MONTANA STATE UNIVERSITY

RESULTS OF CROPPING SYSTEMS RESEARCH CONDUCTED IN SOUTH CENTRAL MONTANA-2015

Southern Agricultural Research Center, Huntley, MT

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1. Project Name: Effect of mixed cover crop functional groups on barley yield and quality

2. Investigators:
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3. Justification: The literature is robust on the effects of single species cover crops. They provide many positive benefits such as reduced leaching losses by scavenging nutrients left by a previous crop. Cover crops can protect soil from erosion by keeping the soil surface covered and knitted together with roots. In some instances cover crops have been successfully used to suppress weeds. All these benefits come at the cost of soil water use. In humid regions where rainfall is plentiful, cover crops are common and play an important role in crop production. But in the semi-arid region the challenge has been to find a way to incorporate cover crops that does not diminish yield and profitability.

   Mixed species cover crops are a more recent idea in crop management. Here the cover crop is a mixture of species, sometimes consisting of as many as 20 different species. The diversity of the mixture, including grasses, legumes, taproot crops, and brassicas, and sometimes mixing warm and cool-season species creates conditions for a potentially different impact on soil properties and for the following crop as compared to that of a single species cover crop. Research has shown that mixtures of different species can enhance residue decomposition, provide a faster turnover of nutrients, and create a more diverse environment for earthworms, arthropods, fungi, bacteria, and other soil organisms which help develop soil quality. Soil properties do not change quickly and there is little reason to try measuring changes until several cycles of a practice have been in practice. For cover crops that appear in the rotation as frequently as every other year, three cycles would require six years to complete. This may be enough time for soil quality changes to occur. A more conventional approach of cover crops every third year or less in frequency would require a decade or more to result in quantifiable soil quality changes. This study was conceived to quantify long-term changes in soil quality due to the inclusion of mixed species cover crops in the cropping system. In order to speed up the potential changes in soil quality a two year cycle of cover crop/malt barley was begun in 2014. A second series of cover crops was planted in 2015 so that cover crop and grain phases would be present in each year.

4. Objectives: Determine the impact of different functional groups of cover crops on the yield and quality of a following crop. For the purposes of this study functional groups are defined as legumes, taproot crops, and grasses.

5. Methods: A two-year rotation was begun in spring 2014 of cover crop/malt barley on a dryland field near Huntley, MT. In 2014 cover crops were grown in eleven treatments using grasses of barley and forage sorghum, legumes of dry pea and soybean, taproot crops of turnip and safflower, mixtures of all six species, mixtures of all excluding legumes, all excluding grasses, all excluding taproots, and a chemical fallow as a check. Seeding rates of cover crops were those considered optimum for each as a single species (Table 1). Seeding rates in mixtures were adjusted by dividing these optimum values by the number of crops in each mix. Cover crops were seeded as blocks 15 ft wide by 60 ft long in mid-May in a randomized complete block with four replications. They were allowed to grow to maturity or until a killing frost in the fall. In 2015 malt barley (Moravian 115) was planted on Apr 3 in 15 ft wide strips perpendicular to the cover crop strips. A nitrogen treatment was included with rates of 0, 25, 50, and 75 lbs N/acre (urea) applied in bands approximately 2 in from the seed row at planting. All crops were seeded using a 15 ft wide SeedMaster air drill in a no-till environment. The grain crop and fertilizer treatments were arranged in a strip-strip plot design.

6. Results: Cover crop production in 2014 averaged 2023 lbs/a when turnip and fallow were excluded (Table 2). Turnip as a cover did not establish well, and grew very little in this environment. Nitrate in the profile varied by cover crop with mix minus taproot, and mix minus legumes matching that of fallow. Nitrate in the profile following soybean was the lowest of all treatments which may be related to the fact that soybean did not nodulate even though inoculum was applied to the seed prior to planting.

   Barley yield in 2015 averaged 70% of the fallow yield when following a cover crop treatment. Exceptions to this included turnip (where a lack of turnip growth provided similar treatment effect as fallow) and pea, where barley yielded nearly 97% of the fallow treatment. There was no significant interaction of nitrogen rate by cover crop ($Pr > F = 0.4422$) indicating that yields responded to fertilizer nitrogen the same for each cover crop type. Test weight was low across all treatments which indicated the crop experienced drought conditions as it neared maturity. Protein and plump data helped confirm existence of drought conditions with fallow and turnip having the lowest protein which allowed more nitrogen to end up as grain, and those same two treatments having the highest percent plump, likely because of more available moisture near maturity. An interesting relationship is shown when preseason soil water is plotted against grain yield (Figure 1). The treatments with higher amounts of stored soil moisture at the beginning of the season had higher grain yield. This relationship might have been stronger if soils had been sampled to 4 feet since differences due to cover crop treatments were likely evident at deeper depths.

7. This study will be continued in 2016 to build any potential soil quality differences. We will begin looking for soil quality differences after the third cycle of cover crops.

Table 1. Cover crop target populations

Functional Group	Cover Crop Species	plants/ft^2
Grasses	Barley	17
	Forage sorghum	1.5
Legumes	Dry pea	9
	Soybean	4.5
Taproots	Turnip	6
	Safflower	6.5

Table 2. Biomass production of cover crop treatments after first frost in 2014, and available nitrate-nitrogen sampled in March 2015 for cover crop treatments, Huntley, MT 2015.

Treatments	2014 Biomass	Nitrate-N
	lbs/a	lbs/a
Barley	2556 ab	32.3 abcd
Forage sorghum	1794 cd	18.0 cd
Turnip	33 e	34.0 abc
Safflower	2670 a	28.3 abcd
Dry pea	1581 cd	38.0 ab
Soybean	1417 d	17.3 d
Mixture of all	2031 abcd	24.5 bcd
Mix minus grasses	2007 abcd	23.8 bcd
Mix minus legumes	2281 abc	34.0 abc
Mix minus taproots	1880 bcd	39.3 ab
Fallow	0 e	41.8 a
LSD (.05)	701.6	16.2

Means within a column followed by the same letter are not different using Fisher's protected LSD at the 5% probability level.

Table 3. Malt barley yield and quality following cover crop treatments.

Treatments	Grain Yield	Test weight	Protein	% Plump
	lbs/a	lbs/bu	%	%
Barley	40.4 e	38.3 c	14.6 ab	41.2 e
Forage sorghum	36.8 f	40.3 ab	13.2 f	51.7 cd
Turnip	56.8 a	41.0 a	13.3 ef	68.2 a
Safflower	46.8 c	40.1 ab	13.4 cdef	60.8 ab
Dry pea	52.8 b	39.4 bc	15.2 a	55.2 bc
Soybean	37.8 ef	40.3 ab	13.3 def	50.4 cd
Mixture of all	39.6 ef	38.8 c	14.1 bcd	44.5 de
Mix minus grasses	43.6 d	39.3 bc	14.1 bcd	52.9 c
Mix minus legumes	43.9 cd	38.8 c	14.3 bc	48.6 cde
Mix minus taproots	39.4 ef	39.4 bc	14.1 bcde	49.4 cd
Fallow	56.3 a	40.8 a	13.3 f	65.3 a
LSD (.05)	3.1	1.14	0.86	7.5

Means within a column followed by the same letter are not different using Fisher's protected LSD at the 5% probability level.

Figure 1. Barley yield at highest (non-limiting) nitrogen rate as a function of total inches of water in a 24 inch profile, Huntley, MT 2015