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Agronomy Section

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CROPPING SYSTEMS RESEARCH IN NORTH DAKOTA

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Research Summary

Cropping systems research has focused on the impact of tillage, crop sequences, and crop rotations on phenotype response in hard red spring wheat (HRSW) and other field crops in North Dakota. Attempts have been made to quantify the impact of cropping systems on soil quality. This paper summarizes ongoing or recently completed cropping-systems research in the state.

Introduction

Crop-fallow was the dominant production system for HRSW and other field crops in North Dakota through the 1970s. Intensified cropping systems began replacing crop-fallow in eastern North Dakota in the 1980s, and became widely used in central and western North Dakota by the late 1990s. For example, continuous small-grain systems accounted for most of the HRSW produced in southwestern North Dakota during 1998 (M.V. McMullen, personal communication, 2001).

Intensive tillage generally is used to prepare the seedbed prior to sowing HRSW and to control weeds and other pests during the fallow phase in the crop-fallow system. Minimum and no till practices have replaced intensive tillage on many farms as continuous small-grain and more-diverse cropping systems have been adopted. For example, minimum till practices were used on only 18% of total crop land in North Dakota in 1989, but on 28% by 1998. Prolonged wet conditions resulted in some producers returning to intensive tillage during the late 1990s in eastern North Dakota, but intensive tillage is being replaced with minimum and no till practices throughout much of central and western North Dakota.

The intensification of cropping systems and reductions in tillage that occurred in the 1980s and 1990s stimulated interest among producers in knowing the impact of cropping systems on crop response. Requests from producers were made to scientists at North Dakota State University and at the USDA-ARS Northern Great Plains Research Laboratory to determine the impact of intensifying and diversifying cropping systems on yield and quality of HRSW and other field crops. Summarizing results of ongoing cropping systems research at Mandan and near Fargo provided answers to some of the questions asked about cropping systems by producers. Other research was begun that reflected some of the emerging concepts and technologies being adopted by innovative producers.

Cropping systems studies are located across North Dakota. A brief description of selected studies and who to contact for additional information are provided.

Agricultural Experiment Station North Dakota State University

Carrington Research Extension Center

A study was begun in 1987 to determine the impact of contrasting crop rotations, fertilizer regimes, and tillage systems on performance of HRSW and other selected crops in south central North Dakota. The three rotations initially established were: (i) 'traditional' (HRSW - sunflower - barley - fallow); (ii) 'alternating grass/legume' (HRSW - soybean - millet - pea); and (iii) 'low-input' (HRSW - buckwheat+sweetclover - sweetclover plowdown - winter rye). The traditional rotation has been maintained since the study began. The alternating grass/legume rotation has been adjusted after completing each cycle of the 4-yr rotation. The crop sequence for the grass/legume rotation during the 1999-2002 cycle is HRSW - soybean - durum - pea. The low-input rotation has been replaced with a '2-yr grass/2-yr broadleaf' (2-in/2-out) rotation. The current crop sequence for the 2-yr grass/2-yr broadleaf rotation is HRSW - corn - soybean - canola.

All crops in each rotation occur every year. Within each crop/rotation combination, three tillage treatments (conventional, minimum, and no till) are maintained. Four N-fertility treatments are applied in combination with the tillage treatments: low (0 to 30 lb N/acre), medium (40

to 60 lb N/acre), high (80 to 90 lb N/acre), and composted manure. Fertilizer is applied within each crop/rotation, except during fallow or legume phases of any applicable crop sequence. Manure is applied at the rate of 160 lb N/acre at the beginning of each 4-yr cycle.

Further information about this study can be obtained by contacting Greg Endres (gendres@ndsuext.nodak.edu), Bob Henson (bhenson@ndsuext.nodak.edu), or Blaine Schatz (bschatz@ndsuext.nodak.edu) at 701-652-2951.

Dickinson Research Extension Center

The Long-term Organic and Tillage Study (LOTS) was begun in 1999 to determine if (i) weed population and density are greater in a cropping system where synthetic fertilizers and pesticides are not used (i.e., organic) compared with rotations where synthetic fertilizers and pesticides are used (i.e., chemical intensive); (ii) wheat yield and quality are reduced in an organic cropping system compared with chemical-intensive cropping systems; and (iii) economic returns from an organic cropping system are superior to the returns from chemical-intensive cropping systems. A 6-yr organic rotation (HRSW + alfalfa - alfalfa - alfalfa plowdown - HRSW - corn - oat + peas) is being compared with 4-yr alternating 'grass/broadleaf' (HRSW- pea - HRSW - canola) and alternating cool-season and warm-season grass/broadleaf (HRSW - pea - corn - buckwheat) rotations. A continuous HRSW monoculture also is included. All crop/rotation combinations occur each year. Intensive tillage occurs as needed in the organic rotation; the 4-yr rotations and the continuous HRSW monoculture are under no-till management.

The objectives of the Short-Rotation Tillage Studies are to determine (i) how phenotypic response of HRSW is affected when preceded with a dicotyledonous crop (canola and pea) in a rotation compared with HRSW in a continuous HRSW monoculture; (ii) how soil fertility and water status is affected by inserting canola and pea in a rotation with HRSW compared with a continuous HRSW monoculture; and (iii) if a tillage X cropping system interaction occurs for phenotype response in HRSW. Hard red spring wheat is rotated with pea and in a separate study with canola in plots under conventional, minimum, and no till management. A continuous HRSW monoculture also is maintained under the three tillage systems in both studies. The tillage regimes have been maintained in the plots since 1993, while the cropping system (HRSW - canola, HRSW - pea, and continuous HRSW monoculture) first were established in 1999. All tillage/cropping system combinations occur each year.

The Off-Station Rotation Study was begun in 1999 to determine if grain yield and quality are superior for HRSW in a crop-fallow monoculture compared with 3-yr alternating grass/legume/oilseed and small-grain rotations. The grass/legume/oilseed rotation was HRSW- pea - canola during the 1999-2001 cycle, while the small-grain rotation was HRSW - durum - oat. All crop/cropping system combinations occur each year.

The Ley Farming System Study was begun in 1999 to develop pasture-based cropping systems that are environmentally and economically superior to conventional grain-based cropping systems. Hard red spring wheat is rotated with a 2-yr pasture-legume phase and compared with a HRSW - canola - oat rotation. More than 25 different pasture-legume treatments are included in the study.

Questions about the studies should be directed to Patrick Carr (pcarr@ndsuext.nodak.edu) at 701-483-2581.

Main Station, Fargo

Department of Plant Sciences. Crop sequencing studies are done intermittently, as personnel with the necessary expertise and funding become available. Most recently, the effects of 17 previous crops (alfalfa, barley, canola, corn, durum wheat, flax, HRSW, mustard, navy bean, oat, pea, pinto bean, potato, soybean, sudangrass, sugarbeet, and sunflower) and fallow on stand establishment and seed yield of canola, and on mature plant stand, yield and quality of sugarbeet, were compared at Fargo and Prosper in eastern North Dakota during 2001. The effects of preceding soybean with these same 17 crops and fallow were compared at these same two sites during 2000 as well as 2001. The objective of this crop sequencing effort was to quantify inhibitory or stimulatory effects of preceding crops on popular dicotyledonous crops in North Dakota.

Further information about the crop sequencing studies can be obtained by contacting Dwain Meyer (dmeyer@ndsuext.nodak.edu) at 701-231-8154.

Department of Soil Science. The impact of tillage (fall discing or no fall discing) on durum wheat performance following pea residue was compared during 2001 to determine the effects of contrasting tillage systems on growth and yield of small grains in rotation with grain legumes. The objective of a separate study is to determine the impact of three different tillage regimes in a small grain - row crop rotation on selected soil-quality attributes after 22 years. An adjacent grassland area is included in the comparison between the different tillage/crop rotation combinations.

Further information on cropping system studies obtained by contacting Ed Deibert (edward.deibert@ndsu.nodak.edu) at 701-231-8578).

North Central Research Extension Center, Minot

The impact of preceding crops on disease incidence and severity in canola is being evaluated in a 4-yr study. The objectives of this study are to (i) document the influence of crop rotation on the incidence and severity of sclerotinia stem rot and blackleg in canola; (ii) determine the impact of previous crop on disease levels in canola; and (iii) determine if fungicide applications can be eliminated or rates reduced by altering the sequence of crops in the rotation. The four crops included in the study are barley, canola, flax, and spring wheat.

Additional information about this study can be obtained by contacting Brian Jenks (bjenks@ndsuext.nodak.edu) at 701-867-7677.

Williston Research Extension Center

A study was begun in 1995 to demonstrate that annual legumes could be used to diversify crop rotations in western North Dakota and eastern Montana. The cropping systems being compared are HRSW grown continuously or alternated with fallow, forage lentil, grain lentil, pea, and safflower. All crop/system combinations occur every year. Both harvested and green-manured strategies are included for each legume treatment, and two different fertilizer regimes are applied to the continuous HRSW monoculture and to HRSW when preceded by a

green-manured legume treatment. Nitrogen is applied to HRSW in the continuous monoculture at the recommended rate based on soil testing and also at a reduced rate. Nitrogen is applied at the recommended rate and also at an elevated rate when HRSW is preceded by a green-manured legume treatment.

Further information on this study can be provided by contacting Jim Staricka (jstarick@ndsuext.nodak.edu) at 701-774-4315.

USDA-ARS Northern Great Plains Research Laboratory

A study was initiated in 1984 to determine the effects of conventional, minimum, and no-till residue-management systems on water conservation, N and water use efficiencies, C sequestration, and crop production. Management variables included in the study were crop sequence [spring wheat - fallow (SW - F) and spring wheat - winter wheat - sunflower (SW - WW - SF)], tillage [conventional, minimum, and no till], and N fertilization (0, 20, and 40 lb N/acre for SW - F and 30, 60, and 90 lb N/acre for SW - WW - SF). Numerous publications were and still are being generated from this study, which was discontinued in the spring of 2001.

A study began in 1993 to determine the influence of minimum and no till cropping systems, which include annual forages and cover crops, on precipitation-use efficiency, biomass production, and soil quality. Management variables in the study are tillage (minimum and no till) and crop sequence (continuous spring wheat with crop residue left on soil surface, continuous spring wheat with crop residue removed, spring wheat-millet, spring wheat-safflower-fallow, spring wheat-safflower-rye, and spring wheat-fallow) and tillage (minimum till and no till). The study will be conducted through 2004.

A study was conducted from 1998 through 2001 to evaluate short-term sequencing effects on crop production, plant diseases, soil water use, weed dynamics, and soil quality. A crop X crop residue matrix was used by seeding four replicates of 10 crops (barley, canola, crambe, dry bean, flax, pea, safflower, soybean, spring wheat, and sunflower) into the crop residue of the same ten crops for two consecutive years, resulting in a 10 X 10 matrix with 100 treatment combinations. Results from the study are summarized in the Crop Sequence Calculator, v. 2.0. A second crop X crop residue matrix experiment will be conducted from 2002 through 2005 to evaluate sequencing effects for a different group of crops (buckwheat, canola, chickpea, corn, lentil, proso millet, spring wheat, sorghum, and sunflower).

Questions about cropping systems studies coordinated by scientists at the Northern Great Plains Research Laboratory can be directed at Mark Liebig (liebigm@mandan.ars.usda.gov) at 701-667-3079.

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