes with their substrates, or protect organic matter, proteins, etc. from decomposition. This reduces organic matter turnover (increasing organic matter concentration and potential C sequestration) and promotes the release of plant-available nutrients (from decomposition) over a longer period of time (acting like a time release fertilizer pellet).

As stated above, AM hyphae provide a hyphal 'net' to collect soil particles and organic debris and assist in aggregate formation. Microscopic examination revealed a substance on AM hyphae that appeared to help material adhere to hyphae. In the early 1990's, this material was extracted, quantified and labeled **glomalin** (Figure 2). Glomalin, not only helps material stick to hyphae to bind

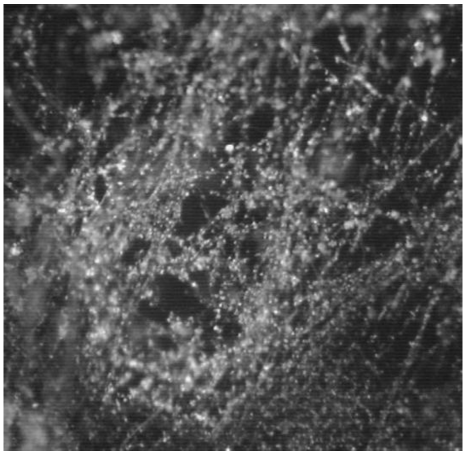

Figure 2. Mats of AM hyphae coated with glomalin. Hyphae will physically entrap soil particles and organic matter, while glomalin will help these materials bind to hyphae. Following a laboratory procedure, bright spots indicate the location of glomalin.

Aggregates together, but also appears to contribute to the stability of aggregates.

Aggregates that are water-stable are not easily disrupted and will persist in the soil for long periods of time.

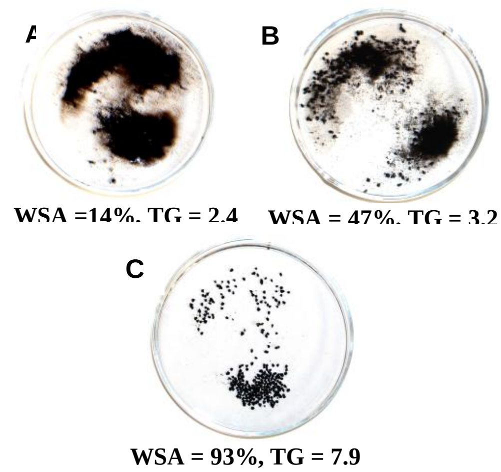

Figure 3. After the addition of water, dry-sieved soil aggregates (1-2 mm) will burst if they are not stabilized. A conventional till, spring wheat (SW)-summer fallow system (A) had a lower percentage of water-stable aggregates (WSA) and concentration of glomalin (TG) (mg g^{-1} soil) than a no-till SW-winter wheat-safflower (B) and a never tilled, moderately grazed pasture (C).

When aggregates are exposed to water, such as during a rainfall event, water will move into the pore spaces within aggregates. When aggregates are not stabilized (i.e. do not have a protective coating), water will rush into the pores. Because water diffuse more rapidly than air, the air will be trapped, air pressure will build, and the aggregate will burst. In managed systems, the amount of water-stable aggregates (percentage WSA) is related to the amount of glomalin (TG) and the intensity of management (Figure 3).

Figure 4. A plug of soil under switchgrass breeding research plots in Mandan was submerged in water triggering the formation of glomalin scum on the water surface.

HOW DOES GLOMALIN DO THAT?

Glomalin is water-insoluble, except under the high heat (121°C) used for extraction. When released from hyphae, glomalin will aggregate together to form a scum on the surface of water. In the soil, this may happen in pore spaces where there is an air-water interface. When soil is submerged in water, this scum will form (Figure 4). Using agitation or a stream of water may cause the scum to form bubbles. This is similar to what may be seen with dish soap – running water creates bubbles but if it sits for a while you will see soap scum on the surface of the water. This scum will attach to any nearby surface, especially aggregates that are formed around AM hyphae. A water-insoluble barrier (hydrophobic lattice) is then formed on the aggregate, which will only allow water to seep in slowly and will prevent aggregates from bursting. The more glomalin, the more water-insoluble the aggregates become. Glomalin-coated aggregates will float on the surface of water along the wetting front until enough water slowly fills the pores and the aggregates sink. (Figure 5).

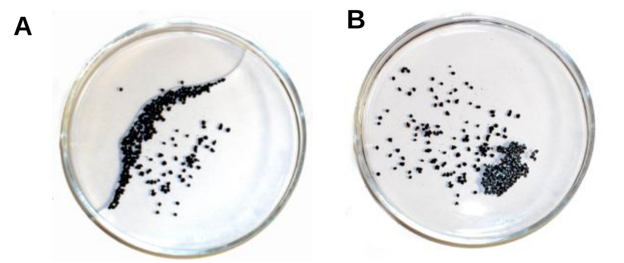

Figure 5. Glomalin provides an insoluble coating to soil aggregates. In a never tilled, moderately grazed pasture, this coating completely encases aggregates allowing many of them to float on the surface water

GLOMALIN AT NGPRL

Glomalin concentrations and percentage WSA have been measured at NGPRL in a three year study comparing a conventional tilled SW-summer fallow (CON) system to a no-till SW-winter wheat-safflower (ALT) system. For 1 to 2 mm aggregates, both aggregate stability and glomalin concentration were higher in the ALT system compared to the CON system at all three depths sampled: 0 to 7.5 cm, 7.5 to 15 cm, and 15 to 30 cm (Figure 6). The same trends also were seen in 0.5 to 1 mm aggregates. This study demonstrates the positive relationship between glomalin and WSA increases with reduced tillage and continuous cropping.

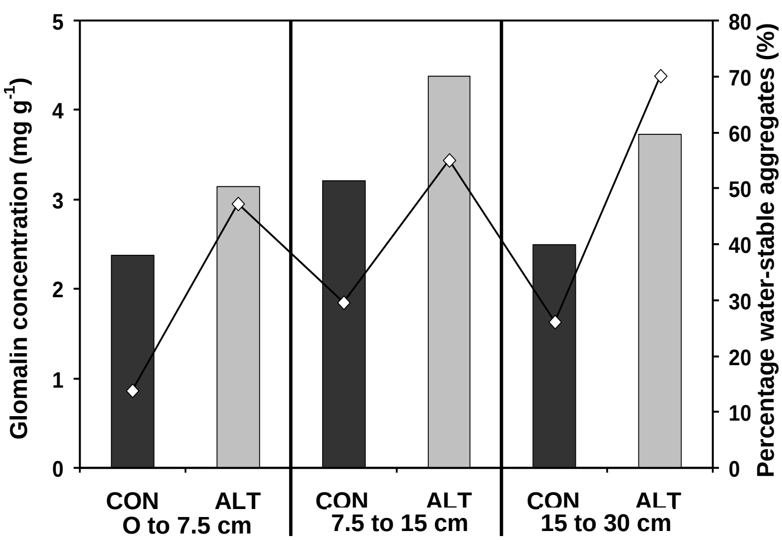

Figure 6. Glomalin concentration (bars) and percentage water-stable aggregates (line) in 1 to 2 mm aggregates collected at three depths (0 to 7.5 cm, 7.5 to 15 cm, and 15 to 30 cm) in conventional till spring wheat - fallow (CON) and no-till spring wheat – winter wheat – safflower (ALT) cropping systems.

Glomalin research is currently in its infancy stage. Projects are planned to measure glomalin and WSA in both cropping and grazing systems. The affects of tillage, crop sequence (including the use of a non-mycorrhizal host like canola or crambie), and grazing pressures will be analyzed. There has been relatively little research on AM fungi in grazing systems. With glomalin added as an additional research component, this work will have a major impact on producers.

Glomalin and AM fungal hyphae are major fractions of soil organic carbon. In addition, most of the plants in grasslands are strongly associated with AM fungi. Another area of research will be on bioenergy crops, primarily switchgrass. The potential for AM fungi to increase switchgrass (and other herbaceous plants) biomass for bioenergy production and for glomalin and fungal hyphae to sequester carbon below-ground will be examined.

GLOSSARY OF IMPORTANT TERMS AND CONCEPTS

Arbuscular Mycorrhizal (AM) Fungi – (literally means 'tree-shaped fungus root' fungi) A group of fungi that form a mutually beneficial relationship with most plants (about 80%) where fungal hyphae extends into the soil often in a finely-branched, tree-shaped network to contact more soil and uptake nutrients, especially highly immobile nutrients, that are delivered to the plant at a tree-shaped network of hyphae (arbuscule) within the plant root cell in exchange for sugars that the plant produces by photosynthesis.

Decomposition – The act of breaking down a substance into smaller parts. Microbial decomposition breaks down organic matter into plant-available nutrients or converts organic matter into inorganic substances.

Depletion zone – An area in which plant-available nutrients have been removed.

Glomalin – A glycoproteinaceous compound (or sugar protein) found on the surface of hyphae from AM fungi that potentially protects hyphae from solute loss, helps substances adhere to fungal hyphae, and binds together and protects soil aggregates.

Hydrophobic – Water-hating or water-insoluble.

Hyphae – Thread-like filaments that form the body of fungi. They are thinner than roots with lengths >100 m (300 ft) in 1 g (0.002 lb). In AM fungi, these filaments will grow out of roots into the soil and will act like a conduit or pipeline for nutrients acquired in the soil several inches from the plant root back to the root.

Hyphal 'net' – Multiple branches in strands of hyphae can form a structure that will act like a net to collect organic matter, soil particles, and debris to begin forming a soil aggregate.

Microbial – Having to do with an organism that can only be seen under a microscope.

Micro-environment – The environment or conditions experienced by an individual organism or a community of microorganisms.

Micro-site – The area within a micro-environment.

Nutrient – A substance that provides nourishment, in this case for plant growth including macronutrients such as N, P, K, S and Ca and micronutrients such as Fe, B, Mn, Mo, Ca, Cu, and Zn.

Nutrient availability – In order for nutrients to be used by the plant, they need to be in a plant-available (or inorganic) form. In the soil, inorganic nutrients come from the weathering of soil minerals and from the decomposition of organic matter.

Scum – The fraction of glomalin that is not attached to hyphae or soil aggregates. Glomalin is hydro-phobic and will self-aggregate to form a scum, similar to soap scum, on the surface of water.

Soil aggregate – A conglomeration of soil particles (sand, silt, and clay), organic matter, roots and fungal hyphae bound together by chemical and physical processes.

Soil fertility – The nutrient capacity of soil or ability of soil to provide nourishment for plant and microbial growth.

Soil quality – The capacity of soil to function or maintain productivity.

Soil structure – The manner in which soil components – sand, silt, clay, organic matter, etc. – are arranged or organized.

WIND EROSION IN SUNFLOWER STUBBLE LAND AS AFFECTED BY TILLAGE AND FALLOWING

S.D. Merrill and D.L Tanaka

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A number of the diverse crops now being grown in our area provide lower soil residue coverage than do small grain crops. Sunflower is one of these crops, and we had the objective of determining the effects of different tillage managements and chemical fallowing on wind erosion in sunflower stubble land through direct measurement. We have been fortunate to have the cooperation of Drs. Ted Zobeck and John Stout of the USDA-ARS Lubbock TX location and of Dr. Larry Hagen of the USDA-ARS Manhattan KS location, who have provided us with expertise and special instrumentation. We have set up an experiment in sunflower stubble at the Research Farm with three tillage treatments: no-till; med-till, defined as a single pass with a tandem disk; and max-till, defined as two passes with an offset disk followed by two passes with a Multchmaster, which gives smoothing action. Tillage was applied in early April 2003. A preplant tillage phase of the experiment lasted until the end of May, at which time the no-till sunflower stubble, which had been partially erect, was mowed to simulate a downed stubble condition. Multiple applications of glyphosate were made during this chemical fallow phase of the experiment, which was ended in mid-September with the seeding of winter wheat. Six approximately square 3.7 acre plots (3 treatments, 2 replications) in an east-west row were instrumented with dustcatcher devices, which capture wind erosion sediments within about 3 inches of the soil surface, and piezoelectric moving particle sensors, which indicate the timing of wind erosion events.

Preliminary results obtained with the dustcatcher devices are presented here. In Fig. A, soil loss from max-till was over 30-times greater than loss from no-till during a non-rain-affected storm period in May, showing the soil-protective power of no-till. Loss from max-till was only a fraction of a ton/acre, which indicates moderating influence of residual random roughness persisting after tillage. During a rain-affected storm, the relatively low losses under no-till and med-till were greatly increased, a result that is believed to be due to wind-driven rain-induced splash erosion. Soil losses measured for the three top windstorms in the chemical fallow period are shown in Fig. B. The relatively large soil losses observed for the max-till treatment were indications of the progressively deteriorating condition of the soil surface in this treatment. Almost all tillage roughness was absent, and the surface soil was in a weak, partially disaggregated state. Soil losses for the no-till treatment were relatively low compared to those for the two tilled treatments for the second- and third-ranked storms, indicating the protective power of no-till. However, the top windstorm was powered by windspeeds that exceeded approximately 60 mph, and our results indicate that significant erosion was occurring even in the no-till treatment. Soil loss in the max-till treatment for this top windstorm was approximately 2 tons/acre, an amount that was roughly equal to all other soil losses from max-till measured during the chem-fallow period.

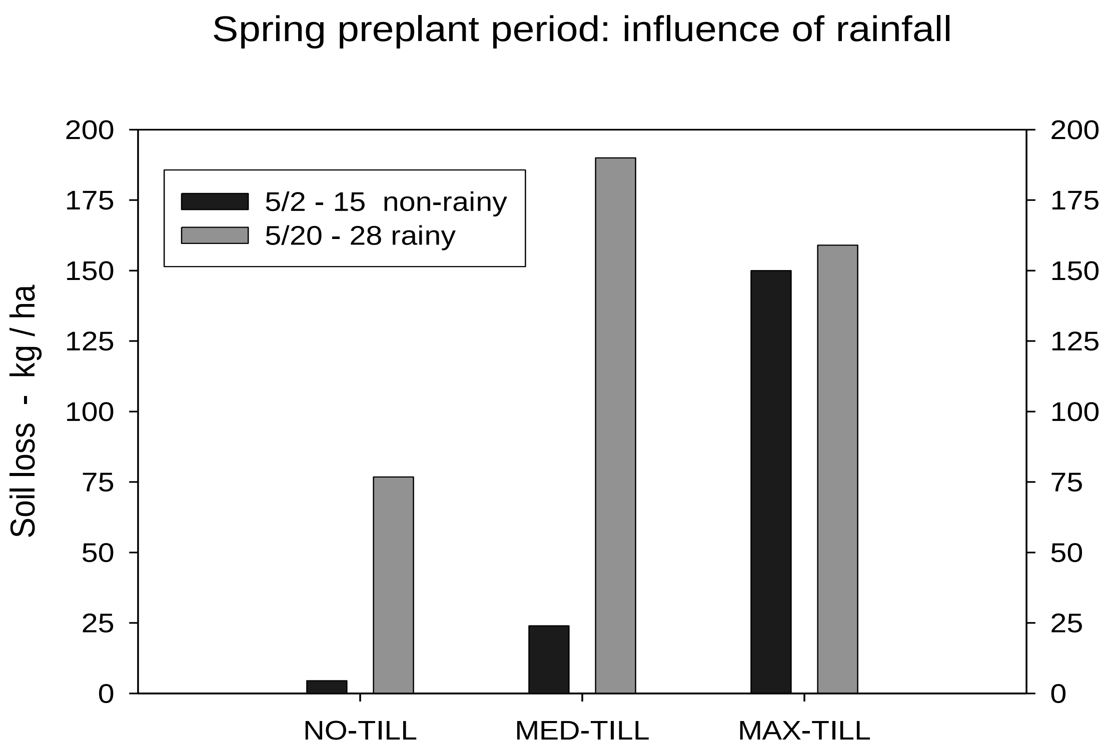

Figure A. Wind erosion sediments expressed as loss measured in tillage treatments during two storm periods in the preplant period following tillage in early April.

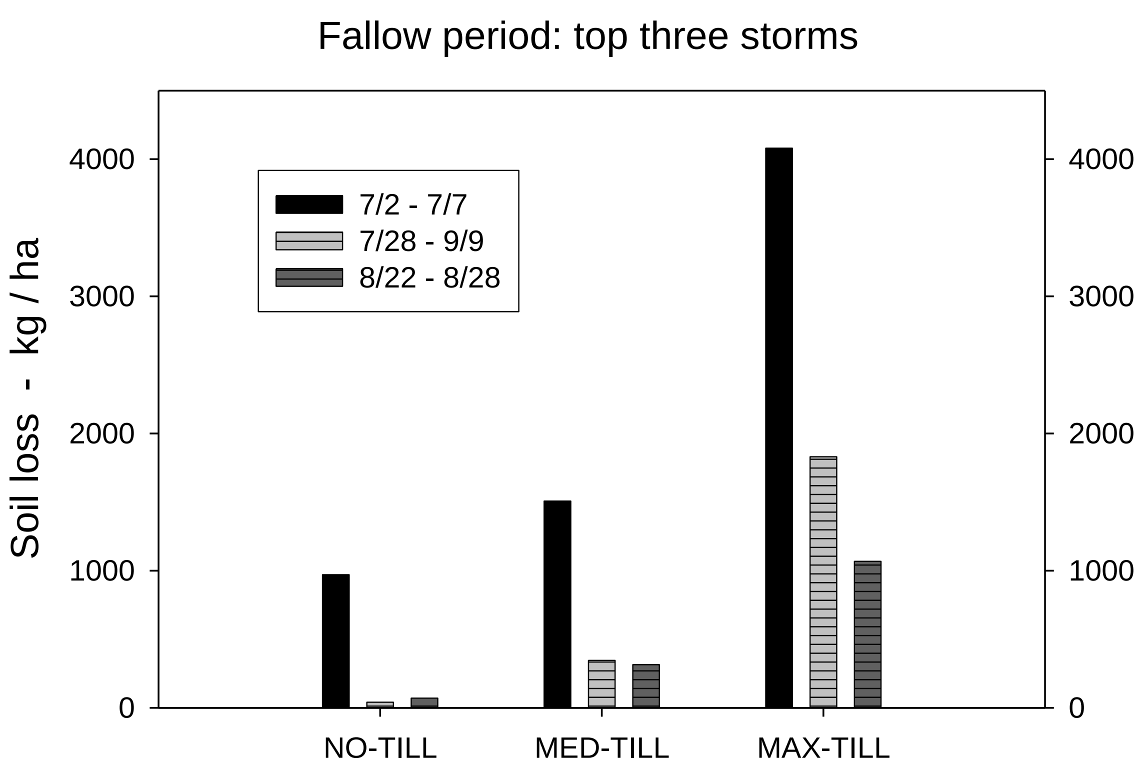

Figure B. Wind erosion sediments expressed as loss measured in the tillage treatments during the three top storms of the chemical fallow period of the experiment.

SOIL WATER DEPLETION IN THE PHASE 3 CROP SEQUENCE EXPERIMENT

S.D. Merrill, D.L. Tanaka, and J.M. Krupinsky

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Measurement of the comparative water use by various crops is an important part of our crop sequence experiments. Water use is defined as soil water depletion over the soil profile during the cropping season plus the precipitation received during the same time interval. When comparing crops, water use must be defined over the same part of the year, and thus precipitation is the same for all crops, and differences are observed as differences in soil water depletion (SWD). Our Phase 3 crop sequence experiment consisted of 10 largely warm season crops. We have measured soil water with the non-destructive neutron moisture meter method, and take readings in steel access tubes at foot increments over the soil profile. The measurements shown in the table were taken in crops that followed spring wheat. In 2002, SWD was calculated between May 13 and Sept. 24, and in 2003, SWD was calculated between May 29 and Oct. 1.

Results shown in the table indicate that sunflower had the highest SWD (and hence, the highest water use) followed by corn. Dry pea had the lowest depletion followed by lentil. During the Phase 2 crop sequence experiment (in crop matrix from 1998 to 2000) , which included mostly cool season species, sunflower was also observed to have the highest water use and SWD, and dry pea to have the lowest water use and SWD. In 2002, sunflower depleted 4.3 inches more soil water than dry pea, and in 2003, sunflower depleted 2.0 inches more soil water than dry pea. Differences of this size are known to carry over to the following spring, and if water is critically limiting, it is well known that there can be effects on the following crop. Depth of root growth and length of active grown season are two factors known to affect SWD and water use. Both sunflower and corn have greater depths of root growth and longer active growth seasons compared to the relatively more shallow-rooted dry pea and lentil crops.

	Soil Water Depletion over 6 ft. depth			
Crop	2002	2003	Avg.	Rank
	- - - - - - - - - - - inches - - - - - - - - - -			
Buckwheat	5.15	6.01	5.58	8
Canola	7.47	5.27	6.37	3
Chickpea	5.46	5.87	5.67	7
Corn	7.04	7.21	7.13	2
Dry pea	4.11	5.65	4.88	10
Grain sorghum	6.05	6.34	6.20	4
Lentil	4.34	6.30	5.32	9
Proso millet	5.25	6.24	5.75	6
Spring wheat	5.02	7.08	6.05	5
Sunflower	8.36	7.64	8.00	1

Table 1. Soil Depletion over 6 Foot Depth

DIFFERENCES IN SOIL WATER DEPLETION AND WATER USE AMONG ALTERNATIVE CROPS

S.D. Merrill, D.L. Tanaka, and J.M. Krupinsky

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A scientific journal paper was recently submitted to the Journal of Soil and Water Conservation. This paper summarizes some of the principle findings of research on the water use and soil water depletion of the diverse crops grown in our Phase II and Phase III crop sequence experiments. This report will cover some of the principal parts of this paper.

Soil water content was measured with a neutron moisture meter positioned in steel access tubes at 1 ft. depth increments. Water content was used to calculate seasonal (about mid-May to mid-September) soil water depletion (SWD) and water use (= SWD + seasonal precipitation, assuming no runoff/runon water or deep drainage). Data shown here were taken over a soil profile depth of 6 ft. in crop sequences consisting of spring wheat followed by an alternative crop. Among the three years for which data are shown here, seasonal precipitation in 1999 was considerably above average that in 2000 was near average, while 1999 precipitation was significantly below average.

Because water use depends on seasonal precipitation, using soil water depletion (SWD) is clearer and more effective for comparing the water use of diverse crop species, especially when multiple years are being studied. It is important that the time period of soil water measurement used for calculation of water use parameters be the same across crop species. SWD was larger in 2000, which was drier, than in wetter 1999 (see Fig. A). Over the two years, sunflower had the highest SWD, followed by safflower and soybean. Dry pea had the lowest average SWD, followed by barley, crambe, and spring wheat, in order of increasing SWD. A useful comparative measure of soil water use is *differential water depletion* (DWD; see Table A). DWD is defined as the difference between a crop's SWD in a given year and the average SWD of crops that year. Calculation of DWD helps to focus on differences among the crops and lessens the effects of differences in precipitation among the years. Among four crops common to both Phase II and Phase III crop sequence experiments, the SWD component of water use was much greater in 2002, a year of significantly lower than average precipitation, compared to wetter than average 1999, while the SWD component in 2000 was intermediate in size (see Fig. B).

It is known that there is a relationship between rooting depth and the soil depths at which crops deplete soil water over the season. During the wetter-than-average year 1999, there was not much difference in the depth distribution of soil water depletion (SWD) among 4 crops (see Fig. C). There was more difference in the average precipitation year 2000, and in drier-than-average 2002, a much greater part of sunflower's SWD came from the lower part of the soil profile compared to dry pea or spring wheat. For producers in a dryland agricultural area, the comparative water use of crops has its greatest impact in the spring in the form of different amounts of soil water left in the ground at seeding time. Our measurements in April 2001 (see Table B) indicate that there were 3.4 inches more soil water in the soil following dry pea compared to land on which sunflower had been grown. In April 2003, there were 4.2 inches more soil water following dry pea than following sunflower. If water becomes critically limiting, these differences can have considerable impact.

Table A. Differential water depletion: a way to define soil water depletion by crops so that the effects of wet years and dry years are substantially overcome.

	Differential water depletion		
	1999	2000	2002
	- - - - - - - - - - - - - - - inches - - - - - - - - - - - - - - - -		
Safflower	0.85	2.48	
Sunflower	1.35	2.98	2.12
Spring wheat	-0.71	-0.64	-1.22
Barley	-1.17	-1.44	
Flax	0.93	-0.77	
Crambe	-0.77	-1.43	
Canola	0.61	-0.98	1.23
Soybean	0.72	0.91	
Dry pea	-1.37	-1.41	-2.13
Dry bean	-0.43	0.33	

Table B. The producer's bottom line: soil water left the spring after. Soil water measured to profile depth of 6 ft. in April of 2001 and 2003 and differences from spring wheat.

Crop grown in previous year	Soil water (inches) per 6 ft. of soil profile		Less (-) or more (+) soil water (inches) than spring wheat	
	April 2001	April 2003	April 2001	April 2003
Sunflower	20.1	15.1	-2.0	-2.8
Canola	22.2	16.2	+0.1	-1.6
Spring wheat	22.0	17.9	0	0
Dry pea	23.5	19.3	+1.4	+1.4

Figure A. Soil water depletion to depth of 6 ft. for alternative crops growing after small grain crops in the Phase II crop sequence experiment.

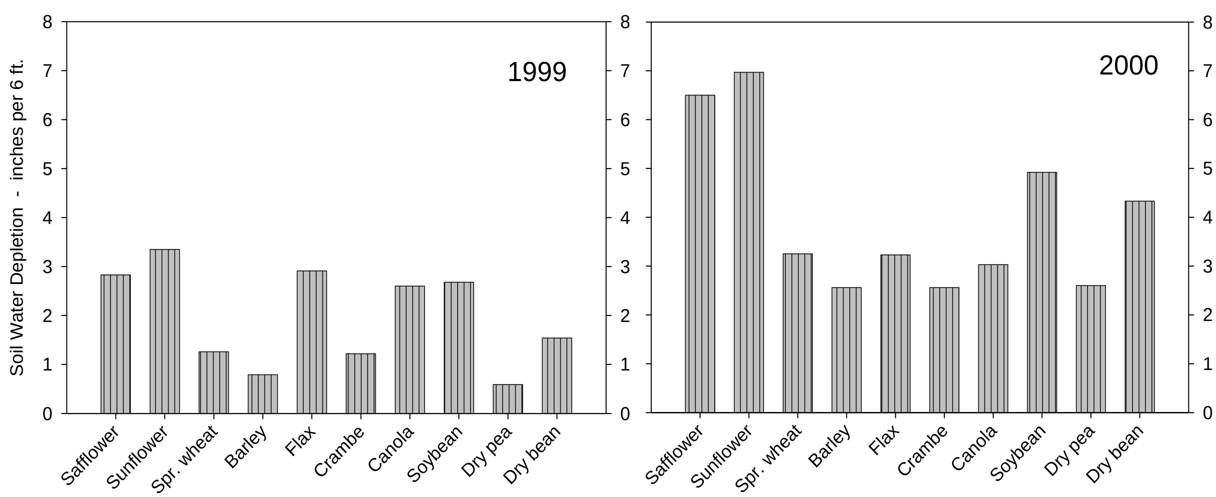


Figure B. Seasonal precipitation and soil water depletion components of water use for four alternative crops over three years. These four crops were common to both Phase II and Phase III crop sequence experiments

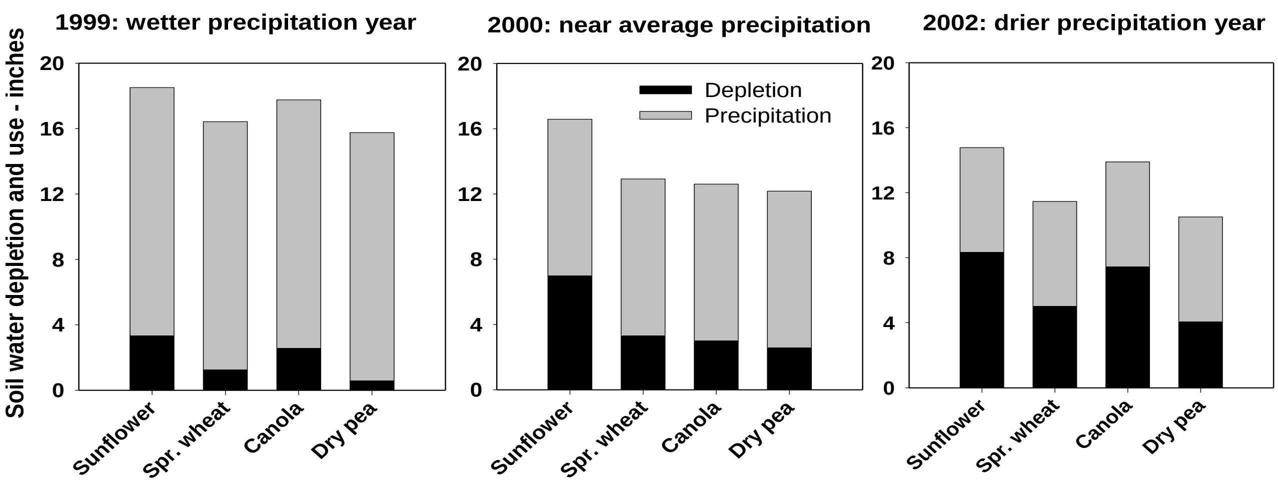
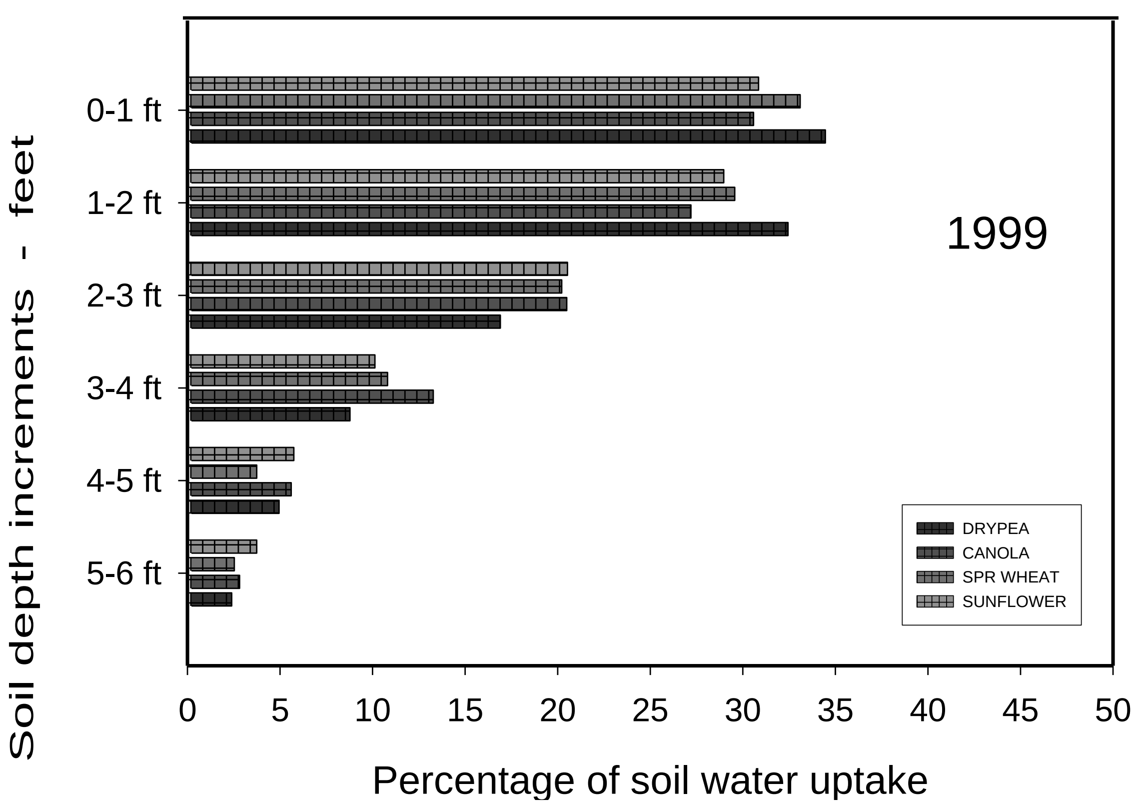
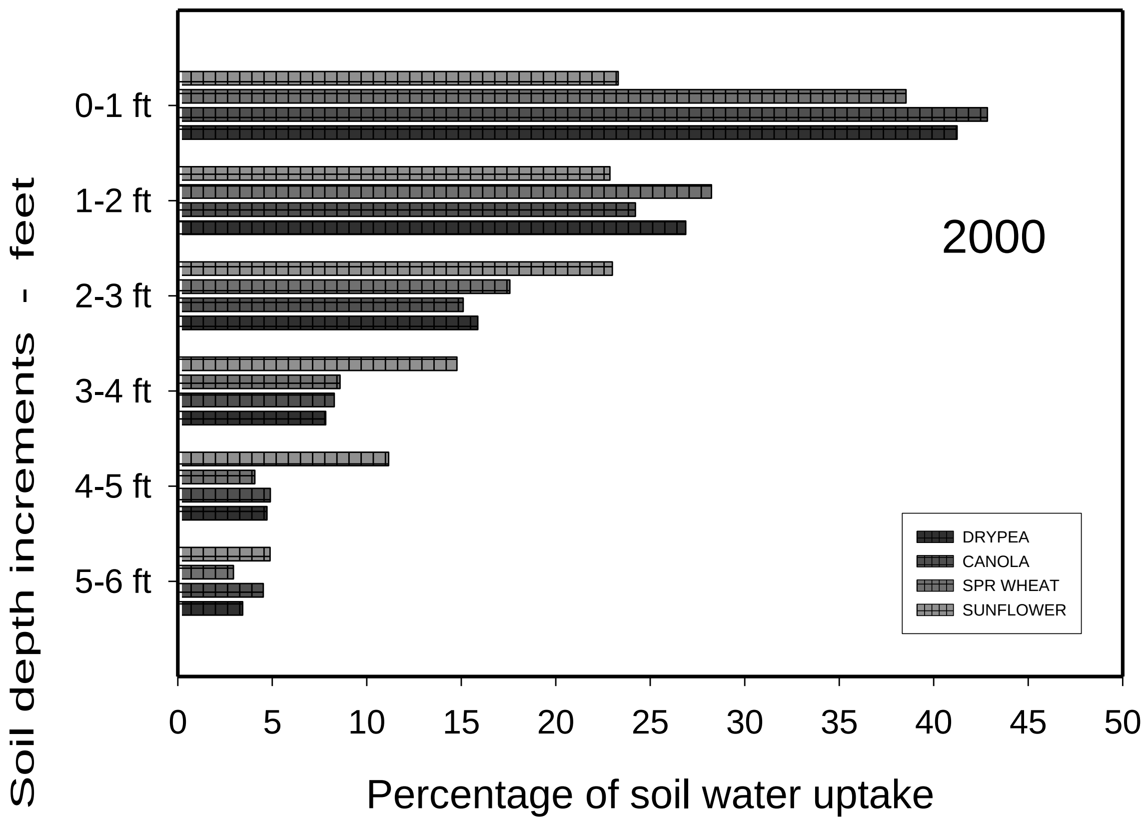
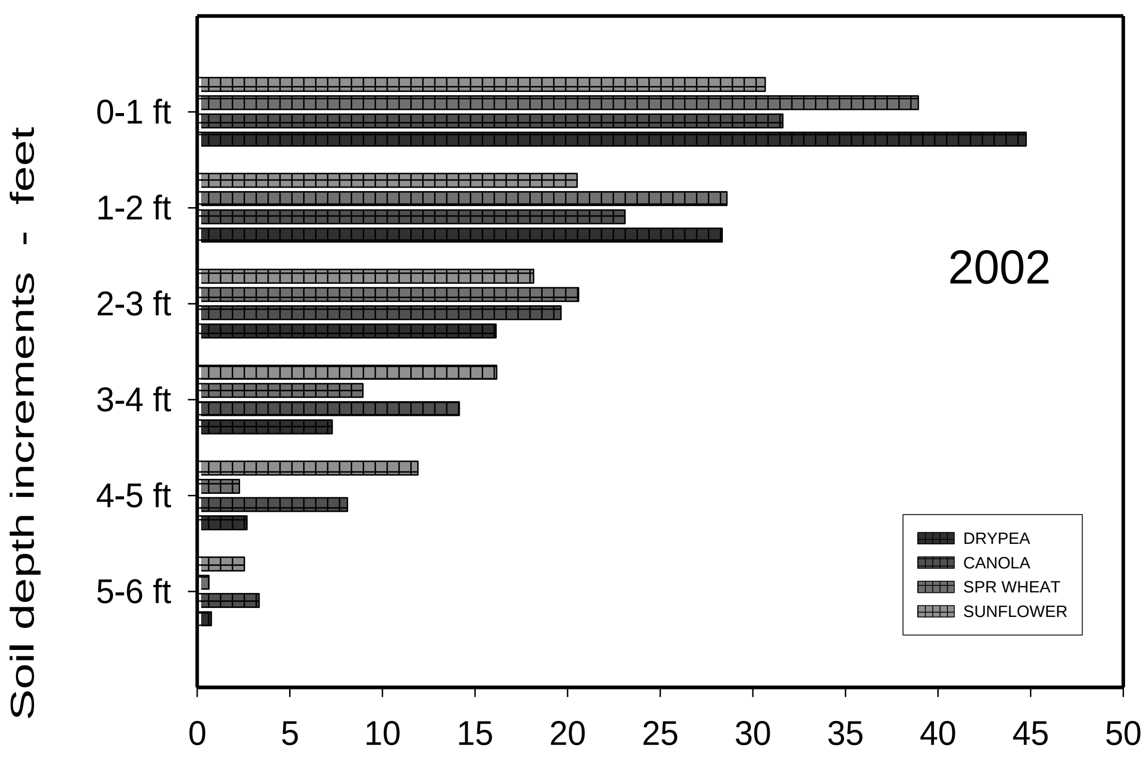


Figure C. Distribution of soil water depletion over soil depth for the four crops that were common to both Phase II and Phase III crop sequence experiments. Graphs of 2000 and 2002 are on the next page.




2000
Soil depth increments - feet
0-1 ft
1-2 ft
2-3 ft
3-4 ft
4-5 ft
5-6 ft
DRYPEA
CANOLA
SPR WHEAT
SUNFLOWER
0
5
10
15
20
25
30
35
40
45
50
Percentage of soil water uptake


2002
Soil depth increments - feet
0-1 ft
1-2 ft
2-3 ft
3-4 ft
4-5 ft
5-6 ft
DRYPEA
CANOLA
SPR WHEAT
SUNFLOWER
0
5
10
15
20
25
30
35
40
45
50

SCLEROTINIA (WHITE MOLD) AS INFLUENCED BY CROP SEQUENCE AND BIOLOGICAL CONTROL, 2003

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Diversification of cereal cropping systems with oilseeds and pulses presents the producer with a range of options. Crop diversification also improves management of plant diseases through crop selection and interruption of disease cycles with crop rotations. The influence of the previous crop and crop residues on *Sclerotinia sclerotiorum* (white mold) needs to be fully understood in order to develop effective crop sequences for cropping systems that minimize risk for Sclerotinia.

The development of Sclerotinia was minimal in 2003, because of low precipitation and above-average temperatures for July and August. The effects of crop sequence, management practices, and biological control on Sclerotinia disease were evaluated in three experiments:

Experiment 1) A multi-disciplinary team of scientists is conducting a Crop Sequence Project, which is a multi-phased project to develop guidelines for diversified crop production systems and to provide producers with management flexibility for developing their own cropping systems and managing disease risk. The Crop Sequence Project includes a crop by crop residue matrix to evaluate the impact of previous crops (buckwheat, chickpea, corn, lentil, proso millet, grain sorghum, canola, dry pea, sunflower, and wheat) and crop residue on Sclerotinia diseases of chickpea, canola, dry pea, lentil, or sunflower. With the exception of Sclerotinia basal stalk rot on sunflower, Sclerotinia diseases were not detected because of the dry conditions in 2003. Sclerotinia basal stalk rot was present on sunflower and increased during four evaluations but because of the low number of sunflower plants infected, disease severity could not be statistically related to the crops grown in 2002 (Figure 1). During the third and fourth evaluations of sunflower, insect and disease problems in combination with the drought caused premature wilting of plants, seriously impacting the sunflower-following-sunflower plots (Figure 2). Evaluations will continue in 2004 on chickpea, canola, dry pea, lentil, and sunflower at another crop by crop residue matrix site.

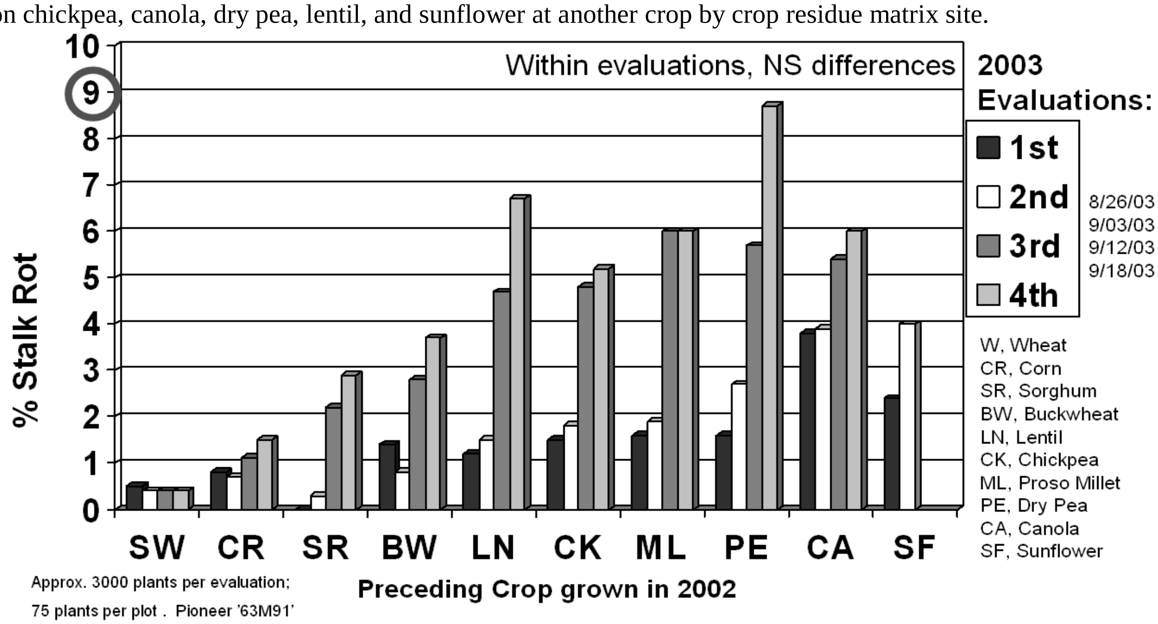

Figure 1. Sunflower evaluated for Sunflower stalk rot in 2003 following 10 crops in 2002.

Sunflower after Sunflower
(Research Example, NOT a recommendation)

wheat/sunflower/sunflower
Plot 425, 2003

Wheat/sorghum/sunflower
Plot 426, 2003

Figure 2. Sunflower after sunflower impacted by insects, diseases, and drought compared to sunflower after sorghum.

Experiment 2) The use of *Coniothyrium minitans* (Intercept® WG) to reduce the risk of Sclerotinia disease was evaluated. Treatments included the timing of Intercept® WG applications, tillage or no-till, the use of a non-host crop (spring wheat) for one season (2002), and the use of a sunflower indicator crop to determine the presence of Sclerotinia (2003). Because of the dry conditions and higher than average temperatures in July and August in 2003, inadequate numbers of sunflower plants were infected with Sclerotinia basal stalk rot to statistically relate disease levels to treatments (Figure 3).

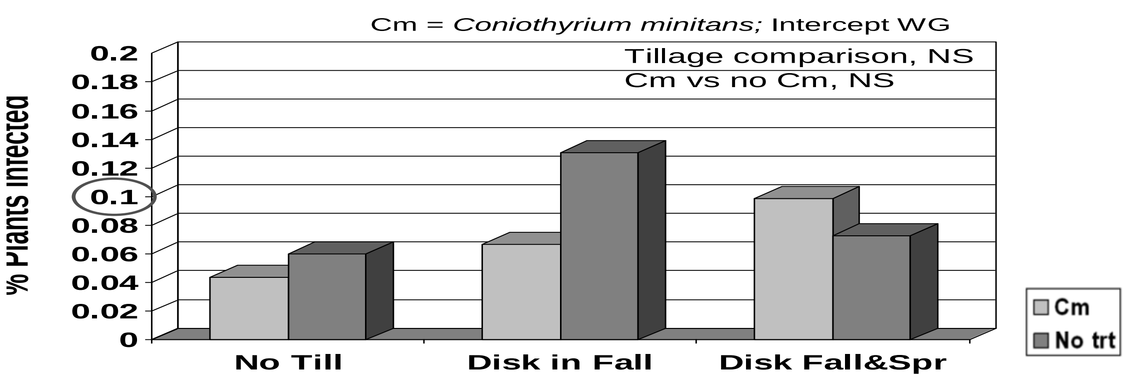

Figure 3. Tillage and Cm influences on Sclerotinia stalk rot of sunflower used as an indicator crop. 2003

Experiment 3) An experiment to evaluate the combination of crop sequence and the application of *Coniothyrium minitans* (Intercept® WG) to reduce the risk of Sclerotinia disease was established. Treatments included the uniform application of sclerotia, the growing of susceptible and resistant crops (crambe, dry pea, oats, and spring wheat), and varying the timing of Intercept® WG applications. Plots were evaluated for Sclerotinia, soil water, and surface soil properties in 2003, and will be evaluated again in 2004. Influence of crop sequences and management practices on development of Sclerotinia will be evaluated with an indicator crop, which will be direct seeded over the residue of the previous crops.

GRAZING STRATEGIES TO MAINTAIN INTERMEDIATE WHEATGRASS STANDS

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Intermediate wheatgrass's ease of establishment and growth pattern makes it a good perennial forage choice in our area. However, producer acceptance has been slow because intermediate wheatgrass does not persist as well as other grasses when it is grazed. In general, the ability of grasses to persist depends on a plant putting up new shoots faster than it loses old ones. One way to measure this ability is with a tiller replacement ratio. When the ratio is greater than one the grass is persisting but when it is less than one the grass is not persisting. In 2000, we began a study to evaluate the effects of 1) time of grazing, 2) fertilizer application and 3) entry on intermediate wheatgrass persistence.

Eight different intermediate wheatgrass entries including three experimental strains and two cultivars developed at the location were seeded in 1997. Beginning in 2000, plots were grazed once per season when the plant growth was in either 1) early vegetative stage (3-5 leaves), 2) mid-culm stage (the stem was about half way through elongating or 3) late boot stage (flower had not emerged totally from the upper sheath). Some plots were left ungrazed for the entire study to serve as a control. Half of the plots were fertilized in March 2001. Precipitation for the study period was 134, 126 and 71% of the long-term (1913-2003) average for 2000, 2001 and 2002, respectively.

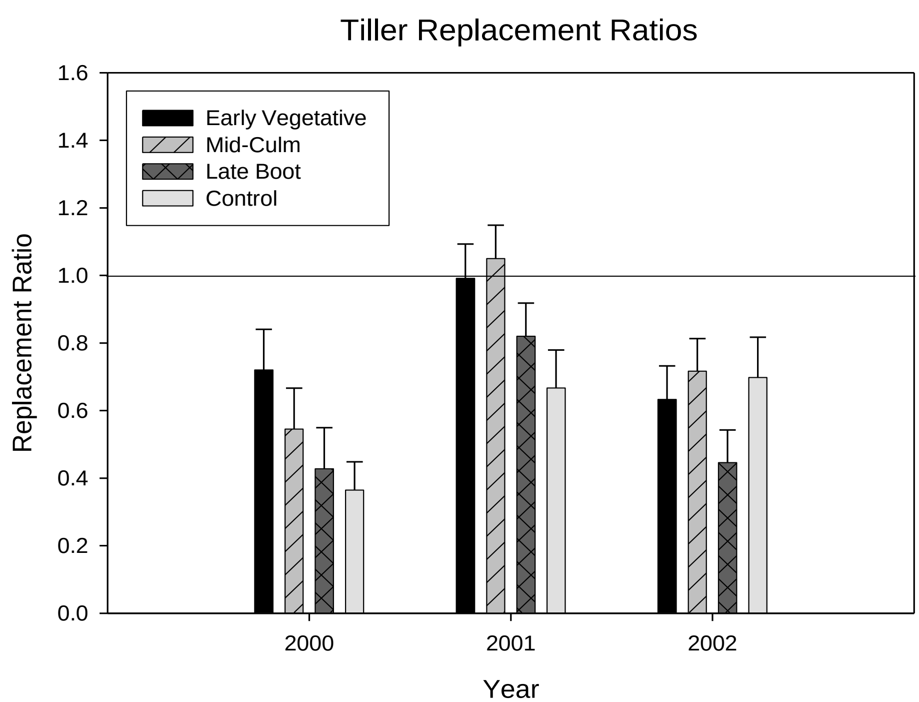

Figure 1. Average tiller replacement ratios for intermediate wheatgrass cultivars grazed at three different growth stages as well as left ungrazed.

In only one year (2001) of the three-year study did intermediate wheatgrass develop enough new shoots to replace the ones it was losing (Figure 1). Ungrazed plots generally showed poorer persistence (ie. lower ratios) than did grazed plots except during the dry year of 2002. Plots grazed prior to the boot stage (ie. early vegetative or mid-culm) showed better persistence than did plots grazed at the boot stage in all years. Fertilizing the plots did not improve the persistence of these entries. In fact, in 2001 and 2002, the fertilized plots had a slightly lower tiller replacement ratio than did the unfertilized plots.

None of the entries tested had a tiller replacement ratio greater than one (ie. showing persistence) in 2000 or in 2002 (Figure 2). The drought of 2002 could have had a negative impact on persistence but it is unclear why the ratios were so low in 2000. In 2001, three entries had recruitment ratios greater than one ('Manska', 'Reliant' and M-1891, an experimental strain). Manska, Reliant and the entries with an M prefix were developed at the location. In the drought year of 2002, 'Reliant' and 'M-1891' had the greatest persistence as shown by a higher tiller replacement ratio.

SUMMARY

Persistence continues to be a problem in intermediate wheatgrass and, while this study did not provide an obvious solution, there were several findings of interest. This study suggests that in wetter years, intermediate wheatgrass persistence is enhanced by grazing and that grazing relatively early in the season, generally before mid-June, improves persistence the most. Some entries, such as 'Reliant' and 'M-1891', tended to have better persistence in both a wet (2001) and a dry (2002) year suggesting producers should choose their cultivars carefully. Talking to a neighbor or the forage extension specialist will help in selecting a cultivar for the producer's immediate area. The use of both timed grazing and cultivar selection may be a good combination to extend the life of intermediate wheatgrass stands. This study is also evaluating productivity, nutrient quality and soil quality. These data are still to undergoing laboratory analysis and will be reported later.

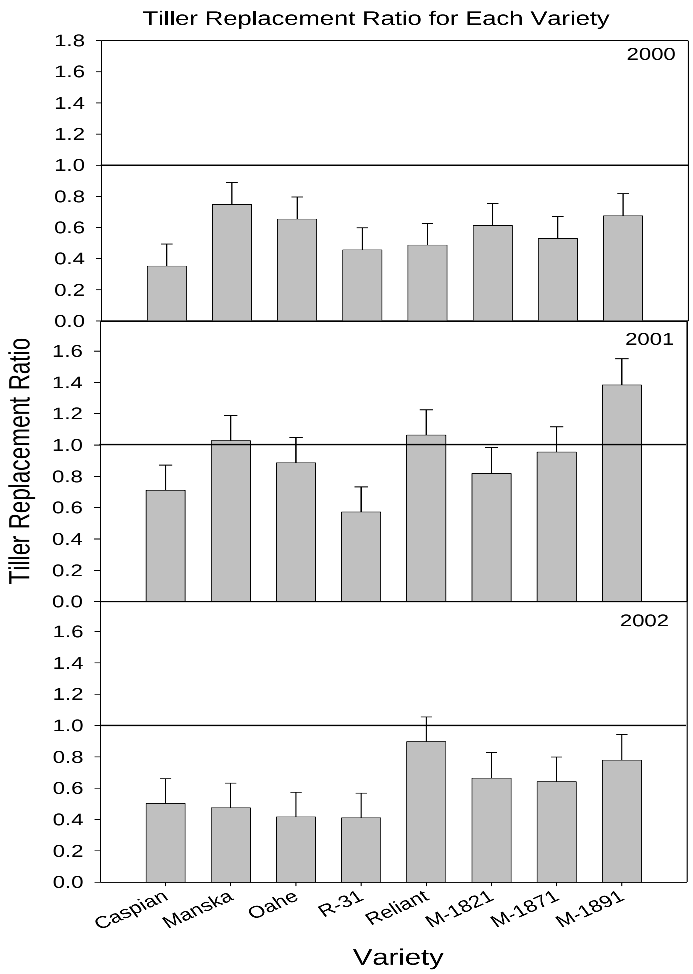

Figure 2. Replacement ratios for all entries used in the study. These ratios are averaged over grazing treatments without the ungrazed plots for each year.

FORAGE BREEDING AND GENETICS RESEARCH AND EVALUATION OF BIOMASS YIELD OF SWITCHGRASS

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J.F. Karn, S.L. Kronberg, and H.A. Johnson

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GRAZING-TYPE ALFALFA

Experimental populations of alfalfa have been developed that have approximately two-thirds of their parentage from yellow-flowered *Medicago falcata* and one-third from purple-flowered *M. sativa.* These populations have broad, deep-set crowns, fine stems, and high levels of drought resistance. Seed from one of these populations is undergoing increase in eastern Oregon and will be used to establish grazing trials in the northern Great Plains. The best potential use of this type of alfalfa is in grass mixtures for grazing. In years with near-average May and June rainfall, hay yields of pure stands of these experimental populations have averaged approximately two tons for a single cutting in late June at the early-bloom stage of development. Regrowth is much slower than for typical purple-flowered hay-type cultivars, but long-term survival is high.

FORAGE GRASSES

We have doubled the normal chromosome complement of Russian wildrye to produce a more robust plant with improved seedling vigor. Russian wildrye plants with a doubled (tetraploid) chromosome number have higher water-use efficiency than normal (diploid) plants, and the high forage quality of Russian wildrye was not compromised. Seed yield of tetraploid experimental strains must be improved before this plant material can be considered for cultivar release. Other breeding research is underway to improve forage yield and quality of crested wheatgrass; seed yield, seedling vigor, and forage quality of western wheatgrass; and seedling vigor of blue grama.

SWITCHGRASS FOR BIOFUEL

Economic studies by the U.S. Department of Energy indicate that switchgrass used as a biofuels crop would be economically competitive with other crop species in much of the northern Great Plains, including cropland in central and western North Dakota. These studies assume biomass yields of 4 to 5 tons per acre at a price of approximately $40 per ton. Eight switchgrass cultivars and experimental strains were evaluated at Mandan on a Parshall fine sandy loam and a Wilton silt loam site and at Dickinson on a Farnuf fine sandy loam site. Biomass yields were usually higher from a single annual harvest in mid-September than a mid-August harvest. Biomass yields of three cultivars averaged over the two harvest dates are reported in Table 1. 'Sunburst' from South Dakota was the highest yielding entry. 'Trailblazer' from Nebraska also had high biomass yield but was subject to winter injury. 'Dacotah' from North Dakota headed on approximately July 7 compared to a heading date of approximately August 10 for Sunburst. The later maturity of Sunburst resulted in a higher biomass yield potential for this cultivar than for Dacotah. Biomass yield of Sunburst at Mandan site 2, the highest yielding site, ranged from 1.4 tons per acre in 2002, a drought year, to 5.6 tons per acre in 2001, a year with above average precipitation. Maximum biomass yield of Sunburst could be obtained from a late August to mid-September harvest, a time period when small grain harvest is often completed and harvest of late-season crops has not begun.

Table 1. Biomass yields of switchgrass cultivars measured at two sites near Mandan and at Dickinson for three years and averaged over two harvest dates.

	Mandan site 1			Mandan site 2			Dickinson		
Cultivar	2000	2001	2002	2000	2001	2002	2001	2002	2003
	---tons/acre---								
Dacotah	2.4b	3.6b	1.1b	3.4b	4.2c	1.0c	1.4b	2.5b	2.0a
Sunburst	3.9a	4.7a	1.5a	4.7a	5.6a	1.4a	2.3a	3.4a	2.3a
Trailblazer	3.7a	4.1ab	1.4a	4.6a	4.9b	1.2b	2.5a	3.4a	2.1a

Means within a column followed by the same letter are not significantly different at <0.05.

CARBON SEQUESTRATION IN NATIVE GRASSLAND INVADED BY SHRUBS AND IN SEEDED SWITCHGRASS

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NATIVE GRASSLANDS

Land use changes and increasing fossil fuel use have contributed to increased atmospheric carbon dioxide concentrations. Grasslands are a species rich ecosystem that may be important in mitigating these increases in atmospheric carbon dioxide. The effect of shrub invasion on carbon dioxide uptake in Northern Great Plains grasslands is not known. The Bowen ratio/energy balance technique was used to measure carbon dioxide uptake and evapotranspiration over a grazed mixed-grass prairie and a mixed-grass prairie that has extensive invasion of woody shrubs over a 4 year period. Peak biomass occurred during the July to early August period and averaged 1,574 lb/ac for the prairie and 1,614 lb/ac for the shrub prairie site. Carbon dioxide uptake was greater for the shrub prairie site during the period of increasing uptake during May and June, whereas, the prairie site had greater uptake during the period of decreasing uptake from August to mid-October. Total carbon dioxide uptake was similar for both sites averaging 3,116 lb carbon dioxide/ac/yr for the prairie and 3,126 lb carbon dioxide/ac/yr for the shrub prairie. Evapotranspiration rates were higher in the prairie than the shrub prairie site. These results suggest that invasion of shrubs into a Northern Great Plains grassland ecosystems does not reduce carbon dioxide uptake. A small level of shrub invasion into grasslands may have advantages for wildlife population and for enhancing species diversity.

SWITCHGRASS

Grasslands possess a significant underground biomass component, the root system, which serves as a large carbon storage sink for atmospheric carbon dioxide. Seeded grassland generally produces biomass amounts that can serve as a biofuel crop for renewable energy. Switchgrass (*Panicum virgatum* L) has been promoted as a biofuel crop. Our objectives were to determine biomass and carbon partitioning in aboveground and belowground plant components and changes in soil organic carbon in field grown switchgrass. The cultivars Sunburst and Dacotah were field grown over three years at Mandan, ND. At seed ripe harvest, stem biomass accounted for 46% of total aboveground biomass, leaves 7%, senescence plant parts 43%, and litter 4%. Excluding crowns, root biomass averaged 27% of the total plant biomass and 84% when crown tissue was included with underground biomass. Carbon partitioning among aboveground, crown, and root biomass showed that crown tissue contained more than 50% of the total biomass carbon. Regression analysis indicated that soil organic carbon to 3-ft depth increased at the rate of 4.5 ton carbon/ac/yr over the three yr period. The quantity of carbon lost through soil respiration processes was equal to 44% of the carbon content of the total plant biomass. Although nearly half of the carbon captured in plant biomass during a year is lost through soil respiratory processes the quantity of soil carbon gain indicates that Northern Great Plains switchgrass plantings have potential for storing a significant quantity of soil carbon.

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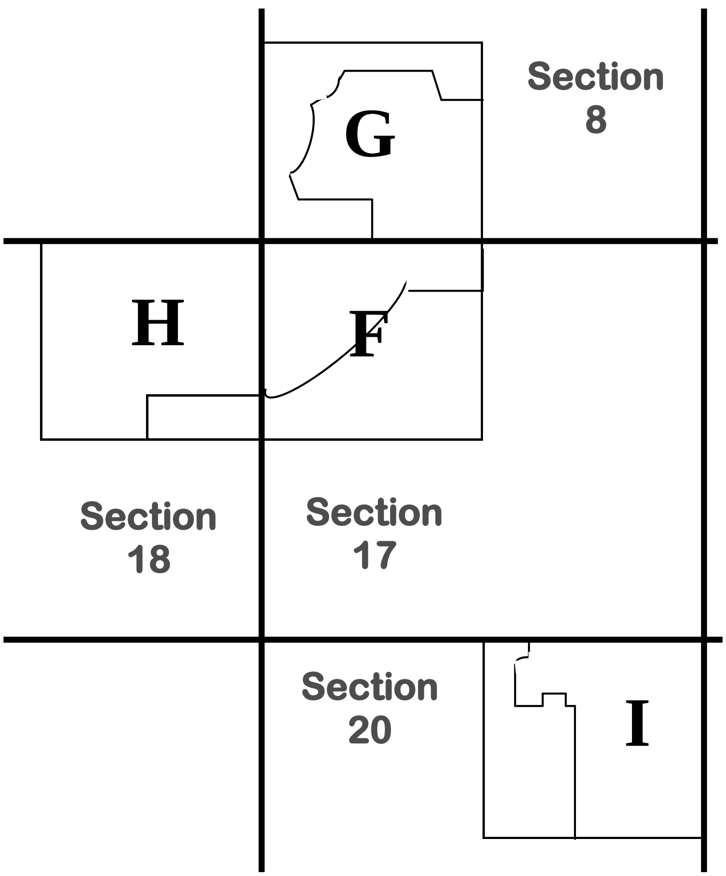

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