PROJECT NO: New

TITLE: Expand upon the Cover Crop CIGs grant ("Adapting cover crops in dryland wheat-based cropping systems in southern Idaho") received from the NRCS, with grower cooperators Hans Hayden and Cory Kress.

PERSONNEL:
Dr. Juliet Marshall, Ext. Crop Mgmt. Specialist (SC and E Idaho)
Dr. Xi Liang, Cropping Systems Specialist, Aberdeen, ID
Dr. Arash Rashed, Entomologist, Aberdeen, ID
Dr. Christopher Rogers, Barley Agronomist, Aberdeen, ID

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JUSTIFICATION: The utilization of cover crops has been adopted in a number of areas, but it has not been integrated in the dryland cropping systems in southeastern Idaho. Improving conservation practices while improving the economic sustainability for local growers is particularly difficult in this low annual precipitation area, but may be more effective in the upper elevation, higher rainfall areas around Swan Valley. Considering the restricted rotation choices available to regional dry land growers, the successful demonstration of cover crop incorporation would be extremely beneficial for disease and pest reduction. Also considering water runoff from snow melt, high wind speeds and slopes in this area, cover crops could be a good option in protecting soil from water and wind erosion.

The cereals team consisting of Xi Liang, Arash Rashed, Christopher Rogers, and Juliet Marshall has received a Conservation Innovation Grant to examine the potential for the incorporation of cover crops into the dryland winter wheat production area south of Interstate 86. The funding is for $55,722 over 3 years (after UI overhead). The CIGs funding will allow the team to establish plots, perform soil testing, and monitor for wireworms as we test the efficacy of different rotations and cover crops. The objective is to improve soil health while reducing insect and disease issues for growers where we have limited crop rotation options. Winter experiments have already been established; therefore, funding could be used to begin soil health testing in spring and summer of 2016, as well as to establish Swan Valley spring plots in 2016.

HYPOTHESIS & OBJECTIVES: Additional matching funding is sought to improve our ability to assess "soil health" by using methods promoted by the NRCS, and to expand the research into the spring grain direct seed areas such as Antelope Flats and Swan Valley. Funding would:

1) Improve our ability to measure soil health – utilizing phospholipid analysis of soil samples to estimate soil microbial populations and DNA extraction of soil samples to determine live, active soil microbial flora and fauna.
2) Expand the study into direct-seeded areas that are restricted to spring cereal crops. The following three objectives will evaluate the effects of incorporating a cover crop mix into a cereal-based dryland cropping system by:

    a) Determining the conditions for effective establishment and growth of cover crops;

b) Measuring soil water dynamics (infiltration rates and water use efficiency) as affected by cover crop integration in comparison to standard grower practices;
c) Monitoring soil health (i.e., soil organic matter and organism diversity) affected by cover crop integration over time.

PROCEDURES:

Experimental design and treatments-Rockand Valley and Arbon Valley

At each location, plots for three treatments are arranged in a completely randomized design with six replicates:

1) Control – standard grower practices consisting of: 2015-2016 winter wheat; 2017 spring wheat; and 2018 summer fallow.
2) Cover crops with winter kill: 2015-2016 winter wheat, 2016 cover crops planted following winter wheat harvest; 2017 spring wheat followed by cover crops; and 2018 summer fallow followed by cover crops. Cover crops are allowed to winter kill, and the field will not be tilled before cereal planting.
3) Cover crops with spring incorporation: 2015-2016 winter wheat; 2016 cover crops following winter wheat harvest; 2017 spring wheat followed by cover crops; and 2018 summer fallow followed by cover crops. Cover crops are incorporated into the soil during the tillage prior to 2017 spring wheat planting and 2018 fallow.

For Treatment 2 and 3, one cover crop mix will be planted with a seeding rate of 30 kg ha^{-1} including turnip, radish, vetch, spring pea, and field pea with a ratio of 1:1:5:10:10. Cover crop selection and the mix ratio was recommended by Marlon Winger, USDA NRCS. The brassica species (i.e., turnip and radish) can help decrease soil compaction and the legume species (i.e., vetch, spring pea, and field pea) can provide biologically derived nitrogen in cereal-dominated rotational systems. Cover crops will be planted in mid-August after cereal harvest in plots of 14 × 30 m. The planting will be carried out using single-disc combined with a planter for minimum soil disturbance. During the period of cover crop growth, no fertilizer will be applied. The field experiment will be conducted for three years from 2015 to 2018.

Experimental design and treatments-Swan Valley

Plots for three treatments will be arranged in a completely randomized design with six replicates:

1) Control – standard grower practices consisting of: 2016 spring wheat; 2017 spring wheat; and 2018 spring wheat.
2) Fall cover crops: 2016 spring wheat, 2016 cover crops planted following spring wheat harvest; 2017 spring wheat; 2017 cover crops planted following spring wheat harvest; and 2018 spring wheat.
3) Spring cover crops: 2016 spring wheat; 2017 spring cover crops; 2018 spring wheat.

For Treatment 2 and 3, one cover crop mix will be planted with a seeding rate of 30 kg ha^{-1} including turnip, radish, vetch, spring pea, and field pea with a ratio of 1:1:5:10:10 (the same as above).

Field measurement and sampling

At each location, daily precipitation and temperature will be recorded using data loggers for rain gauges (Spectrum Technologies, Inc. Aurora, IL) and temperature sensors (Spectrum

Technologies, Inc. Aurora, IL) installed in the fields. Soil water status will be monitored at 15, 30 and 60 cm using soil volumetric water content sensors (EC-5, Decagon Inc. Pullman, WA) to determine the soil water fluctuation resulting from infiltration and water use by cover crops. After emergence, seedlings of cover crops will be counted by species in three areas of 50 × 50 cm in the middle of each plot. Leaf area index will be measured (AccuPAR LP-80, Decagon Inc. Pullman, WA) weekly for soil coverage. After 6-8 weeks of growth, aboveground biomass of cover crops will be harvested in three areas of 50 × 50 cm in the middle of each plot for the estimate of dry aboveground biomass. Roots will be sampled in the three areas of 50 × 50 cm using soil augers (diameter of 5.7 cm) at 0-15, 15-30, and 30-60 cm after aboveground harvest. Soil will be washed off of root samples and analyzed for morphological characteristics (i.e., root length and surface area) using a WinRHIZO system (Regent Instruments Inc. Quebec, CA). Aboveground and belowground/root biomass will be dried at 70 °C until a constant weight is achieved, weighed and recorded as dry aboveground and belowground biomass.

Soil samples will be taken at the initiation of the study and every spring before planting from plots at 0-15, 15-30, and 30-60 cm. The samples will be used for analysis of soil physical and chemical properties. Samples will be dried and ground to pass a 2-mm sieve. Selected soil samples will be analyzed for pH, soil organic matter, total nitrogen, total carbon, and soil CO_2 respiration using the Solvita test. Additionally, a 4.7-cm diameter, stainless steel core chamber, and slide hammer will be used for determination of surface soil bulk density determined by weighing soil after oven drying for 48 h at 70 °C. The 0-15, 15-30, and 30-60 cm samples will be collected and analyzed for soil particle size after oven drying for 48 h at 70°C.

Each plot will be sampled periodically to evaluate the presence of wireworms and nematodes and their species diversity. Wireworm populations will be monitored using solar bait traps (two per experimental plot) placed 15 cm below the soil surface. Monthly sampling would allow the detection of changes that may occur overtime in response to seasonal changes and/or gradual changes due to the incorporation of the cover crop mix into the cropping system. The changes of population numbers and biodiversity of the pest species will be quantified, and compared between treatments with cover crop integrated and the control (in the absence of the cover crop mix). Soil samples (and cereal root samples) will be collected (a minimum of two per experimental plot) to evaluate the presence of nematodes and soil-borne disease in each plot, and additional samples will be collected for phospholipid fatty acid (PLFA) analysis, which is used to measure microbial biomass and community composition. Samples can also be collected for DNA analysis for soil-borne pathogen species analyzed in Australia.

The determination of soil water status will help us understand the effects of the cover crop incorporation treatments on soil water fluctuations due to infiltration and soil water consumption. The effects are expected to be dynamic and continuous with the establishment and development of cover crops, indicated by leaf area index and the accumulation of aboveground and root biomass. The organic matter inputs from cover crops are expected to change soil characteristics over time. The measurements of soil physical, chemical, and biological properties, pest population, and organism diversity will quantify the positive effects of cover crops on cereal-based cropping systems.

DURATION: 3 years

COOPERATION:

Hans Hayden, 3747 Mid Crystal Road, Arbon ID, 83212
Cory Kress, 5377 Rockland Hwy, Rockland ID, ID 83271
Gorden Gallup, 1922 Swan Valley Hwy, Ririe ID 83443
Marlon Winger, USDA NRCS

ANTICIPATED BENEFITS/EXPECTED OUTCOMES/INFORMATION TRANSFER

Recommended cultivation practices of cover crops from this project will be delivered to growers at workshops. The results from the project will also be published as peer-reviewed journal articles.

LITERATURE REVIEW:

Growers in southern Idaho have shown an increased interest in integrating cover crops into their current cropping systems. Cover crops, such as radish (*Raphanus sativus* L.), turnip (*Brassica rapa* L.), mustard (*Sinapis arvensis* L.), peas (*Pisum sativum* L.), and vetch (*Vicia sativa* L.) are of interest to growers as cover crops due to their suppression of pests and improvement of soil health (Garcia et al., 2013; Snapp et al., 2005; Zhou et al., 2012). In agricultural ecosystems, healthy soils can help to reduce soil erosion, improve water and nutrient use efficiencies, and ensure productivity (USDA-NRCS, 2015).

Root systems stabilize soils and add organic matter to the soil. Radish cover crops have produced as much as 150 kg ha^{-1} of root biomass in eight weeks, and root biomass of peas could range from 524 to 848 kg ha^{-1} in ten weeks (Brust et al., 2014; Gan et al., 2009). The fibrous roots and exudates of cover crops help improve soil structure by holding soil particles together (Bronick and Lal, 2005). The deep tap roots of brassicas and legume species penetrate and open up compacted soils, which decreases compaction and improves infiltration. In addition to organic matter inputs, legumes can provide slow release nitrogen via nitrogen fixation, which is beneficial for reducing synthetic nitrogen inputs in the following crops (Snapp et al., 2005). The enhanced soil organic matter and improved soil structure increases stabilization of soil particles and soil water storage, improving plant establishment.

At the same time, changes in soil structure are expected to impact soil pest activity, where these pests can significantly damage southern Idaho cropping systems. Chief among soil dwelling pests in Idaho are wireworms and nematodes. Given their inaccessible living habitat and the lack of effective registered pesticides in cereals, these soil dwellers are extremely hard to control and have been increasingly challenging for cereal production in southern Idaho. Indeed, crop rotations with non-cereal crops have been suggested as alternative approaches to reduce the damage caused by wireworms (Andrews et al, 2008). While the beneficial effects of crop rotations and conservation tillage have been documented (Edwards et al., 1988; Havlin et al., 1990; Govaerts et al., 2006), studies have yet to consider the impact of integrating various cover crops, specific to southeastern Idaho, on wireworms and nematode populations and their species composition. Thus, even though the benefits of cover crops in the protection of soil erosion and improvement of soil health have been broadly explored, these advancements have not been fully integrated in cropping systems of southeastern Idaho.

A major concern regarding the incorporation of cover crops in current cereal rotations in dryland areas of southeastern Idaho is soil water consumption. Compared to fallow, soil water content with a cover crop mix (consisting of grasses, brassicas, and legumes) is reduced approximately 20 mm in the 0-15 cm soil depth over three months in North Dakota (Berti et al., 2015). The integration of cover crops in rotations may increase the difficulty in storing sufficient soil moisture for the following cereal crops. Unfortunately, there is little information on the trade-off between infiltration improvement and water consumption due to cover crop integration in southeastern Idaho. Such information is critical before the successful integration of cover crops into current cropping systems can be achieved. Investigations of the effectiveness of the integration of cover crops into cereal-based dryland production in southeastern Idaho are critical to determine the feasibility of these alternate management practices in the region.

Citations

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IDAHO WHEAT COMMISSION - BUDGET FORM

Allocated by	Idaho Wheat Commission	during FY 2015	$ -
Allocated by	Idaho Wheat Commission	during FY 2016	

REQUESTED FY 2016 SUPPORT:

	Salary	Temporary Help	Fringe	Travel	OE	Graduate Tuition/Fees	TOTALS
Idaho Wheat Commission		$ 7,500	$ 2,940	$ 2,700	$ 22,255	$ -	$ 35,395

OTHER RESOURCES (not considered cost sharing or match):

UI (salaries, o|	$ 8,640
TOTAL OTHER RESOURCES	$ 8,640

TOTAL PROJECT ESTIMATE FOR FY 2016:	$ 35,395	$ 8,640	$ 44,035
	(Requested)	*(Other)*	*(Total)*

BREAKDOWN FOR MULTIPLE SUB-BUDGETS:

	Marshall	*Rashed*	*Liang*	*Rogers*
Salary			$ -	
Temporary Help	$ 2,500		$ 2,000	$ 3,000
Fringe Benefits	$ 980		$ 784	$ 1,176
Travel	$ 1,200		$ 1,000	$ 500
Operating Expenses	$ 15,255		$ 4,000	$ 3,000
Graduate Student Fees			$ -	
TOTALS	$ 19,935		$ 7,784	$ 7,676

Total Sub-budgets $ 35,395

10.7.2015 - Version