STEEP PROGRESS REPORT-2004

RESEARCH PROJECT TITLE: Initiating Long-term Agronomic Experiments in North-Central Oregon and South-Central Washington.

INVESTIGATORS:

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INTERIM OR FINAL REPORT: Interim

PROJECT OBJECTIVES:

The overall focus of this project is to develop profitable and sustainable cropping systems for north-central Oregon and south-central Washington. The main objective to establish a long-term experiment that will compare the effects of a conventional wheat-fallow system with potential alternative and intensive crop systems and crop management practices such as direct seeding. Specific objectives include determining systems that

- increase residue cover,
- increase soil OM,

- increase available soil moisture,
- reduce wind and water erosion,
- reduce soil water evaporation,
- sustain soil productivity.

Information to address these objectives will be, however, obtained only after long-term experimentation.

KEYWORDS: Long-term experiments (LTEs), intensive cropping systems, direct seeding

STATEMENT OF PROBLEM: The wheat/fallow rotation reduces soil organic carbon, exacerbates soil erosion, and it is not biologically sustainable. Despite these concerns, adoption of alternate cropping systems, such as intensive cropping and direct seeding, has been slow due to lack of long-term research in Oregon on viability of alternate cropping systems. Occasional crop failures occurred under long-term conventional intensive cropping studies conducted at the Sherman Experiment Station in the 1940s to the 1960s. But with the advent of new varieties and agronomic practices such as direct seeding, long-term research is needed to enhance benefits and reduce risks for annual cropping.

AGRONOMIC ZONE OF INTEREST: Research will be targeted for Agronomic Zones 4 and 5 in north-central Oregon and south-central Washington. The investigations will emphasize dryland production with increased cropping intensity under reduced tillage and direct seed cropping systems.

ABSTRACT OF RESEARCH FINDINGS: Experimental plots were first seeded in the fall of 2003. Grain yields obtained in 2004 are meaningless since we are in the process of setting up the treatment conditions for our experiments. Baseline information on soil physical and chemical properties, weeds species and distribution, and diseases was collected and documented. Grain yields of winter wheat and spring wheat crops indicate that the plots were uniform at the beginning of the season. Treatment effects are expected to show in 2005.

RESULTS AND INTERPRETATION

The experimental site was solid seeded in the spring of 2003 to homogenize the site. Experimental plots were then established in the fall of 2003 (Fig. 1). Each plot measures 48 x 350 ft. Plots were established after harvest 2002 in an RCB arrangement, with 3 replications. Soil at the site was a Walla Walla silt loam. The following treatments are being evaluated in this study:

1. Winter wheat-conventional fallow
2. Winter wheat-chemical fallow (DS)
3. Continuous winter wheat
4. Continuous spring wheat

5. Continuous spring barley
6. Winter wheat-spring barley-chemical fallow
7. Winter wheat-winter pea
8. Flex crop

Each phase of each rotation is present each year. Tubbs, a winter wheat, was direct seeded on November 10, 11 and 13, 2003 at a rate of 25 seeds ft^{-2} using the Fabro® drill. Austrian winter pea was seeded on November 13, 2003 at a rate of 7 seeds ft^{-2} using the Fabro® drill. The CT fallow plots were seeded using the John Deere HZ® drill. Winter wheat plots were sprayed with 16 oz. glyphosate on November 14, 2003 and with with 16 oz. Bronate and 5 oz. Harmony Extra on April 18, 2004. On March 26 and 30, 2004 the LTE plots were sprayed with 16 oz. glyphosate and Zak, a spring wheat, and Camas, a spring barley, were seeded on April 2 and 3, 2004 using the Fabro® drill. Fertilizer was applied during seeding at a rate of 100 lbs of product (37-0-0-7) at seed depth but separated from the seed horizontally by approximately 1 inch. Crops were harvested in July and August, 2004.

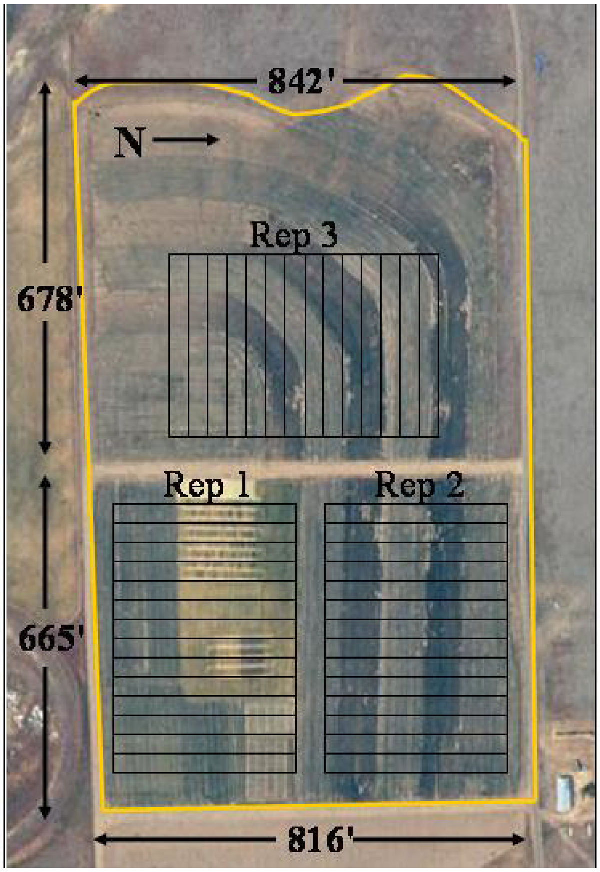

Fig. 1. Long-term Cropping Systems Experimental Plots at CBARC, Moro.

Baseline data sets

Soil analysis*-Stephen Machado and Christopher Humphyreys*

Each plot was sampled to establish the baseline soil information. Soils were analyzed for pH, NO_3-N, NH_4-N, P, SO_4-S, K, OM, and pH (Table 1). Levels of all elements, except NO_3-N, were not significantly different between plots indicating that the plots had been homogenized effectively. Any differences in the levels of these elements over time will be directly attributed to the treatments. There were no significant differences in NO_3-N in all treatment plots, except in plots of treatment 2, 4, and 10 that had been left fallow and sampled in June. High levels of N in these plots can be attributed to N mineralization. Soil pH was relatively uniform in all the plots except in plots of treatment 11 where pH was low.

Table 1. Initial soil analysis results of plots at CBARC, Moro, 2003.

Treatment #	†Rotation.	Plots	‡NO_3-N (lb/a)	NH_4-N (lb/a)	P (ppm)	SO_4-S (ppm)	K (ppm)	OM	pH
1	WW-CT fallow	5, 16, 32	15.67	12.67	29.33	9.00	291.33	2.16	6.3
2	CT fallow-WW	14, 22, 34	165.33	13.00	25.33	9.33	327.67	1.87	6.5
3	WW-Chem fallow	8, 28, 40	14.00	8.33	28.00	9.16	255.67	2.03	6.3
4	Chem fallow-WW	4, 25, 37	137.00	9.00	23.00	11.00	352.00	1.84	6.8
5	WW-WW	11, 19, 39	14.33	11.00	30.00	7.33	286.33	1.72	6.3
6	SW-SW	12, 27, 38	16.33	9.33	25.33	8.83	323.67	1.86	6.5
7	SB-SB	2, 26, 41	20.00	9.33	28.67	11.33	356.00	1.92	6.5
8	WW-SB-Chem fallow	10, 20, 33	24.67	13.67	32.33	10.67	287.33	1.68	6.1
9	SB-Chem fallow-WW	13, 17, 31	24.33	10.00	28.00	10.50	376.33	1.79	6.3
10	Chem fallow-WW-SB	7, 18, 35	123.00	4.67	23.33	10.83	289.67	1.92	6.7
11	WW-WP	9, 24, 30	22.33	9.67	37.00	12.50	270.00	1.78	5.9
12	WP-WW	6, 21, 42	15.33	11.67	34.67	9.83	333.00	2.01	6.2
13	Flex	3, 15, 36	18.67	11.33	36.67	8.67	278.67	2.42	6.0
14	Flex	1, 23, 29	23.00	14.00	41.33	12.00	369.33	1.94	6.1
se	-	-	44.65	2.82	4.00	2.29	33.37	0.22	0.2

†All plots are direct seeded except the CTentional fallow treatments (1&2); Chem-chemical; CT-CTentional tillage; Flex-crop-cropping system decided based on prevailing soil moisture conditions and grain price; SB-spring barley; SW-Spring wheat; WP-winter pea; WW-winter wheat.

‡ Total N in a 4 feet-depth soil profile.

Soil OM was sampled again before seeding the second crop to determine its distribution in the top foot (Table 2). Once more, there were no significant differences in OM between the plots at all the depths sampled. However, in each plot, OM decreased with increase in soil depth. Future differences in OM in the plots will, therefore, be attributed to cropping system treatments.

Table 2. Soil organic matter in selected rotations in 2004

	Rotation				
Depth (inches)	†Winter wheat/CTentional Fallow	†Winter wheat/Chemical Fallow	†Continuous winter wheat	†Winter wheat/spring barley/fallow	†Winter wheat/winter pea
0-4	1.77a	1.83a	1.80a	1.87a	1.69a
4-8	1.13a	1.37a	1.00a	0.97a	1.14a
8-12	0.83a	1.33a	0.77a	0.80a	0.78a
se	0.19	0.19	0.19	0.19	0.19

† Letters compare means at the same depth between plots or rotations. Means with the same letters are not significantly different from each other at the 0.05 probability level

Water Infiltration and Earthworm Measurements*- Stewart Wuest, Tami Johlke, Bob Correa, and Amy Baker, all ARS Pendleton.*

On 6 April, 2004 we performed cylinder infiltration measurements on each plot. The 20-cm diameter cylinders were driven 25 cm deep. After tamping the soil around the inner perimeter of the cylinder, water was ponded on the surface for 30 minutes before starting 20 to 30 minutes of infiltration rate measurements. A constant head of 2 to 4 cm water was maintained over the average soil surface using a float valve, and readings were taken from calibrated water supply reservoirs. These infiltration measurements are baseline readings and will be useful only when compared to measurements taken several years after treatments have been in place.

Soil samples were taken from each plot for earthworm counts at the same time. Cores were 20-cm diameter and 20 to 25 cm deep. During sampling, no earthworm-sized pores were observed at the bottom of the cores. The soil was moist at the time of sampling. Samples were returned to Pendleton and washed through a screen with 1.2 mm openings. No earthworms or earthworm cocoons were found.

Weeds*-Dan Ball, Sandy Frost, and Larry Bennett*

A study was conducted in several cropping systems of the Moro LTEs plots to evaluate Downy brome (*Bromus tectorum*) and broadleaf weed control. Herbicide treatments were applied on November 14, 2003 and April 18, 2004 (Table 3). Weed plant counts were taken on March 29 and May 5, 2004 (Table 4). Results indicate that there were no significant differences in downy brome counts between all treatments on March 29. On May 5, winter plots showed more downy brome counts than spring crops. There were no significant differences in knotweed and prickly lettuce counts between the treatments at both dates.

Table 3. Herbicide applications.

	Nov 14, 2004	Apr 18, 2004
Treatments	All	1,3,5,8,11
Herbicide	glyphosate	Harmony Extra + Bronate + NIS
Rate	16 oz/A	0.5 oz/A + 16 oz/A + 0.25% v/v

Table 4. Response of weed populations to cropping systems. (04-Moro LTE)

	Downy brome		Knotweed		Prickly lettuce	
Treatment	Mar 29, 2004	May 5, 2004	Mar 29, 2004	May 5, 2004	Mar 29, 2004	May 5, 2004
	----------------------------------plants / m^2 --					
WW–CT	0	5	68	0.8	0	0
Fallow-CT	2	0	8	0	2	0
WW – DS	6	4	32	16	2	0
Fallow-chem	2	0	0	0	2	0
WW – DS	0	8	28	17	0	0
SW – DS	4	0	2	0	10	0
SB – DS	0	0	2	0	4	0
WW – DS	4	8	24	12	2	0
SB – DS	6	0	42	0	2	0
Fallow-chem	12	0	10	0	0	0
WW – DS	0	8	10	3	0	0
WP – DS	2	2	0	0	0	1
Flex crop	10	0	4	0	2	0
Flex crop	8	0	4	0	2	0
LSD (0.05)	NS	7	NS	NS	NS	2

***Diseases**-Dick Smiley, Jennifer Gourlie, Sandra Easley, and Ruth Whittaker*

Winter wheat plants were too small to be effectively sampled during the fall of 2003. Diseases in each fall- and spring-planted plot were assessed during the spring. All samplings involved collecting 20 to 40 plants over the length of each plot, washing soil from roots, and scoring each plant individually for incidence (percent plants) and severity (qualitative rating scale) of diseases such as Fusarium foot rot, take-all, and Rhizoctonia root rot. Our staff also examined plants for the presence or level of damage by other diseases and insect pests. Soil samples (about 20 cores per plot; 1-inch diameter by 6-inch depth) were also collected and sent to Western Laboratories (Parma, ID) for quantification of plant-parasitic nematode genera. We examined the data for the presence of replicate (slope position or location) effects as well as for differences among treatments.

Five winter wheat treatments (1A, 2A, 3, 6A) were sampled on March 16, 2004. Diseases did not differ significantly ($p<0.05$) among winter wheat treatments or replicates. However, we detected a consistent trend in which Fusarium crown rot, Rhizoctonia root rot and take-all each had a higher incidence and a higher severity in each of the direct-seed treatments (2A, 3, 6A, 7A), as compared to the conventionally tilled and planted treatment (1A). Since the incidence and severity for each disease was considered “low” in all winter wheat treatments, none of the diseases were likely to have affected grain yield. We also noted the presence of small swollen areas on some winter wheat roots. Ratings for these swellings did not differ among treatments ($p=0.30$) but there was a significant ($p=0.03$) replicate effect, in which the swellings were more prevalent in rep #3 (27% plants) than in reps #1 and #2 (9% plants). Rep #3 is west of the field road and reps #1 and #2 are east of the road.

A winter pea treatment (7B) was also sampled on March 16, 2004. Peas had a minor occurrence of a blackening disease of the cotyledon, possibly caused by *Thielaviopsis basicola*. Blackening was minor but occurred on up to 20% of the plants. A complex of *Rhizoctonia* and *Pythium* species also caused a minor occurrence of root rot on up to 20% of the plants. Vascular browning caused by Fusarium wilt was not detected.

Two spring wheat treatments (4, 8B) and three spring barley treatments (5, 6B, 8A) were sampled on May 7. Diseases did not differ significantly ($p<0.05$) among spring grain treatments. Rhizoctonia root rot occurred at a high level of incidence and severity on spring wheat and spring barley. Rhizoctonia root rot was detected on 55% of all spring cereal plants, and occurred with an average severity rating of 2.0 on a scale from zero (none) to five (severe). These ratings for Rhizoctonia root rot may have become elevated in response to the very short duration (3 to 4 days) between planting and application of herbicide to kill volunteers and grass weeds. A spray-to-plant interval of at least 14 to 21 days is important for breaking the green bridge, and should be employed during 2005. The incidence and severity for take-all were each low, and none of the plant crowns exhibited symptoms of Fusarium crown rot.

Lesion, stunt, dagger, and cyst nematodes were detected in the soil samples collected on March 24, one week before spring crops were planted. Lesion nematode was the only group present in significant numbers, with populations in the 42 plots ranging from 80 to 4,040/kg of soil. Average numbers did not differ significantly ($p<0.05$) among the treatments, but trended to be more numerous in the winter wheat (1,829/kg) and over-wintering conventionally tilled fallow (1,513/kg; this treatment contained volunteers and grassy weeds at the time of sampling) than in any of the chemical fallow or spring-planted plots (600 to 973/kg). There was also a trend ($p=0.16$) for lesion nematodes to occur in lowest numbers (754/kg) in replicate #2 (top of slope east of road), intermediate numbers (1,121/kg) in replicate #1 (bottom of slope east of road), and in highest numbers (1,699/kg) in replicate #3 (full length of slope west of road). While this relationship was similar to that observed for the root swellings on winter wheat plants in those replicates, there was no other apparent association between lesion nematode numbers and cropping practice during the preceding year, as judged by inspection of the plot images overlaid onto an aerial photograph.

Grain yields- *Stephen Machado and Christopher Humphyreys*

Grain yields of the first crop are shown in figure 2. There were no significant differences in grain yield between plots seeded to winter wheat. Grain yields of plots seeded to spring crops were significantly lower than grain yields of winter wheat seeded plots. However, there were no significant differences in grain yields between the plots seeded to spring wheat. The uniform grain yields in winter and spring wheat plots indicate that plot productivity was fairly uniform at the initiation of this experiment. This supports soil analysis data that showed that nutrient levels were fairly uniform among the plots. Future differences in grain yield will be directly attributed to cropping system treatments.

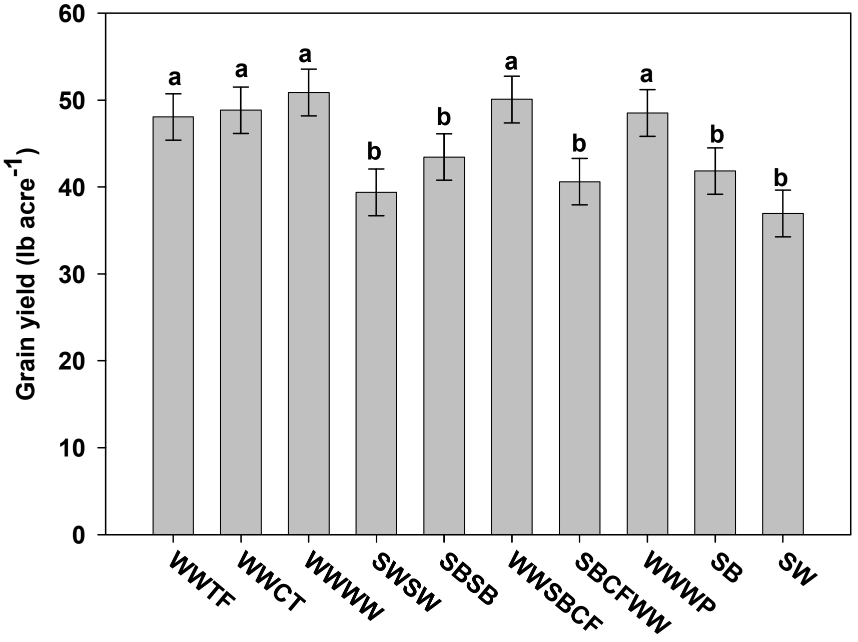

Fig. 2. Initial grain yields of plots assigned to different cropping systems at CBARC, Moro, 2004.

INTERACTION WITH OTHER SCIENTISTS CONDUCTING RELATED ACTIVITIES:

Scientists form OSU and USDA-ARS Pendleton are collaborating in this project.

PUBLICATIONS AND PRESENTATIONS:

No publications have been prepared from this project yet.