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. Due to the lack of available funds the project was scaled back from what was proposed. We only conducted the study at one site and included only three broadleaf and two cereal crops.

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 are being 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. Weed competition and dry conditions caused yellow mustard yield to be lower than expected based on available spring moisture. Pea yield was average or above average based on past experience. Spring wheat and barley yield was equivalent to surrounding fields. Safflower yield was 559 lb/A and used significantly more moisture than other crops and also had severe broadleaf weed problems. Chemical fallow had a net loss of one inch of moisture in a five foot profile over the growing season. 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, spring wheat, and barley yield were all lowest in plots that had safflower as the previous crop.

Results and Interpretation:

<u>Evaluation of impact of alternative crops on cereal yield.</u> 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. The experiment was conducted at the WSU Wilke Research and Extension

Farm near Davenport, WA 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. Crops were fertilized at 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. 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 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.

Crop establishment and weed populations were assessed by counting the number of plants in two 0.25 m^2 areas in each plot. Weeds were treated using registered herbicides if any available. The chemical fallow plots were kept weed free applying glyphosate 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 to evaluate crop water use. Rainfall during the growing season was monitored. Winter wheat (Eltan) was seeded on October 18, 2003, and spring wheat (Alpowa) and barley (Barronesse) were seeded on May 3, 2004.

Populations for broadleaf crops were in the range considered to be normal and initial weed populations were fairly low (Table 1). As the season progressed, late germinating weeds caused significant competition with yellow mustard and safflower, decreasing yield. At harvest time, all three broadleaf crops were infested with large lambsquarters and Russian thistle plants. 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. Because of weed infestations and lack of rainfall during the growing season caused yellow mustard yield to be lower than expected. Pea yield was not as affected by weed competition because of early maturity before weeds competed with the crop. 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). A net one inch of water was lost from the chemical fallow plots during the growing season but there was sufficient moisture in the seed zone for seed germination due to timely rainfall.

Safflower depleted soil moisture more than other crops while chemical fallow had the greatest amount of soil moisture (Table 2). By spring 2004, there were no statistical differences in soil moisture content among treatments (average of 12.5 inches in five feet), although chemical fallow plots tended to have higher moisture content.

Winter wheat seed in chemical fallow plots established in the fall, but all other winter wheat seeded into a previous crop did not emerge until early spring. Winter wheat seedling populations were highest with spring wheat as the previous crop (Table 3), due to volunteer spring wheat. Winter wheat seeded after safflower had the fewest plants. Weed populations were greatest after pea and safflower due to poor weed control in these crops. Winter wheat after chemical fallow had the lowest weed populations. Winter wheat grown after chemical fallow, yellow mustard, or pea ranged 21 to 28% higher in yield than winter wheat grown after safflower. This may be due in part to soil water depletion and weed populations after safflower but not all yield reduction can be attributed to these factors. This yield depression also was seen in spring wheat and barley. Test weight, tiller number and crop water use was not significantly different among treatments.

Spring wheat and barley establishment were not affected by previous crop and averaged 34.5 plants/ft^2 (Tables 4 and 5). Spring weed populations were lowest in plots that were previously pea, chemical fallow or spring wheat, followed by those in barley. Plots that were previously in yellow mustard or safflower had the highest weed populations. As previously mentioned, both spring wheat and barley yield were substantially lower following safflower than any other crop. Although not statistically significant, spring wheat following pea and barley after chemical fallow had the highest yield. In spring wheat, test weight, tiller number, or crop water use was not influenced by the previous crop. Barley water use was lower after yellow mustard than pea or chemical fallow while none of the other previous crops influenced crop water use.

<u>Effect of wheat or barley on alternative crop production.</u> A second study was conducted 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 were no significant difference in yield for the various cereal crops (Table 6). Data from the broadleaf crops is still being analyzed.

Table 1. Crop establishment weed populations, yield and water use, 2003.

Crop (variety)	Stand	Weed population	Yield	Water[a] use
	plant/ft^2	plant/m^2	lb/A	in
Yellow mustard (IdaGold)	14.4	7.5	229	4.8
Pea (Cruiser)	7.1	6.5	882	4.6
Safflower	7.0	5.5	559	7.0
Barley (Baronesse)	12.7	2.0	1551	4.8
Spring wheat (Alpowa)	8.1	2.0	1712	4.4
Chemical fallow	-	-	-	1.0
LSD (0.05)	1.8	4.1	285	0.9

[a]Crop water use is calculated by collecting soil moisture at beginning of season subtracting soil moisture at season end plus any precipitation recorded.

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

Previous crop (variety)	Soil moisture (fall 2003)	Soil moisture (spring 2004)
	---------inches ---------	
Yellow mustard (Ida Gold)	5.1 b	12.3
Pea (Cruiser)	5.2 b	12.9
Safflower	3.9 c	12.1
Spring Wheat (Alpowa)	5.3 b	12.4
Spring Barley (Baronesse)	5.0 b	12.0
Chemical fallow	8.5 a	13.5
LSD (0.05)	0.9	NS

Table 3.Winter wheat crop establishment, weed populations, yield and water use.

Previous crop (variety)	Stand	Weed population	Yield	Test weight	Tiller Number	Water use
	plants/ft^2	plant/m^2	lb/A	lb/bu	no./plant	in
Yellow mustard (Ida Gold)	21.3	9.6	64	56.0	5.7	8.2
Pea (Cruiser)	30.6	31.1	61	57.0	5.1	8.2
Safflower	15.0	21.5	47	55.0	7.9	7.2
Spring Wheat (Alpowa)	39.1	7.2	60	56.0	7.0	7.2
Spring Barley (Baronesse)	26.3	7.2	52	56.0	7.9	8.4
Chemical fallow	29.7	4.8	66.0	57.0	5.9	6.9
LSD (0.05)	8.6	2.7	11	ns	ns	ns

Table 4. Spring wheat crop establishment, weed populations, yield and water use.

Previous Crop (variety)	Stand	Weed Population	Yield	Test weight	Water use
	plants/ft^2	plant/m^2	lb/A		in
Yellow mustard (Ida Gold)	36.6	12.0	41	57.0	6.8
Pea (Cruiser)	45.6	0	51	56.0	8.6
Safflower	46.9	19.1	25	51.5	7.3
Spring Wheat (Alpowa)	40.6	4.8	41	57.7	7.3
Spring Barley (Baronesse)	36.3	7.2	42	57.0	6.9
Chemical fallow	39.7	4.8	45	58.5	8.7
LSD (0.05)	ns	2.7	11	ns	1.4

Table 5. Spring barley crop establishment, weed populations, yield and water use.

Previous crop (variety)	Stand	Weed Population	Yield	Water use
	plants/ft^2	plant/m^2	lb/A	in
Yellow mustard (Ida Gold)	21.3	9.6	2432	6.5
Pea (Cruiser)	47.5	2.4	2680	8.2
Safflower	49.7	7.2	1943	7.5
Spring Wheat (Alpowa)	50.0	4.8	2197	7.0
Spring Barley (Baronesse)	50.9	7.2	2546	6.8
Chemical fallow	55.0	4.8	2768	8.3
LSD (0.05)	8.6	2.7	699	1.4

Table 6. Yield of various alternative crops grown in wheat or barley residue, averaged over residue type.

Crop (variety)	Yield
	lb/a (bu/a)
Yellow mustard (Ida Gold)	
Pea (Cruiser)	
Safflower (Gila)	
Soft white spring wheat (Alpowa)	1745 (29)
Hard red spring wheat (Tara)	1811 (30)
Hard white spring wheat (ID 377S)	2311 (39)
Spring barley (Baronesse)	1784
LSD (0.05)	ns

Interaction With Other Scientists Conducting Related Activities:
This project is complimentary to other cropping systems projects currently funded by STEEP. This includes Bill Schillinger, Joe Yenish, Don Wysocki, Jim Cook, Dennis Roe.

Publications and Presentations:
This project was shown and discussed at the 2003 and 2004 Wilke Field Day.