

1. Project Name: Spring barley performance following various cover crop mixes in southcentral Montana.
2. Investigators:
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3. Justification: There is a lot of interest in using mixed species cover crops to improve sustainability of crop production systems. Quite a lot of data and multiple publications on the impact of single species cover crops exists in the literature and from research conducted by current and former scientists. Less information is available to evaluate impacts of multi-species cover crops. In dryland systems where precipitation usually limits yield potential, the loss of stored soil moisture typically has a negative impact on yield and quality of a crop following a cover crop. Also the question of soil quality changes as impacted by inclusion of multi-species cover crops has not been addressed.
4. Objectives: A no-till dryland cropping system was established in 2015 consisting of a 2 year rotation of barley following treatments of multi-species cover crops. The rotation will be continued for several cycles in order to provide a means to test for differences in soil quality that may develop due to cover crop treatments. Soil quality analysis will be conducted at a later date.
5. Methods: Eleven treatments were arranged as combinations of 6 species including 2 from each of 3 functional groups. Functional groups were defined as Legume with soybean and dry pea as the component species; Taproot which included safflower and purple top turnip; and Grass represented by barley and forage sorghum. Treatments were constructed as four mixes, All mix (all 6 species), Mix minus grass, Mix minus taproot, Mix minus legume, and then six treatments consisting of each individual species, and a control treatment which was chemical fallow. Cover crop treatments were established in a randomized complete block design with four replications. Plot size was 15 feet wide by 60 feet long and all crops were planted using a Seedmaster air drill under no-tillage conditions. Seed rates of cover crops were based on literature values for optimum populations. For the mixtures these optimum rates were reduced by dividing by the total number of species in the mix. Cover crops were planted in May of 2015 and allowed to grow until mature. The following year barley was established using the same drill planted in passes perpendicular to the cover crop strips. Four fertilizer rates were applied at planting by using a 2nd knife to place urea in bands adjacent to the seedband. Nitrogen rates were 0, 20, 40,

and 60 lbs N/a. Barley seed rate was 40 lbs/a targeting a population of approximately 500,000 plants per acre. The barley variety was Moravian 115.

6. Results: Cover crops established and grew significant amounts of biomass in 2015 (Figure 1). Forage sorghum dominated with over 5 tons/a accumulated. Safflower produced over 3 ton/a of biomass. Turnip on the other hand grew very little as did the other cool season crops such as barley and pea. The mixed-species cover crops were dominated by either safflower or forage sorghum with little contribution from pea or turnip. Planting date had a major influence on performance of individual species within a mix and in this year the warm season species performed the best in terms of biomass accumulation. An advantage of a mixed-species cover crop may be consistency of biomass production. All the mixtures produced around 2 tons/a, but mixture composition varied.

After the winter and prior to planting, the soil profile recharged with water from precipitation and nitrate from mineralization (Figures 2 and 3). No significant differences in soil water were detected in the top 12 inches of soil. But differences in water retention deeper in the profile were especially apparent in the fallow profile and provided a significant difference of nearly 3 inches of soil water at planting between fallow and any cover crop treatment. Turnip and pea cover crop treatments had about 1 inch more profile water at planting than safflower, sorghum, and soybean. This is likely due to less growth of turnip, thus less water use during the cover crop period, and earlier maturity of pea which allowed precipitation in late summer early fall to be stored rather than transpired. The mixed-species treatments had similar amounts of profile water between them to start the barley season. Chemical fallow had the largest accumulation of soil nitrate followed by turnip which produced the lowest biomass of the cover crop treatments. Nitrate following peas was the next highest level which can be attributed to the contribution from it being a legume plus a greater amount of time for decomposition following maturation. Soybean did not nodulate well, and provided less nitrogen benefit when measured in early spring prior to barley planting as compared to pea even though soybean out-yielded pea. The mixture without legumes had a lower amount of nitrate than the mix without grasses or the mix without taproots which illustrates the importance of including a legume if nitrate accumulation is a goal. The all mix treatment also had low nitrate amounts which may be because of the low biomass contribution from the legumes in that treatment.

Grain yield of barley was nearly 41 bu/a following fallow, but was less than 50% of that following any cover crop treatment (Figure 4). This compares with about a 70% of fallow yield for the same study in 2015 (data not shown). Precipitation during the barley growing season was approximately 6 inches most of which was received prior to May 27. The late season dry period reduced yield and grain quality of barley over what was expected. Test weight was low across all treatments, and protein was 3 to 4 points above what is preferred for malt barley (Table 1). Barley response to added nitrogen was limited to the first increment of fertilizer N application (Table 2). Any additions of nitrogen beyond 20 lbs/a increased protein levels without affecting grain yield.

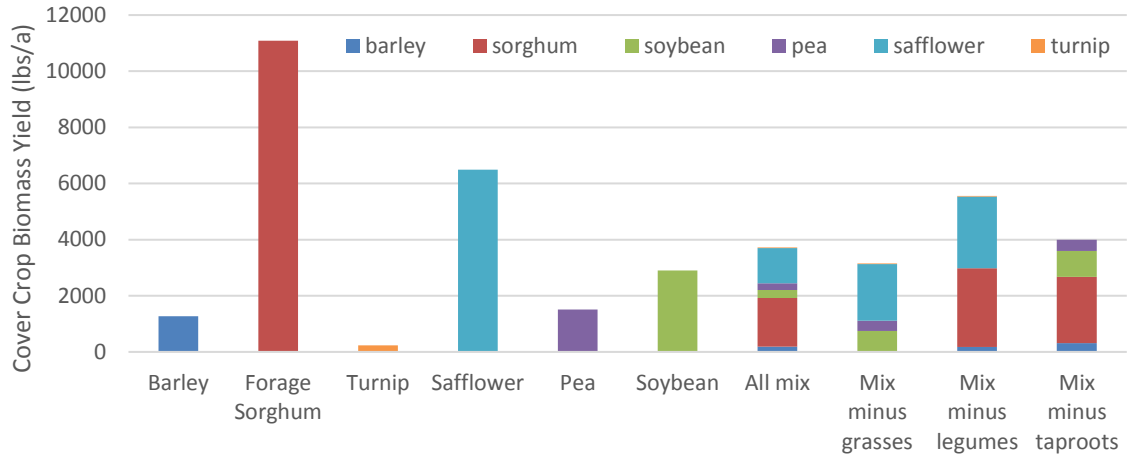


Figure 1. Biomass yield of cover crop mixtures in year 1, Huntley MT, 2015.

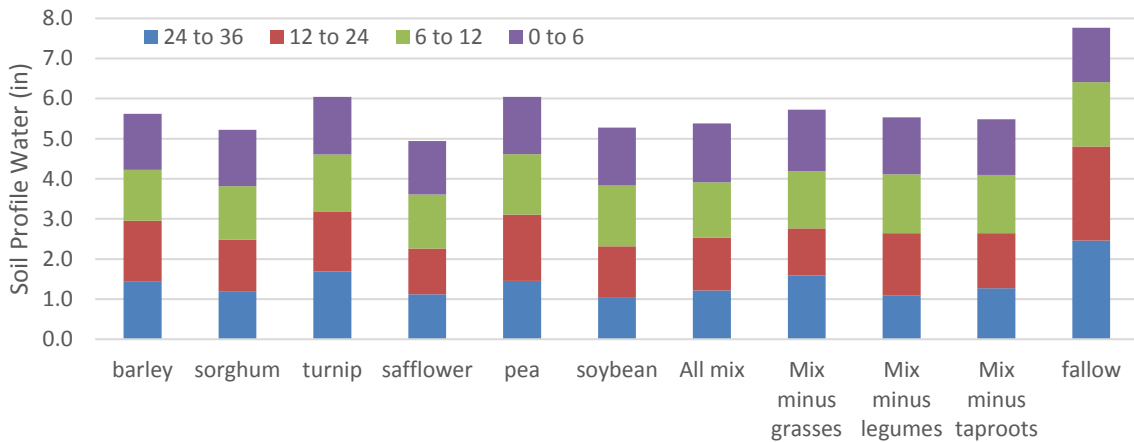


Figure 2. Differences in total soil water in year 2 at barley planting following cover crops, Huntley MT, 2016.

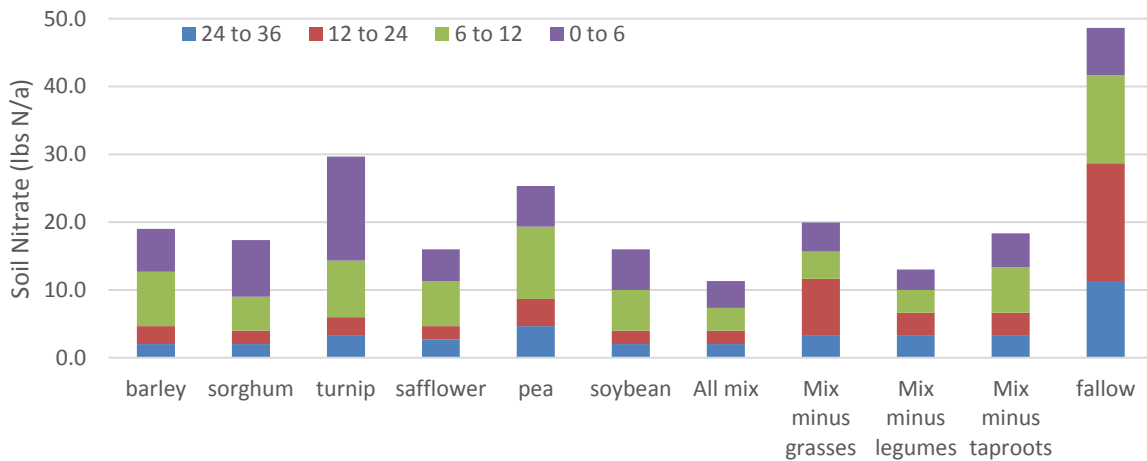


Figure 3. Residual nitrate in year 2 at barley planting following cover crops, Huntley MT, 2016.

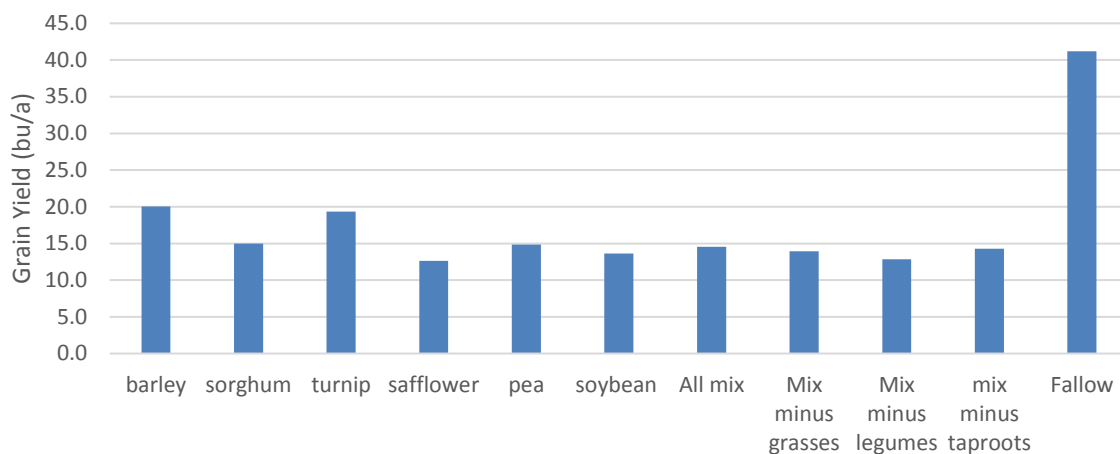


Figure 4. Grain yield of barley following cover crops, Huntley MT, 2016.

Table 1. Dryland barley performance following cover crops, Huntley MT, 2016.

Cover Crop	Grain Yield Bu/a	Test Wt Lbs/bu	Protein %	Plump %	Thin %
barley	20.0	46.3	15.0	78.3	2.7
sorghum	15.0	46.7	13.8	78.2	3.2
turnip	19.3	47.1	13.8	81.6	3.1
safflower	12.6	45.1	14.5	72.3	2.8
pea	14.9	47.0	15.6	79.2	3.0
soybean	13.6	46.3	14.5	73.2	3.1
All mix	14.6	46.1	14.7	69.0	3.9
Mix minus grasses	13.9	47.3	14.8	73.0	3.4
Mix minus legumes	12.8	46.3	14.7	73.2	2.8
mix minus taproots	14.3	45.6	14.6	76.1	2.8
Fallow	41.2	44.9	14.0	76.3	3.7
LSD(.05)	3.1	1.9	0.8	4.1	0.9

Table 2. Dryland barley performance across nitrogen rates in cover crop study, Huntley MT, 2016.

N Rate lbs/a	Grain Yield Bu/a	Test Wt Lbs/bu	Protein %	Plump %	Thin %
0	17.1	46.1	12.5	76.8	2.9
20	19.2	46.5	15.2	75.5	3.1
40	17.2	45.9	15.2	74.3	3.4
60	16.3	46.3	17.1	75.4	3.2
LSD(.05)	1.8	1.1	0.4	2.5	0.5

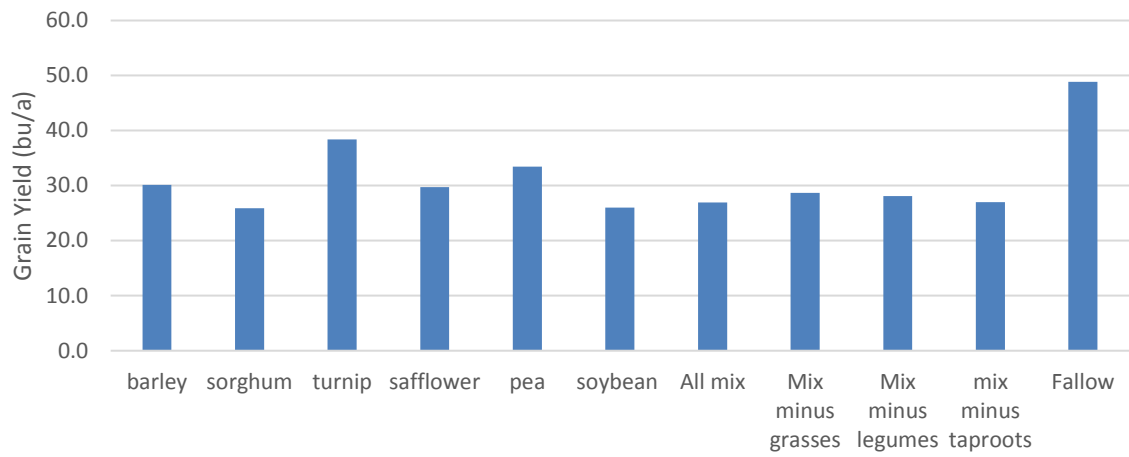


Figure 5. Grain yield of barley following cover crops averaged over 2 seasons, Huntley MT, 2015-16.