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

July 2004

NORTHERN GREAT PLAINS

INTEGRATOR

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

NORTHERN
GREAT
PLAINS
RESEARCH
LABORATORY

Our Vision:

An economically sustainable and environmentally sound agriculture.

Inside this issue:

DROUGHT EFFECTS ON RANGELAND ECOSYSTEMS

Periodic and widespread droughts have regularly occurred on rangelands in contrast to the common view of drought as an extreme event. Historical records and tree-ring data sets indicate there have been periodic major droughts over the last 8000 years. The recent droughts of the 1930s, 1950s, 1988 and 2002 remind us periods of water shortage are to be expected on rangelands. Range managers should consider droughts as a normal rather than abnormal event and plan for them.

One of the best ways to reduce the long-term effects of drought on future rangeland productivity is to reduce the stocking rate. When stocking rates were reduced by 2/3 on the mixed grass prairie in North Dakota during the mid-1930, grass species recovery was accelerated. Some cool-season grasses had even exceeded their pre-drought abundance shortly after the end of the dust bowl. However when to reduce stocking is the question. There have been several indices developed and currently some short-term (90-day) drought outlook predictions are also available.

There has been considerable work on establishing the relationship between precipitation (distribution and frequency) and forage production on rangelands. While many studies have established the strong linkage between these two factors, we still need information on 1) the probabilities of environmental risk, 2) influence of timing and frequency of rainfall, not just total rainfall and 3) the influence of temperature, independent of drought on plant development to make better and earlier predictions of forage production.

While traditionally drought related research has focused on forage production and species composition, a better understanding of the multiple benefits of rangelands has resulted in evaluating the effect of drought on ecosystem attributes like carbon sequestration. Some research has shown that during droughts rangelands change from a carbon sink to a carbon source. In the shortgrass prairie, heavy grazing (>75% utilization) increased carbon losses.

Grazing management during droughts can have long-term effects on rangelands. Reducing stocking rates relatively early can shorten the rangeland recovery period and improve future productivity.

Drs. John R. Hendrickson, Al Frank, and Justin Demer (USDA-ARS, Cheyenne, WY) as reported at the Western Science Seminar in Medicine Hat Alberta

LOCATION OF GENES INFLUENCING BARLEY WAX COATINGS

By Megan Wolf, Mandan High School 2004 Senior who accomplished her International Science Fair research at the Northern Great Plains Research laboratory and was advised by Mary Kay Tokach and Dr. John

The objective of this study was to measure linkage between the morphological and molecular markers, and to confirm the hypothesis that the tested traits were allelic.

There are more than 1000 morphological marker genes identified in barley, and less than half have been located to chromosome. Only a small portion of that half has been mapped to a specific chromosome site. Some of the morphological traits include height, spike morphology, leaf color, desynapsis, maturity, wax coatings on various plant parts, and awn length. *Continued on page 4*

The Staff at the Northern Great Plains Research Laboratory sincerely hopes you can join them for the 2004 Friends & Neighbors Day on July 22nd.

This event celebrates three milestones:

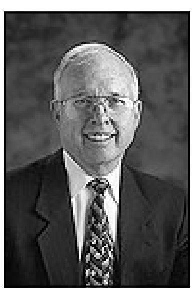
90 Years of Ag and Environmental Research at the Northern Great Plains Research Laboratory. Congress appropriated funds to begin the "Mandan Station" in 1912, but research began in 1914. This year we celebrate 90 years of service to farmers and ranchers of this region.

20 Years of the Area IV SCD Cooperative Research Farm. The Soil Conservation Districts developed, and continue to strongly support this 400 acre 'farmer-sized fields' research farm to advance conservation and environmental research.

50 Years of USDA Agricultural Research Service. This year-long celebration of the commitment of USDA toward agricultural, environmental, and food science research continues.

The day will be marked with a Cattleman's Tour, a tour of agronomic research ongoing at the Area IV Research Farm, and a Campus Tour with many guest presenters. The children's area is always a hit

Many supporters of the Northern Great Plains Research Laboratory's research will be on hand and many will host exhibits and equipment displays.



Dr. Edward B Knipling USDA Agricultural Research Service Acting Administrator from Beltsville, Maryland, will join in the festivities and present a short address to the gathering after the free barbecue.

Milo Hatzenbuhler and Emma will provide entertainment to complete the festivities.

NORTHERN GREAT PLAINS INTEGRATOR

Northern Great Plains Integrator is published and distributed by the USDA-ARS, Northern Great Plains Research Laboratory, 1701 10th Ave., S.W., Mandan, ND 58554. ● Persons with disabilities who require alternative means for communication of program information (Braille, large print, audiotape, etc.) should contact USDA's TARGET Center at 202-720-2600 (voice and TDD). ● The United States Department of Agriculture prohibits discrimination in all its programs and activities on the basis of race, color, national origin, gender, religion, age, disability, political beliefs, sexual orientation, and marital and family status. ● To file a complaint of discrimination, write USDA, Director, Office of Civil Rights, Room 326-W, Whitten Building, 14th and Independence, SW, Washington, DC 20250-9410 or call 202-720-5964 (voice or TDD). ● USDA is an equal opportunity provider and employer. ● Mention of trade or manufacturer names is provided for information only and does not constitute endorsement by USDA-ARS. ● **Any material in this publication may be copied and distributed in part or whole if due credit is given to the authors.** ● Editor: Cal Thorson, Technical Information Specialist, USDA-ARS Northern Great Plains Research Laboratory, 1701 10th Ave., S.W., Mandan, ND 58554 O:701 667-3079 F:701 667-3077 E: thorsonc@mandan.ars.usda.gov

Northern Great Plains Cropping Systems: Tillage and Cropping Effects on Soil Quality Indicators

The extreme climate of the northern Great Plains of North America requires cropping systems to possess a resilient soil resource in order to be sustainable. Farming practices in the region have evolved from tillage-dependent wheat-fallow systems to continuous cropping practices under no-till management. The advancement of farming practices has placed greater emphasis on the retention of plant residues on the soil surface, thereby mimicking native ecosystems.

In 2001, an evaluation was carried out a long-term experiment at NGPRL to better understand the interactive effects of tillage, crop sequence, and cropping intensity on soil properties, with particular focus on properties considered as soil quality indicators. The experiment was conducted at the Area IV SCD Cooperative Research Farm south of Mandan.

Management effects on soil properties were largely limited to the surface 7.5 cm in both experiments. Differences in soil condition between a continuous crop, no-till system and a crop-fallow, conventional tillage system were substantial (Table 1). Within the surface 7.5 cm, the continuous crop, no-till system possessed significantly more soil organic carbon (by 7.28 Mg ha^{-1}), particulate organic matter carbon (by 4.98 Mg ha^{-1}), potentially mineralizable nitrogen (by 32.4 kg ha^{-1}), and microbial biomass carbon (by 586 kg ha^{-1}), as well as greater aggregate stability (by 33.4%) and faster infiltration rates (by 55.6 cm hr^{-1}) relative to the crop-fallow, conventional tillage system. Thus, soil from the continuous crop, no-till system was improved with respect to its ability to provide a source for plant nutrients, withstand erosion, and facilitate water transfer.

Table 1. Soil properties as affected by management for the long-term cropping systems study. Data is for the 0-7.5 cm depth. Below 7.5 cm, few properties were affected by management, and are therefore not shown. As a contrast, properties in a grazed pasture with the same soil type are shown in the right column.

Soil property	SW-F, CT	SW-WW-SF NT	Grazed Pasture
Soil bulk density (Mg m^{-3})	1.19	1.13	0.85
Wet aggregate stability, 1-2 mm fraction (%)	14	47	93
Infiltration rate (cm h^{-1})	20.3	75.9	29.1
Electrical conductivity	0.14	0.19	0.26
Soil pH	6.43	6.16	627
Soil $N0_3$-N (kg ha^{-1})	1.9	3.0	7.2
Potentially mineralizable nitrogen (kg ha^{-1})	24.1	56.5	85.7
Soil organic carbon (C) (Mg ha^{-1})	16.42	23.70	31.56
Total nitrogen (N) (Mg ha^{-1})	1.63	2.24	2.55
Carbon in particulate organic matter (Mg ha^{-1})	2.61	7.59	15.77
Nitrogen in particulate organic matter (Mg ha^{-1})	0.21	0.54	1.04
Percentage (%) of soil organic C as particulate organic matter C	16	32	50
Percentage (%) of total N as particulate organic matter N	13	24	41
Microbial biomass C (kg ha^{-1})	424	1010	1598
Microbial biomass N (kg ha^{-1})	39	100	148

SW, spring wheat; WW, winter wheat; SF, sunflower; F, fallow; CT, conventional-till; NT, no-till

Variables driving these changes in soil condition were 1) the greater amount of crop residue returned to the soil surface in the continuous crop system, 2) the greater amount of root biomass in no-till as compared to conventional tillage, and 3) the slower rate or residue decomposition in no-till relative to conventional tillage. These results confirm that farmers in the northern Great Plains can improve soil quality by adopting production systems that rely on intensive cropping practices with no-till management.

Information taken from Liebig, M.A., D.L. Tanaka, and B.J. Wienhold. 2004. Tillage and cropping effects on soil quality indicators in the northern Great Plains.

Dr. Frank Retires

Dr. Al Frank, retired in May 2004. Frank joined the USDA-ARS as a Plant Physiologist in 1969. He spent his entire career at Mandan, working in the early seventies on determining the role of field windbreaks in conservation agriculture, during the eighties he worked on physiology of forage and rangeland plants, and the physiology of small grain, and from the early nineties he continued work on the physiology of forages and small grains, and added research on the role of grasslands in carbon sequestration. He is the author or coauthor of 175 scientific publications. Frank has been recognized by Fellow Awards from the American Society of Agronomy and the Crop Science Society of America, and the Outstanding Achievement Award from the International Society for Range Management.

Mr. Flakker Retires

Chuck Flakker retired in June 2004. He joined the staff of the Northern Great Plains Research Lab in October 1966. At the time of his retirement, he was the staff member with the longest tenure at the laboratory. During his 38 year tenure, he was a technician in the livestock research, cropping systems, and tree breeding programs. He has been a tremendous resource for arborists seeking information on the remaining tree nurseries from the former tree breeding program.

BARLEY WAX COATINGS *CONTINUED*

These traits have been backcrossed to Bowman barley at the NDSU Department of Plant Sciences to get all of them in a common background. These traits have been placed into a morphological marker linkage map, but have not been associated with molecular marker linkage maps.

Experiments were performed to determine whether the morphological markers tested were linked to specific molecular markers. The trait tested was eceriferum (a waxy coating on the spike). Many different markers were tested on parent plant and Bowman barley. Those that showed putative polymorphisms were tested on the segregating progeny.

To acquire the necessary DNA , an extraction was performed. Plant tissue was harvested and frozen in liquid nitrogen, which prevented the break down of any DNA.

Agarose gels were used to separate and detect visible bands of DNA, which are the molecular markers. A Polaroid photo was taken under UV light using the SYBR Green photographic filter, and the pictures were examined.

Gene	Marker	Result	Linkage Distance (cM)
cer-zt	Bmag0141	Not Linked	112.6
	Bmac0218	Monomorphic	N/A
	Bmag0278	Monomorphic	N/A
	Bmac0134	Linked	30.3
cer-zb	Bmag0005	PCR adjustment needed	N/A
	Bmac01 13	Linked	48.5
cer-zr	Bmag0223	Not Linked	134.5
	Bmag0113	Not Linked	108.5

The markers on the pictures were scored as resembling the morphological marker parent, the Bowman parent, or a heterozygote, which showed both bands. The results from these pictures were then compared with the morphological markers observed and the data were entered into a program called MAPMAKER/EXP 3.0. This program analyzed the data and determined the linkage distance between each morphological gene and the SSR markers, using maximum likelihood estimates.

NORTHERN GREAT PLAINS

Technology Transfer Product of the Northern Great Plains Research Laboratory
United States Department of Agriculture
Agricultural Research Service

USDA-ARS-NGPRL
1701 10th Avenue SW PO Box 459
Mandan, ND 58554-0459

Phone: 701 667-3018 Fax: 701 667-3077