LONG-TERM DIRECT SEED ALTERNATIVE CROPPING SYSTEMS RESEARCH AT THE RON JIRAVA FARM: YEAR 5

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Summary of Research Findings

The 2001 crop year was one of extreme drought that severely affected spring-sown crops in all low-rainfall dryland regions in the inland Pacific Northwest. Grain yield in continuous spring wheat plots was 14 bu/a in 2001 compared to the previous 4-year average of 44 bu/a. After consulting with a grower-scientist advisory committee, two new 4-year rotations were added to the study for years 2001-2004 (Table 1). Similar to spring-sown crops, re-crop winter wheat failed in the 2001 crop year. Winter wheat, grown after 4 years of continuous spring cropping where annual grass weeds were not present, was heavily infested with downy brome. Winter wheat seedlings following back-to-back broadleaf crops survived the winter under 100+ days of snow cover only to die from Rhizoctonia root rot during the 2-3 leaf stage of growth in early spring. Rhizoctonia occurred in large patches. There are reports in the literature that *Brassica spp.* such as mustard and other deep-rooted broadleaf crops reduce disease pressure and enhance grain yield of the subsequent wheat crop. We have not found this to be true in this study. Considering that broadleaf crops provide no apparent benefit for Rhizoctonia root disease control and leave less soil water available for the ensuing one or two cereal crops, growers in low-precipitation areas on the inland PNW are probably better off to plant continuous cereals.

Objectives

The objective of the study is to determine the long-term feasibility of diverse, cereal-based, direct-seed cropping systems for low-rainfall dryland areas of the inland Pacific Northwest. Specific objectives are to evaluate and compare several long-term direct-seed annual cropping systems on: *i*) root disease, soil moisture dynamics, and grain yield of wheat, *ii*) weed species shifts and weed ecology, *iii*) physical and biological properties of the surface soil, and *iv*) the agronomic and economic of potential as a replacement for the traditional winter wheat-summer fallow system.

Methods and Materials

This study was initiated in 1997 at two locations. The Adams County site is on the Ron Jirava Farm near Ritzville. Precipitation at the Jirava site averages 11.5 inches, elevation is 1850 ft asl, and the soil is a deep Ritzville silt loam. The experimental design is a randomized complete block with four replications. During the first four years (1997-2000) the three spring cropping systems were: *i*) a 4-year safflower – yellow mustard – wheat – wheat rotation; *ii*) a 2-year wheat – barley rotation and; *iii*) continuous wheat. All phases of all rotations were sown each year for a total of 28 plots, each plot 60 ft X 500 ft. All crops are sown with an 8-foot-wide Cross-slot drill which delivers seed and all fertilizer in one pass. Fertilizer rate (nitrogen, phosphorus, and sulfur) is held constant in all plots and is based on nutrient and soil moisture availability.

The first four years of cropping systems research were completed in 2000 (i.e., one cycle of the 4-year rotation). A committee of growers and scientists extended and expanded the project for years 2001-2004. Beginning with the 2001 crop year, the experiment includes two 4-year rotations, two 2-year rotations using soft white and hard white spring wheat and spring barley, and continuous soft white and hard white spring wheat (Table 1). Both 4-year rotations contain winter wheat. Expansion of the project in phase II was possible because the original plots were wide. Starting in year 5 (2001), we split each plot to create 30 ft x 500 ft strips (total = 56 plots). We were able to create the additional treatments and still have four replicates; thus, the statistical precision of the experiment was maintained.

Table 1. Previous (1997-2000) and current (2001-2004) crop rotations in the long-term cropping systems study at the Ron Jirava farm in Adams County, Washington. All phases of each rotation are planted every year in 500-ft-long plots, each replicated four times.

Years 1997 through 2000	Years 2001 through 2004
Four-Year Rotations	
1. Safflower-YM-SWSW-SWSW	1. SWWW-SWWW-SWSW-SWSW
	2. SWWW-SB-YM-SWSW
Two-Year Rotations	
2. SWSW-SB	3. SWSW-SB
	4. HWSW-SB
Continuous Spring Wheat	
3. Continuous SWSW	5. Continuous SWSW
	6. Continuous HWSW

Abbreviations: HWSW, hard white spring wheat; SB, spring barley; SWSW, soft white spring wheat; SWWW, soft white winter wheat; YM, yellow mustard.

Results

Crop Yields. Grain yields for all years at the Adams county site are shown in Table 2. In 2001, grain yield for all crops was very low due to drought conditions. Total crop-year precipitation (1 Sept. 2000 to 31 Aug. 2001) was only 8.0 inches. There was an average of only 2.25 inches of available soil water in the six-foot soil profile in mid March 2001 and only 2.44 inches of rainfall occurred between mid March and August. Green patches of healthy spring wheat and barley were surrounded by vast areas of drought stressed wheat. These "leopard spots" occurred widely throughout the inland PNW wheat region in 2001 and are certainly associated with drought, but their exact cause remains a mystery. Numerous lifelong growers reported that they had never previously seen such leopard spots in their fields.

Re-crop winter wheat grain yields were 7 bu/a or less in 2001 (Table 2). Many winter wheat seedlings survived the winter months only to be killed by Rhizoctonia root rot in early spring. There was heavy downy brome infestation in winter wheat grown after four years of continuous spring wheat during which time downy brome was completely absent. Downy brome infestation was not as bad in winter wheat grown after yellow mustard compared to after continuous spring wheat, but Rhizoctonia root rot was more severe (see Rhizoctonia section of this report). The best cereal yields (14 bu/a) were achieved in the continuous soft white spring wheat plots (Table 2).

Table 2. Crop yields at the Ron Jirava farm in Adams County, Washington, since beginning the cropping systems study in 1997. The 2001 crop year was a transition period where two new four-year rotations were introduced.

Rotation	Units	1997	1998	1999	2000	2001	5-yr Avg.
1. Four-year							
Safflower	lb/a	1420	720	1040	600		
Y. mustard	lb/a	1430	340	110	490	350	540
1st yr wheat	bu/a	---	41	27	40	8	
2nd yr wheat	bu/a	---	---	25	38	6	
2. Two-year							
Wheat	bu/a	---	40	28	44	12	
Barley	ton/a	2.30	1.13	0.76	1.30	0.35	1.17
3. Cont. wheat	bu/a	64	41	27	43	14	38

Also in 2001: Winter wheat after 4 years of continuous spring wheat = 7 bu/a.
Winter wheat after back-to-back broadleafs (i.e., safflower and YM) = 5 bu/a.
Hard white spring wheat after barley = 10 bu/a.
Hard white spring wheat after back-to-back broadleafs = 6 bu/a.

Impacts of Rhizoctonia Root Rot. Percent land area infected by Rhizoctonia root rot at the Adams County site has been presented in previous WSU Field Day reports. It is highly unlikely that the severe patches caused by Rhizoctonia solani AG8 in the first wheat crop following two consecutive broadleaf crops were due to survival of the pathogen in old wheat residue over the two years since wheat was last grown in these plots. Even a short period of fallow can greatly reduce the severity of this disease. It seems more likely that, since all crops in these systems are hosts and since the period of time from planting (mid March to early April) to harvesting (August for mustard, barley, and wheat and September for safflower) was approximately the same, the amount of primary inoculum for production of Rhizoctonia root rot in the next crop was also then approximately the same.

The wide host range of *R. solani* AG8 has been well documented. Nevertheless, different kinds of crops have diverse effects on the soil environment, they have tap versus fibrous root systems, and they produce various amounts of crop residue or the residue decomposes at different rates when left on the soil surface in direct-seed systems. Depending on the extent of these differences, the amount of disease in this low-precipitation area could also differ, at least between systems as dissimilar as our original (1997-2000) 4-year rotation and the continuous wheat system. The original 4-year rotation was designed to augment any benefit of broadleaf crops for control of root disease by including two broadleaf crops back-to-back before returning to wheat. Previous studies on rotational effects of broadleaf crops have been limited to a single broadleaf crop as a break crop before wheat.

In spite of the differences in crops and rotations, the incidence and severity of both Rhizoctonia root rot were similar if not the same on wheat whether the cropping system was continuous wheat, a 2-year barley – wheat rotation, or a 4-year safflower – mustard – wheat – wheat rotation. In this study, broadleaf crops provided no benefit for Rhizoctonia root disease control and left less soil water available for the ensuing one or two cereal crops, thus growers in low-precipitation areas on the inland PNW are probably better off to plant continuous cereals.