STEEP PROGRESS REPORT

TITLE: No-till Sowing into Standing Irrigated Stubble Instead of Burning

INVESTIGATORS:
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GROWER ADVISORS: Neil Fink, Clark Kagele, Keith Schafer, Jeff Schibel, and Gary Schell are deep-well irrigators in east-central Washington. John Aeschliman and Perry Dozier are dryland producers in the high-precipitation zone, and Ron Jirava in the low-precipitation zone, of Washington. These growers actively encouraged this research and helped design the project. They will serve as advisors throughout the life of the project.

INTERIM REPORT: Second year

OBJECTIVES: The objective of this long-term (6-yr) project is to determine the feasibility of direct seeding into high levels of residue as a substitute for burning in irrigated cropping systems. Specific objectives are to:

1. Test a 3-yr crop rotation of winter wheat - spring barley - winter canola. Crops are sown with a Cross-slot no-till drill into (i) standing stubble, (ii) after mechanical removal of stubble, and (iii) after burning the stubble. An additional treatment of annual winter wheat sown after stubble burning + moldboard plowing (sown with a double-disk drill) is included as a check.
2. Evaluate and develop effective techniques for sowing crops into heavy surface stubble using no-till methods.
3. Document cumulative effects of a diverse no-till crop rotation under three stubble management practices on soil physical and biological properties, water use efficiency, diseases, weed ecology, and farm economics. Compare these effects to those under the check treatment (i.e., continuous winter wheat after stubble burning + moldboard plowing).

KEY WORDS: Heavy residue, no-till, irrigated cropping systems, diverse rotations, stubble burning.

STATEMENT OF PROBLEM: Many deep-well irrigators in east-central Washington practice a continuous winter wheat rotation (i.e., grow winter wheat on the same field every year). Irrigated wheat grain yields range from 90-to 140-bushels per acre with residue production of 10,000 pounds or more per acre. After grain harvest in August, the traditional practice is to burn the stubble and invert the surface soil with moldboard plow tillage in preparation for sowing in September. Generally, growers feel they need to burn their fields because high residue levels hamper sowing. Alternatives to field burning are needed to reduce smoke emissions and maintain air quality.

Another reason why irrigated growers burn and moldboard plow winter wheat stubble is to control downy brome, a winter annual grass weed. Previous research has shown that long-term control of downy brome is very difficult in continuous irrigated winter wheat using no-till. Therefore, new crop rotation and stubble management strategies are needed to make no-till (without burning) work.

AGRONOMIC ZONE OF INTEREST: Irrigated. The research is also applicable to the high precipitation zone where cereal stubble after harvest may exceed 10,000 lb/acre.

ABSTRACT OF RESEARCH FINDINGS: An irrigated cropping systems study was initiated in 2000 at the WSU Dryland Research Station at Lind. The crop rotation is 3-year winter wheat - spring barley - winter canola sown *i*) directly into standing stubble, *ii*) after mechanical removal of stubble, or *iii*) after burning the stubble. The traditional practice of continuous annual winter wheat sown after burning and moldboard plowing is also included as a check treatment. Second year (2002) grain yields averaged across residue and soil management treatments were 105 bu/a for winter wheat, 2.27 t/a for spring barley, and 2305 lb/a for winter canola. There were no significant yield differences within any crop as affected by residue management. Soil DNA analysis showed that risk of several diseases of winter wheat was low to moderate in all treatments. *Pratylenchus neglectus* (nematodes) was greatest in burn/plow and *Fusarium pseudograminearum* greatest with in standing stubble. Annual analysis of soil show that soil quality in no-till plots (without burning) is increasing rapidly compared to burned and burn/plow treatments.

RESULTS AND INTERPRETATION: This study was initiated on 10 acres of prime cropland at the Washington State University Dryland Research Station at Lind. To obtain baseline residue levels to begin the experiment, the entire 10 acres was planted uniformly to Madsen winter wheat in September 1999. Grain yield (harvest August 2000) was 110 bu/a and straw production exceeded 10,000 lb/a.

Beginning in the 2001 crop year, a 3-yr crop rotation of winter wheat - spring barley - winter canola was grown under three stubble management methods. These are sowing crops: *i*) directly into standing stubble, *ii*) after mechanical removal of stubble (i.e., after swathing and bailing), and *iii*) after burning of stubble. A check treatment of continuous annual winter wheat sown after stubble burning + moldboard plowing is also included. The experimental design is a modified split plot with four replications. Each portion of the 3-yr no-till crop rotation in each stubble management method is sown each year. Thus there are 40 plots (3 crops x 3 stubble management practices + the check continuous winter wheat x 4 replications).

2002 Crop Year. Excellent stands of all crops were generally achieved using the Cross-slot drill for no-till plots and a double-disk drill for the burn/plow. However, winter canola stands were sparse in a few of the drill passes through standing barley stubble. Through trial and error, we now know that the Cross-slot openers must be in the ground before entering standing stubble plots (instead of trying to push the openers through heavy residue). Accordingly, all winter canola plots for the 2003 crop year have excellent stands. A complete list of field operations in this experiment was reported in the 2001 STEEP report and is not repeated here.

Similar to 2001, there were no within-crop grain yield differences in 2002 as affected by residue management treatment (Table 1). Spring barley and winter canola were hurt by late spring frost, whereas winter wheat generally escaped frost damage. Soil water content in all 40 plots is measured to a depth of six feet just after harvest and again in April (water data not shown).

Table 1. Grain yields of winter wheat, spring barley, and spring canola in 2001 and 2002 as affected by various stubble and soil management practices.

	Winter Wheat (bu/a)		Spring Barley (ton/a)		Winter Canola (lb/a)	
	2001	2002	2001	2002	2001	2002
Stubble burned	85	106	2.88	2.21	2574	2502
Stubble mechanically removed	67	110	3.03	2.33	2486	2226
Standing Stubble	69	107	2.88	2.26	2282	2188
Burn and Plow	75	97				
LSD (0.05)	NS	NS	NS	NS	NS	NS

NS = no significant differences at the 5% probability level.

Tim Paulitz assessed plant diseases. In early April 2002, soil samples were taken between the rows of growing winter wheat. Soil samples were air dried and then sent to Australia for DNA analysis for *Pratylenchus neglectus* (nematodes), *Rhizoctonia solani* AG-8, Take All, *Fusarium culmorum*, and *Fusarium pseudograminearum* (Table 2). *Pratylenchus neglecutus* was detected at significantly higher levels in burn/plow, whereas fusarium was greatest in the standing stubble and mechanically removed (i.e., non burned) treatments.

In October 2002, winter canola in the standing residue management treatment became diseased. Canola samples showed pythium disease (possibly a new species) as well as heavy infestation of rhizoctonia. All winter canola was subsequently 'winter killed' by 4^0F temperatures in late October.

Weed species in 2002 included prickly lettuce, mares tail, tansy mustard, downy brome, as well as small populations of pepper weed, oyster plant, mayweed, and star thistle. The only significant difference in weed populations as affected by crop or residue management was in downy brome (Table 3). There was essentially no downy brome present in any plot that had been burned, or in winter canola (where Assure II herbicide was used). Small downy brome populations were present in winter wheat and spring barley in the standing stubble and stubble mechanically removed plots.

Table 2. Effect of tillage and residue management on soil DNA levels of several plant pathogens in winter wheat. Data from Tim Paulitz, USDA-ARS.

	Pratylenchus neglectus	Rhizoctonia solani AG-8	Fusarium	Take-All
	DNA (pg/g soil)			
Stubble burned	12 b	70 a	11 a	21 a
Stubble mech. removed	16 b	80 a	52 ab	19 a

Standing stubble	18 b	72 a	83 b	18 a
Burn & plow	49 a	31 a	16 ab	30 a

[x] Within-column averages followed by a different letter are significantly different at the 5% probability level.
pc/g = picograms/gram

Table 3. Population of four weed species in winter wheat, spring barley, and winter canola in 2002 as affected by residue management.

		Weeds (per 3 m^2)				
Crop	Residue Management	Prickly Lettuce	Mares-tail	Tansy Mustard	Downy Brome	Total[x]
Winter Wheat	Burn/Plow	0	0	0	0 d	0
Winter Wheat	Burned	5	18	1	1 cd	26
Winter Wheat	Mech. Removed	4	14	2	12 a	32
Winter Wheat	Standing	4	7	1	4 bcd	16
Spring Barley	Burned	7	2	2	0 d	13
Spring Barley	Mech. Removed	12	7	1	9 ab	30
Spring Barley	Standing	5	6	0	7 abc	18
Winter Canola	Burned	3	4	4	0 d	11
Winter Canola	Mech. Removed	5	3	5	0 d	16
Winter Canola	Standing	3	1	13	0 d	22
		NS	NS	NS		NS

Within-column averages followed by the same letter are not significantly different at P<0.05.
[x]Includes small populations of pepperweed, oyster plant, mayweed and star thistle.

INTERACTION WITH OTHER SCIENTISTS CONDUCTING RELATED ACTIVITY:
In addition to the co-investigators of this project, the PI is cooperating with: Doug Young, WSU Pullman, on economic evaluation of spring wheat vs. winter wheat-fallow in the Horse Heaven Hills as well as at the Jirava cropping systems study near Ritzville; Jim Cook, WSU Pullman, on Rhizoctonia root rot in continuous no-till farming; Ann Kennedy, USDA-ARS Pullman, on soil microbiology of dryland cropping systems at Lind and Ritzville; Roger Veseth, WSU/UI Moscow, on cropping systems technology transfer; Frank Young, USDA-ARS, on the Ralston project; Richard Smiley, OSU Pendleton, on evaluation of Australian wheat lines; Stewart Wuest and John Williams, USDA-ARS Pendleton, on reducing water erosion on frozen agricultural soils; and Stephen Machado and Steve Petrie, OSU Pendleton, on cropping systems research at Moro, OR.

PUBLICATIONS AND PRESENTATIONS (2002 only)

Published Abstracts

Schillinger, W.F., T.C. Paulitz, and A.C. Kennedy. 2002. Direct seeding into heavy irrigated cereal stubble instead of burning. Soil Science Society of America annual meeting 11-14 Nov.,

Indianapolis, IN. [CD-ROM]. *ASA, CSSA, and SSSA Abstracts.*

Experiment Station Research and Extension Reports

Schillinger, W., H. Schafer, B. Sauer, T. Paulitz, A. Kennedy, D. Young, A. Kennedy, S. Schofstoll, D. Wysocki, K. Saxton, B. Fode, K. Schroeder, and C. Claiborn. 2002. Irrigated cropping systems research at Lind. pp. 96-99. In: *2002 Field Day Proceedings: Highlights of Research Progress*. Dep. of Crop and Soil Sciences Tech. Rpt. 02-1, WSU, Pullman, WA.

Field Days, Presentations, and Advisory Meetings

This project was shown and discussed by Schillinger to 170 people at the Lind Field Day on June 13, 2002. The project was also shown informally to numerous groups and individuals.

Presentations on this project were made to 40 people at the University of Idaho Canola Working Group meeting in Moscow on March 4, 2002, and to 70 people at the annual meeting of the Columbia Plateau Wind Erosion/Air Quality Project on December 6, 2002.

The annual researcher-grower advisory meeting for this project was held at Lind on November 26, 2002 (15 attended).