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1. Project Name: Spring barley performance following various cover crop mixes in southcentral Montana
 2. Investigators:
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 3. Justification: Crop production in the rainfed areas of Montana has been dominated by wheat for many years. The total number of acres in the wheat-fallow system has steadily declined over the past 20 years but 3 million acres continue to be fallowed in Montana as of 2016. Fallow farming has been successful at reducing the risk in winter wheat production, but is largely responsible for a decline in soil quality. Cover crops have been suggested as a means to stabilize and rebuild soil quality in place of fallow. A lot of information exists on the impact of single species cover crops as they were a common practice early in the previous century prior to the availability and use of modern fertilizers. There is less information on the impact and needed composition of mixed species cover crops to perform the functions of improved plant diversity, reduce C-N ratios of residue returned, improved water infiltration, amelioration of soil compaction, and addition of organic nitrogen to the soil system. The use of mixed cover crops has mostly occurred in regions of ample or at least greater precipitation than what is received in the semi-arid region of the northern Great Plains. This study was initiated to provide a location where mixed cover crops are included in a spring grain cropping system to allow changes to soil quality to approach an equilibrium prior to quantifying them.
 4. Objectives: A two-year rotation of cover crops/small grain crop was established in 2015 at the Southern Agricultural Research Center near Huntley, MT to provide an area for evaluating changes in soil quality and comparison of small grain yield and quality as impacted by cover crop mixtures. It will likely take several crop cycles before quantifiable changes in soil quality can be measured. The impact of four different plant species, or 'functional groups' will be compared. For this study cover crop types are defined as legumes, grasses, taproot, or brassica species.
 5. Methods: Mixed species cover crops and a chemical fallow were established using a randomized complete block with 4 replications in early May of 2015 and 2017 in field J at the Southern Agricultural Research Center. Each group was composed of a warm and cool season species. Treatments included legume mix (pea + cowpea), brassica mix (purple top turnip + mustard), grass mix (oat + millet), taproot mix (safflower + radish), a mixture of all 4 groups, mixture of all without (w/o) legume, all w/o grass, all w/o brassica, all w/o taproot, and a chemical fallow check. Cover crops and spring grain crops are planted using a Seedmaster no-till drill in plots 15 ft wide by 60 ft in length. In 2016, spring barley was planted perpendicular to the cover crop

strips of 2015. This results in a strip plot design with four nitrogen rates placed in bands adjacent to the seed to evaluate the impact of cover crops on nitrogen response of the spring grain. Results for 2017 are just for cover crop growth and development. In the spring of 2018 initial measurements of soil quality changes will be made including infiltration rates, aggregate stability, winter soil water recharge, and soil nitrate levels.

- Results: Total biomass of cover crops averaged 2500 lb/acre (Table 2). Treatments that included grass and taproot species typically provided the greatest amount of biomass, while the brassica species provided the least. The brassicas performed so poorly that weed growth in those plots became dominant yet remained the lowest in biomass production (including the biomass of weeds) of all treatments. The relative competitiveness of the different groups in mixtures indicates that grasses are the most competitive, followed by taproot crops (primarily safflower), and legumes (primarily pea) (Figure 1). In most treatments cool season species outperformed warm season in terms of biomass production (Table 1). The exception was when grasses were excluded (all w/o grass) where safflower provided nearly 60% of the total biomass for this treatment. Actually safflower was the only warm season species in this study that produced significant biomass. The millet, cowpea, mustard, and purple top turnip all provided less than 5% of total biomass for any cover crop treatment. One benefit of a mixture is the more stable yield potential over a single species or single functional groups. Having a variety of species in the cover crop mix improves the chances that one of those species will have an optimum year for production.

The measure of the success of a cover crop may not lie just in total biomass production, but in some combination of biomass production and changes in soil quality as well as minimal negative impact to a following grain crop. Most likely a cover crop will need to accumulate biomass of 1 to 2 tons/acre in order to affect some measurable change in soil quality within just 2 to 3 cycles (4 to 6 years).

Table 1. Relative biomass contribution of cover crop species within mixtures, Huntley, MT 2017.

Cover Crop	Cool Season %	Warm Season %	CV. (%)	LSD (0.05)
all species	65.0	35.0	31.3	12.5
all w/o brassica	72.1	27.9	19.1	11.0
all w/o grass	31.4	68.6	51.1	29.5
all w/o legume	65.0	35.0	33.8	19.5
all w/o tap roots	99.3	0.9	32.2	18.6

Table 2. Total biomass accumulated by various cover crop treatments at Huntley, MT, 2017.

Cover Crop	Dry Matter lb/acre	Relative Yield to pea biomass	Weed % of total biomass
All species	3174.2	1.8	4.0
all w/o brassica	3401.1	1.9	0.5
all w/o grass	2543.5	1.4	7.9
all w/o legume	3572.7	1.9	3.3
all w/o tap roots	2813.3	1.5	1.9
brassica mix	315.7	0.2	136.0
grass mix	2417.8	1.3	4.9
legume mix	1769.5	1.0	11.7
taproot mix	3373.5	1.9	4.0
pea	1833.1	1.0	5.4
Average	2521.4	1.4	18.0
LSD(0.05)	740.0	0.4	28.8
CV %	20.2	20.1	110.6
P value	<.0001	<.0001	<.0001

Figure 1. Biomass composition for each cover crop treatment, Huntley MT, 2017.



