Technology Transfer
for the
USDA-ARS Northern Great Plains
Research Laboratory

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NORTHERN GREAT PLAINS INTEGRATOR

USDA-ARS Northern Great Plains Research Laboratory *Mandan, ND*

NORTHERN GREAT PLAINS RESEARCH LABORATORY

GLOMALIN – HOW DOES SCUM HOLD YOUR FARM TOGETHER?

Soil aggregates improve soil structure by creating defined and stable pores for water and air flow, and root growth. In well-aggregated soils, fertility increases, as soil aggregates act like slow-release fertilizer pellets. Greater nutrients (C,N,S,P) are found within aggregates than found in free soil, because aggregates contain many different microbial communities which efficiently process plant debris into available nutrients in a protected environment near plant roots and/or fungal hyphae.

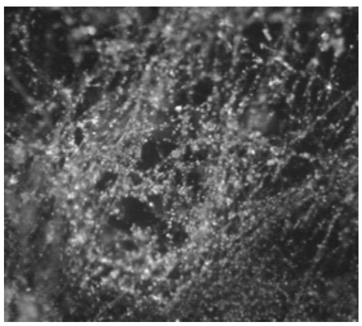

Figure 1. Mats of AM hyphae coated with glomalin physically entrap debris to initiate aggregate formation. After a laboratory procedure, bright spots indicate the location of glomalin.

Soil fungi are a major portion of below ground biomass with fungal biomass carbon equal to or greater than root biomass carbon. Some fungi are important agents in organic matter decomposition (i.e. nutrient turnover). Other fungi (Arbuscular mycorrhizal or AM) form a mutually beneficial relationship with most plants (about 80%). AM fungi enhance soil quality by helping to clump or bind soil particles into soil aggregates.

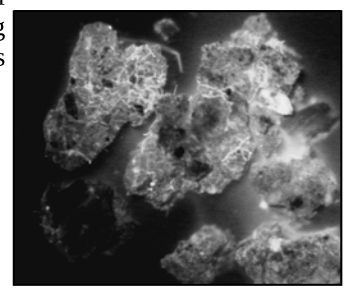

Figure 2. Glomalin is sloughed from hyphae as scum which forms a protective, insoluble coat that keep aggregates water-stable. After a laboratory procedure, bright spots indicate the location of glomalin on AM hyphae and aggregates.

Aggregates are 'protected' or stabilized by biomolecules, as glomalin. Glomalin is found on hyphae (thread-like projections) produced by AM fungi. Numerous strands of hyphae form a net or mat, to entrap soil minerals, organic matter, and debris (Figure 1).

Glomalin is sugar protein that is both sticky and water-insoluble. The sticky part of glomalin glues this conglomeration together while the water-insoluble part forms a protective lattice on the surface of soil aggregates (Figure 2). Management influences aggregate stability and glomalin concentration (Figure 3). In a never tilled, moderately grazed pasture, the insoluble glomalin coating completely encases aggregates allowing many of them to float on the surface water. Without this coating, water will rapidly enter air-filled pores within aggregates increasing air pressure and causing aggregates to explode from the inside. When this occurs as in the conventional till and no-till soils, aggregates are disrupted into small conglomerations or fine particles which may be easily transported by wind or

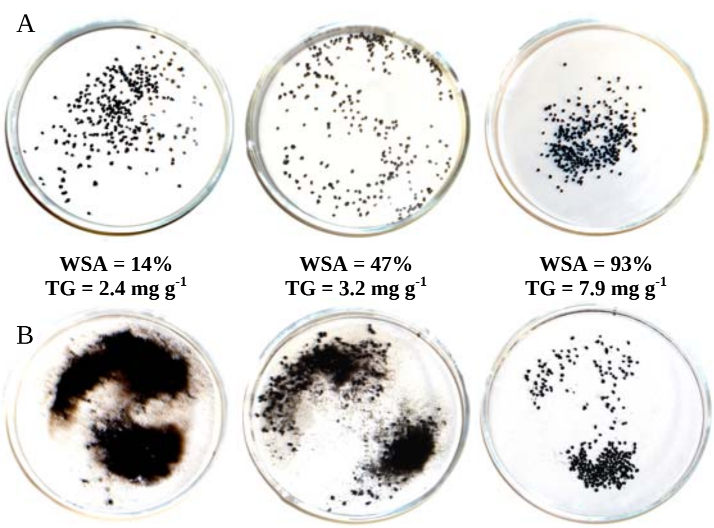

Figure 3. Dry-sieved soil aggregates (1-2 mm) (A) look about the same, but after the addition of water (such as during a rainfall event) (B), these aggregates do not act the same. Concentrations of water-stable aggregates and glomalin in three soils at the Northern Great Plains Research Laboratory change with management (from left to right): conventional till spring wheat - fallow; no-till spring wheat - winter wheat - safflower; and never tilled, moderately grazed pasture.

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Our Vision:

An economically sustainable and environmentally sound agriculture.

Inside this issue:

Glomalin: How Does Scum Hold Your Farm Together?	1
Soil Water Use and Depletion by Diverse Crops	2
2004 Research Results & Technology Conference	3
Dr. Karn Retires	3
NGPRL Scientists Present Research Results in Denver	4

WATER USE AND DEPLETION BY DIVERSE CROP SPECIES IN THE NORTHERN GREAT PLAINS

The introduction of reduced and no-tillage farming practices have allowed producers in the northern Great Plains to move away from traditional small grain-fallow rotations to continuous cropping. Diverse crop rotations are essential for improving soil health, decreasing the depredations of disease, weeds, and insects, and support the economic survival of family farmers faced with increasing input costs and market dynamics over which they have very little control.

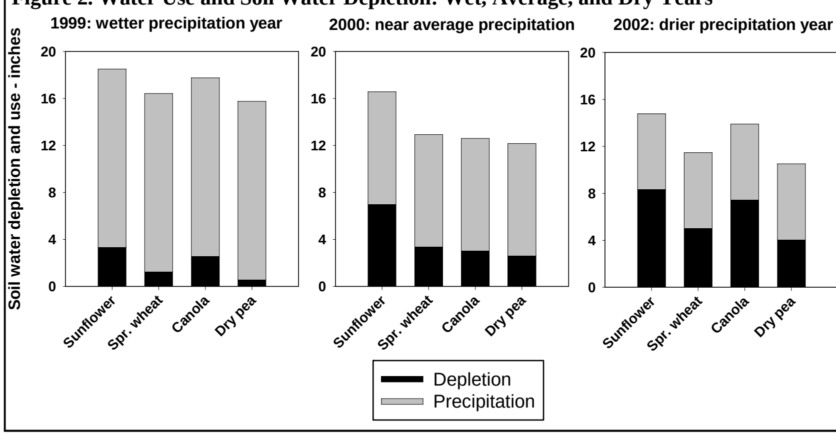
Figure 1. Neutron Moisture Meter

The objective of this research was to determine comparative water use and soil water depletion by diverse crop species. The variable moisture between 1999 and 2002 provided significant opportunity to evaluate this under both wet and dry conditions.

This soil water use research was conducted within two crop sequence projects at the Area IV SCD Cooperative Research Farm at Mandan. The crop sequence projects were set up in a checkerboard-like pattern, so that all 100 combinations of 10 crops grown one year were followed by the same 10 the next year. Four crops (sunflower, spring wheat, canola, and dry pea) were repeated in both crop sequence projects. This repetition allowed evaluation under widely varied environmental conditions.

Crops were seeded no-till into the crop matrix. The matrix, with 30 X 30 plots, was replicated four times each year for two years. Soil water content was measured with a neutron moisture meter (Figure 1) in one foot depth increments. Water content was used to calculate seasonal (May to September) soil water depletion and water use (soil water depletion + precipitation) (Figure 2). We assumed no runoff or deep drainage. 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 2002 precipitation was significantly below average. Among the four crops repeated in both crop sequence projects, the soil water depletion component of water use was greater in relatively dry 2002 compared to relatively wet 1999.

Figure 2. Water Use and Soil Water Depletion: Wet, Average, and Dry Years



Among four crops monitored over the two crop sequence projects, the soil water depletion component of water use varied from 4% to 18% in wetter 1999, but was 39% to 57% of water use in dryer 2002. A greater part of sunflower's soil water depletion came from the lower part of the soil profile compared to dry pea or spring wheat.

During wetter 1999, there was not much difference in the depth distribution of soil water depletion among the four crops. There was more difference in (average) 2000 and in dryer 2002. During wetter 1999, the distribution of soil water depletion within the soil profile did not greatly vary among crops, but in dryer 2002, about 30% of

Table 1. 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	-2.1	-2.8
Canola	22.2	16.2	+0.2	-1.7
Spring wheat	22.0	17.9	0	0
Dry pea	23.5	19.3	+1.5	+1.4

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the soil water depleted by sunflower was taken from below the three foot depth compared to dry pea, which had only about 12% of total soil water depletion from below three feet.

A very useful comparative measure of water use is differential water depletion (Table 2). This is the difference between a crop's soil water depletion in a given year and the average soil water depletion of all crops in that year.

Table 2. 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	

Among the 10 crops, soil water depletion of sunflower was highest, followed by safflower, and then soybean. Dry pea had the lowest soil water depletion, followed by barley, crambe and spring wheat.

While crops with deeper rooting, such as sunflower, usually have greater water use, length of a crop's active growing season is equally important.

For producers in a dry region, the comparative water use of crops has it's greatest impact in the spring time because of different amounts of soil water left in the ground at seeding time (Table 1). Our measurements indicate that there was 3.6 inches more soil water following dry pea than following sunflower in Spring 2001.

When precipitation becomes critically limiting, amounts of soil water left in the profile the spring after growing various crop species can have considerable agronomic and economic impact for farmers. In spring 2003, there were 4.2 inches more soil water following dry pea than following sunflower.

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Area IV SCD Cooperative Research Farm
& National Sunflower Association

Research Results and Technology Conference

Dynamic Agriculture: Rediscovering the Basics

NORTHERN GREAT PLAINS RESEARCH LABORATORY

USDA

Seven Seas Inn & Conference Center
Mandan, North Dakota

TUESDAY, JANUARY 27TH
8:30 AM (CST) REGISTRATION
EVERYONE IS INVITED — NO COST

Crop Sequence Calculator 2.2.5
Dr. Joe Krupinsky, Research Plant Pathologist

Crop Water Use Differences and Potential Effects
Dr. Steve Merrill, Soil Scientist

Getting Back to the Basics when Direct Seeding
Dr. Don Tanaka, Soil Scientist

Predicting Crop Yield with Remote Sensing
Dr. Vern Hoffman, NDSU Agricultural Engineer

Management Effects on Soil Quality in Golden Valley County
Jason Gross, Soil Scientist

Glomalin - How Does Scum Hold Your Farm Together?
Dr. Kris Nichols, Soil Microbiologist

Carbon Sequestration in Northern Plains Croplands and Rangelands
Dr. Mark Liebig, Soil Scientist

Complimentary Lunch

Sunflower Market Dynamics Today and in the Future
Larry Kleingartner, National Sunflower Association

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

Cattle Are What They Eat "*Creating Value-Added Beef*"
Dr. Scott Kronberg, Research Animal Scientist

Status of Improved Grasses and Alfalfa for Grazing
Dr. John Berdahl, Research Geneticist

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

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JIM KARN RETIRES

Dr. Jim Karn, Animal Scientist at the Northern Great Plains Research Laboratory, has retired after 27 years of distinguished service. Jim and his wife, Joy, are enthusiastically helping care for their infant triplet grandchildren in Avondale, AZ.

2004 FRIENDS & NEIGHBORS DAY

O.K.

Please mark your calendar for our **"Friends & Neighbors Day"** on July 22, 2004! Nearly 600 friends of NGPRL research attended last summer. This annual summer event will culminate the Northern Great Plains Research Laboratory's 90th Anniversary. Please join us for the Area IV Research Farm and campus tours, as well as the evening barbecue and entertainment.

Bookmark our website:
www.mandan.ars.usda.gov

Feel free to pass on this issue of ***Northern Great Plains Integrator*** to others interested in agricultural research in the Northern Great Plains.

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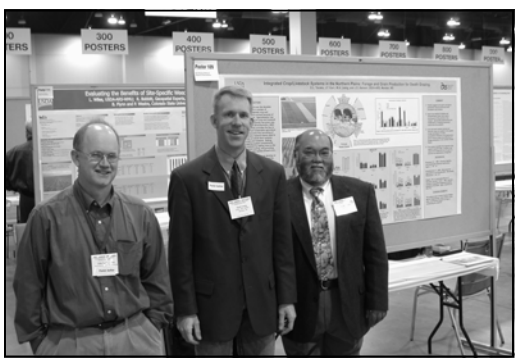
NGPRL SCIENTISTS PRESENT RESEARCH RESULTS IN DENVER

Scientists from NGPRL recently presented research results at the annual meetings of the American Society of Agronomy (ASA) - Crop Science Society of America (CSSA) - Soil Science Society of America (SSSA) in Denver, CO, November 2-6, 2003.

The theme for the 2003 meeting in Denver was 'Changing Sciences for a Changing World: Building a Broader Vision'. More than 4000 people from 40 countries attended the meeting, and over 2800 symposia and paper/oral sessions.

Five posters from NGPRL on integrated crop/livestock systems were presented as a group at the meeting. Poster topics included an overview of integrated crop/livestock systems, a conceptual model for optimizing land allocation between crop and cattle production, and three component posters specific to on-going research at NGPRL reviewing management effects on cattle performance, crop production, and surface soil condition. In addition to the group poster session, NGPRL scientists presented research results on crop water use, crop sequencing, switchgrass growth characteristics, and grazing effects on alfalfa.



John Hendrickson, Mark Liebig, and Don Tanaka at the integrated crop/livestock poster session in Denver, Colorado

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Agricultural Research Service

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