

**Project Title:** Impact of Alternative Crops on Winter Wheat and Spring Cereal Establishment, Growth, Yield, and Economics in Direct Seed Systems in the Intermediate Rainfall Area of Washington.

**Investigators:**

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**Interim Report**

**Objectives:** The objectives of this project are to: a) evaluate the impact of alternative crops on establishment, growth, yield, and economics of winter wheat and spring cereals, and b) evaluate the impact of winter and spring cereals on establishment, growth, yield, and economics of spring seeded alternative crops in a continuous cropping system.

**Key Words:** alternative crops, crop rotations, chemical fallow

**Statement of Problem:** Lack of information about the effect of alternative crops on cereal grain production has limited the effectiveness of designing profitable crop rotations in the intermediate rainfall area of Washington.

**Zone of interest:** Intermediate rainfall zone

**Abstract of Research Findings:**

Studies were conducted at the WSU Wilke Research and Extension Farm near Davenport to evaluate the effect of broadleaf and cereal crops on establishment, growth and yield of winter wheat and spring cereals. Results from the first season of a two-season study showed that spring cereal yield greater and there are more options for weed control than broadleaf crops. In 2003, weed competition and dry conditions caused broadleaf crops to be lower than expected based on available spring moisture. In 2004, broadleaf crop yield was substantially greater. With broadleaf crops, weed management is an important issue. Chemical fallow had a net loss of 1 or 3.5 inches of moisture in a five foot profile over the growing season, depending on year. Winter wheat established in the chemical fallow plots in the fall but did not establish until early spring in all other plots because of lack of moisture in the seed germination area. Winter wheat grown after chemical fallow yielded greatest, and had the highest gross return in 2005, while in 2004, winter wheat grown after spring wheat had the highest yield and gross return.

**Results and Interpretation:**

Evaluation of impact of alternative crops on cereal yield. The focus of this project is to determine the impact of alternative crops on winter and spring wheat and barley. Results from the four year Wilke project concluded that cereal production in a rotation was generally the only crop that was profitable, therefore, maximizing cereal yield (especially winter wheat) in a rotation is desirable. Two year rotations were evaluated at the WSU Wilke Research and Extension Farm near Davenport, WA beginning in 2003 and concluding in 2004. The experiment was repeated beginning in 2004 and completed in 2005. The Wilke Farm is located in an area with historically 15 inches of precipitation per year. Yellow mustard ('IdaGold'), spring pea ('Cruiser'), safflower

(‘Gila’), spring wheat (‘Alpowa’) and barley (‘Baronesse’) were seeded in the spring of 2003. Hard white spring wheat (‘ID 377S’) was added to the experiment in 2004. Crops were fertilized at the time of seeding based on soil tests and projected crop yield. Chemical fallow was included as another alternative in a rotation as potential to increase winter wheat yield and reduce weed competition. Prior to seeding, the plot area was treated with glyphosate to control weeds and volunteer cereals. The experimental design of the study is a split-block arrangement of a randomized complete block with alternative crops as main-plots and winter wheat and spring cereals as sub-plots and crops being randomized within a block with four replications. Main plots were 36 by 36 feet and sub-plots are 12 by 36 feet. Replications are separated with alleyways to allow equipment operations between replications and alleys will be seeded to a spring cereal. Crops were seeded into cereal stubble in a field that have been direct seeded for five to seven years with a double disk direct seed plot drill that seeds six feet and has the capability to supply the complete fertilizer requirement at seeding time.

In crop weeds were treated using registered herbicides if any available. The chemical fallow plots were kept weed free applying glyphosate or glyphosate + 2,4-D when needed. Yield was determined by harvesting a 4.9 by 35 foot swath in a representative area of each plot using a small plot combine. Soil moisture in the profile to 5 feet were evaluated gravimetrically prior to planting and after crop harvest to determine crop use during the growing season. Winter wheat (‘Eltan’) was seeded on October 18, 2003, and on October 26, 2004 and spring wheat (Alpowa) and barley (Barronesse) were seeded on May 3, 2004, and on April 27, 2005.

Populations for broadleaf crops were in the range considered to be normal and initial weed populations were fairly low (data not shown). As the season progressed, late germinating weeds caused significant competition with broadleaf crops, decreasing yield. At harvest, all three broadleaf crops were infested with late emerging lambsquarter ( *Chenopodium album* L.) and Russian thistle (*Salsola iberica* Sennen). This was due to the lack of effective herbicides to control broadleaf weeds in these broadleaf crops. Cereal crops were treated with labeled rates of Harmony and 2,4-D and weed populations were kept in check. Chemical fallow plots required 4 applications of glyphosate to control weeds. Late in the summer, Russian thistle became difficult to control in the chemical fallow plots and required 2,4-D to be mixed with glyphosate to effectively control Russian thistle. Cereal yields were equivalent with other crop yields reported in the area.

During the growing season, safflower used significantly more water for production than the other crops and all other crops used nearly the same amount of water (Table 1). One and 3.5 net inches of moisture was lost from the chemical fallow plots during the growing season in 2003 and 2004, respectively, but there was sufficient moisture in the seed zone for seed germination due to timely rainfall. In 2003, overall yield was low with broadleaf crops, yellow mustard, pea, and safflower yielded 205.2, 785.8, and 464.5 lb/acre, respectively. In 2004, broadleaf crop yield was substantially greater with yellow mustard, pea, and safflower yielding 1355.3, 1301.2, and 1436.9 lb/acre, respectively. Barley yield was also greater in 2004 compared with 2003 while spring wheat yield remained nearly constant between years.

Available soil moisture prior to seeding winter wheat was significantly higher for chemical fallow plots than for those that were in crop during the year (Table 2). In 2003, plots that had grown

safflower were significantly lower than other plots. In 2004, plots that had grown safflower had significantly lower soil moisture than those that had been planted to barley. By spring, soil moisture was significantly different among previous treatments in the experiment initiated in 2003, but for the study initiated in 2004, plots that were previously chemical fallow had significantly higher soil moisture content than all other treatments except yellow mustard.

Winter wheat seeded in chemical fallow plots established in the fall, but all other winter wheat seeded into a previous crop did not emerge until early spring. This has been consistent with other research and production in re-crop situations. During the 2003-2004 experiment, plot yield was quite variable (Table 3). Winter wheat after chemical fallow did not yield greater than other treatments. Winter wheat grown after soft white spring wheat yielded numerically higher than other treatments, but the results were not significant. Spring wheat also yielded greatest following soft white spring wheat and yield was significantly greater than spring wheat grown after yellow mustard or safflower. Barley grown after chemical fallow yielded highest and was significantly greater than barley grown after peas.

During the 2004-2005 study, winter wheat grown after chemical fallow yielded significantly greater than winter wheat grown after yellow mustard, pea, barley, soft or hard white spring wheat (Table 3). Winter wheat grown after safflower yielded higher than winter wheat grown after soft white spring wheat. Both winter wheat and spring wheat did not establish well after soft white spring wheat in contrast to the previous years results. Barley grown after chemical fallow yielded significantly greater than barley after other treatments, this is a consistent trend for both years. In a re-crop system, there was no advantage in choosing winter wheat, spring wheat, or barley, the choice would need to be based on other things such as market potential, economic risk, fertilizer costs, workload, and weed populations.

Gross return of two year rotations for the 2003-2004 study showed that winter wheat followed by spring wheat or spring wheat followed by spring wheat gave higher returns than the safflower rotation, yellow mustard followed by spring wheat or barley, or pea followed by barley (Table 4). Winter wheat or spring wheat following chemical fallow provided higher gross return than spring wheat or barley following yellow mustard or barley following pea.

Gross returns for the two year rotations for the 2004-2005 study showed a significant economic advantage of winter wheat following chemical fallow over all other re-crop treatments (Table 4). There was a significant economic advantage of producing winter wheat over spring wheat after chemical fallow but not barley. In continuous crop situations, there was greater economic return from selecting winter wheat over spring wheat or barley following yellow mustard, pea, safflower and hard white spring wheat. Because of the differences in results of the two replications of this study another two year rotation cycle will be completed to gain further insights and investigate the differences among years at two locations in 2006-2007.

Effect of wheat or barley on alternative crop production. A second study was conducted in 2004 to evaluate the influence of cereal crops on spring crop production the following year. Yellow mustard (Ida Gold), pea (Cruiser), safflower (Gila), soft white spring wheat (Alpowa), hard red spring wheat ('Tara'), hard white spring wheat (ID 377S), and barley (Baronesse) were seeded on

May 3, 2004 into spring wheat and barley stubble. Prior to seeding, plot area was treated with glyphosate for weed and volunteer cereal control.

Preliminary results show that there were no significant differences in yield whether crops were sown into wheat or barley stubble (data not shown). There was no significant difference in yield for the various cereal or broadleaf crops regardless of previous crop.

Table 1. Crop yield and water use in establishment year.

Previous crop	Yield		Water use <sup>a</sup>	
	2003	2004	2003	2004
	----- lb/acre -----		----- inches -----	
Yellow mustard	205	1355	4.8	8.4
Pea	786	1301	4.6	8.3
Safflower	465	1437	7.0	10.3
Barley	1612	4178	4.8	8.6
SWSW <sup>b</sup>	1070	1076	4.4	7.7
HWSW	-	2080	-	8.1
Chemical fallow	-	-	1.0	3.5
LSD <sub>(0.05)</sub>	271	728	0.9	1.1

<sup>a</sup>Crop water use is calculated by collecting soil moisture at beginning of season subtracting soil moisture at season end plus any precipitation recorded.

<sup>b</sup>Abbreviations: SWSW, soft white spring wheat; HWSW, hard white spring wheat.

Table 2. Available soil moisture in a five foot profile in the fall and spring prior to seeding winter wheat or spring cereals.

Previous crop	Soil moisture			
	Fall 2003	Spring 2004	Fall 2004	Spring 2005
	-----inches-----			
Yellow mustard	5.1	12.3	6.4	12.3
Pea	5.2	12.9	5.5	11.6
Safflower	3.9	12.1	4.4	10.7
Barley	5.0	12.0	7.2	11.6
SWSW <sup>a</sup>	5.3	12.4	6.3	11.0
HWSW	-	-	5.9	11.0
Chemical fallow	8.5	13.5	10.2	14.1
LSD <sub>(0.05)</sub>	0.9	NS	2.1	2.2

<sup>a</sup>Abbreviations: SWSW, soft white spring wheat; HWSW, hard white spring wheat.

Table 3. Winter wheat, spring wheat, or barley yield following broadleaf, cereal crop, or chemical fallow.

Previous crop	Crop yield					
	2004			2005		
	Winter wheat	Spring wheat	Barley	Winter wheat	Spring wheat	Barley
	----- lb/acre ----- (bu/acre)					
Yellow mustard	1482.0 (24.7)	1067.8 (17.8)	1924.1	2082.3 (34.7)	1888.4 (31.5)	1884.9
Pea	2016.5 (33.6)	2824.6 (47.1)	1068.8	2191.2 (36.5)	1551.5 (25.9)	1810.1
Safflower	1494.2 (24.9)	1333.5 (22.3)	2739.2	2555.2 (42.6)	1483.5 (24.7)	1980.2
Spring barley	1736.2 (28.9)	2190.2 (36.5)	2042.2	1884.9 (24.3)	1531.1 (25.5)	1520.2
SWSW <sup>a</sup>	3110.8 (51.8)	3154.8 (52.6)	2866.5	1343.9 (22.4)	1262.3 (21.0)	1708.0
HWSW	-	-	-	2344.3 (39.1)	1524.3 (25.4)	1745.4
Chemical fallow	2644.7 (44.1)	2610.3 (43.5)	3104.9	3504.5 (58.4)	2221.8 (37.0)	3303.7
LSD <sub>(0.05)</sub>	-----1659.9----- (27.7)			----- 911.9 ----- (15.2)		

<sup>a</sup>Abbreviations: SWSW, soft white spring wheat; HWSW, hard white spring wheat.

Table 4. Gross return of winter wheat, spring wheat, or barley yield grown in a two year rotation following broadleaf, cereal crop, or chemical fallow.

Previous crop	Gross return					
	2004			2005		
	Winter wheat	Spring wheat	Barley	Winter wheat	Spring wheat	Barley
	----- \$/acre-----					
Yellow mustard	120	64	67	106	96	83
Pea	121	169	37	112	79	80
Safflower	90	80	78	130	76	87
Spring barley	104	131	71	96	78	67
SWSW <sup>a</sup>	187	187	100	69	64	75
HWSW	-	-	-	130	78	77
Chemical fallow	159	157	109	179	113	145
LSD <sub>(0.05)</sub>	-----89-----			-----46-----		

<sup>a</sup>Abbreviations: SWSW, soft white spring wheat; HWSW, hard white spring wheat.

#### **Interaction With Other Scientists Conducting Related Activities:**

This project is complimentary to other cropping systems projects currently funded by STEEP. Chemical fallow plots are managed in relationship to Joe Yenish et.al STEEP funded project work examining herbicide efficacy in chemical fallow management. Additional interactions include Bill Schillinger, Rich Koenig, Don Wysocki, Jim Cook and Dennis Roe.

#### **Publications and Presentations:**

This project was shown and discussed at the 2003 and 2004 Wilke Field Day and will be featured in 2006. Specific aspects of the trial will be utilized in winter grower meetings as well.