



Cover Crop Mixes and Soil Health USDA-NRCS Bismarck Plant Materials Center Progress for 2012-2013

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Introduction

Cover crops offer many benefits for agriculture and soil health. Cover crops can feed the soil food web, provide supplemental forage, soil cover, and wildlife food/cover, capture/ cycle crop nutrients, fix atmospheric N, catch snow, support pollinators, and create pores through compacted soil. What influences do seeding rate and number of species in the cover crop mix have on soil health and future commodity crop yields? These are questions being addressed by the USDA-Natural Resources Conservation Service (NRCS) Bismarck Plant Materials Center (PMC) along with PMCs in CA, WA, MO, OR and FL through a National Cover Crop Study. The study began in 2012 and will continue through 2015. Three mixes are being tested along with a non-cover cropped control (Table 1). Each mix is seeded at three rates: 20, 40, and 60 seeds per square foot. Cover crops are sampled for forage yield and canopy cover. Barley is the commodity crop being grown at the Bismarck PMC. Barley was chosen because it can be harvested early enough in the season to allow planting and growth of a cover crop before a killing frost in North Dakota. It is sampled for grain yield. Soils are sampled for dynamic properties and biological assessment. Protocols for designing the experiment and data collection were compiled by Regional Plant Materials Specialists. This is a preliminary report of results at the Bismarck PMC for 2012 through barley harvest in 2013.

Table 1. Cover crop mixes planted for soil health at the USDA-NRCS Bismarck Plant Materials Center, Bismarck, ND.

Mix	Grass	Legume	Forb
2 species	50.0% triticale	50.0% red clover	
4 species	45.0% triticale	22.5% red clover 22.5% hairy vetch	10.0% radish
6 species	22.5% triticale 22.5% oat	22.5% red clover 22.5% hairy vetch	5.0% radish 5.0% rape

Summary of Preliminary Results

- Cover crop canopy was 90-100% after 47 days of growth.
- Dry matter yields for the cover crops were greatest for plantings at 60 seeds/ft², but yields were not significantly different than those reported for 20 and 40 seeds/ft². There was little forage yield differences between cover crop mixes.
- Weeds were found in greatest abundance in plots planted with cover crops at 20 seeds/ft² and least abundant in plots planted at 60 seeds/ft². The number of cover crop species planted had little influence on weed growth or suppression.
- Average plot temperatures were very consistent for a specific sampling date across all mixes and seeding rates.
- Soil health scores, as calculated by a soil health tool developed by Dr. Rick Haney, were greatest in the spring of 2013 after soil thaw and before commodity crop (barley) planting.
- Moisture percentages and temperature were fairly consistent across all plots at commodity crop planting.
- Commodity crop (barley) grain yields were similar for all treatments.

Materials and Methods

The planting site is located at the Bismarck Plant Materials Center, MLRA 53B. The soil is a Mandan silt loam. The overall average precipitation for the area is approximately 17 inches. Precipitation in 2012 was 14.9 inches. Rainfall received from cover crop planting to termination in 2012 was 2.3 inches.

Baseline soil data was taken prior to any cover crop planting. Data included soil classification, bulk density, temperature, moisture, and resistance. Soil samples were taken for assessment of biological activity and soil composition (soil indicators).



Cover crops were seeded on August 2, 2012, using a Great Plains no-till drill. Plots are arranged in a randomized complete block with four replications. Each plot is divided into subplots for sampling. Plot size is 30 feet x 50 feet. Plots were not fertilized or irrigated. Canopy and height were measured at 30 days (August 31, 2012) using a line transect method. Canopy and height were measured again at termination (47 days). Cover crops were considered terminated by natural freezing on September 21, 2012. Cover crop dry matter yield was determined from a 50 cm x 100 cm frame at termination (September 25, 2012). The samples were separated into individual species and weighed for yield. Samples were recombined and forage was analyzed for %N content. Soils at cover crop termination were again sampled for biological assessment and composition.

Barley (cv Rawson, 2-row), the commodity crop, was seeded on May 8, 2013. Soils were sampled for biological assessment, and moisture and temperature were recorded at that time. The crop was terminated on August 6, 2013. Grain yield was estimated for each plot by clipping and thrashing seed heads from a 17-foot drill row within each plot.

Results and Discussion

The number of frost free days after a commodity crop harvest (small grain) are generally limited (less than 60 days) in the Northern Great Plains. The window is narrow to achieve adequate growth of cover crops.

Cover Crop Biomass 2012

Cover crops were planted the first part of August and were terminated in late September. Precipitation was 2.3 inches in August, and .05 inches in September 2012. Cover crop growth overall was good even though planting date was late and overall precipitation was below normal for the growing season. Timely rains and favorable temperatures after cover crop planting were ideal for germination and growth of cover crops resulting in good stands with 90-100% canopy cover at 47 days. Freezing temperatures for short periods of time were noted beginning in early September. The



plants did not completely die by the September designated termination day, but had frost damage and slow growth. Plants succumbed to freezing in late October.

Triticale (cool-season grass) was the predominant species in all cover crop plots. The grass component contributed 57-98% of the forage in the plots. The radish and rape had good growth. The percent forage contributed by radish ranged from 16% to 47%. Legumes germinated and were present in the plots, but remained short and contributed less than 3% of the total forage yield. Legumes other than red clover and hairy vetch may produce more forage in the short growing season and should be explored.

Weeds were found in greatest abundance in plots planted with cover crops planted at 20 seeds/ft² and least in the 60 seeds/ft² plots. Average forage contribution from weeds in the 20 seeds/ft² plots ranged from 13-16%; in the 40 seeds/ft² plots 3-5% ;and in the 60 seeds/ft² plots 1-3 %. The number of species planted had little influence on weed growth.

Dry matter yields were greatest at the 60 seeds/ft², as expected, but yields were not significantly different than those reported in the 20 and 40 seeds/ft² plots. Yields averaged 4176 lb/ac at 60 seeds/ft²; 3828 lb/ac at 40 seeds/ft², and 3608 lb/ac at 20 seeds/ft². The average for the 2, 4, and 6 species mixes were 3606, 4075, and 3931 lb/ac, respectively. Above ground forage averaged 5%N (Table 2). Plots with no planted cover crop yielded 2643 lb/ac of annual broadleaf weeds.



Table 2. Mean cover crop biomass yield and % N content by cover crop treatments, USDA-NRCS Bismarck Plant Materials Center. Bismarck, ND.

Mix species	Seeding Rate seeds/ft ²	Cover Crop Biomass lb/ac ^{1/}	Cover Crop Biomass % N
2	20	3488	5.0
2	40	3457	4.9
2	60	3873	4.9
4	20	3738	5.2
4	40	3965	5.4
4	60	4523	5.3
6	20	3599	5.3
6	40	4062	5.2
6	60	4133	5.3
P<0.05		NS ^{2/}	NS

1/ Cover crops harvested for biomass on September 25, 2012.

2/ Not significant.

Commodity Crop (2013) - Barley

Grain yield was very good. Average yields across all treatments ranged from 98-119 bushels/ac (12% moisture, 48 pound bushel weight). After one year of cover crops on the plots, there was little yield difference of barley at different cover crop seeding rates. Average bushels/ac yields were 108, 110, and 106 for 20, 40, and 60 seeds/ft², respectively. Average yields for 2, 4, and 6 species mixes were 111, 106, and 107 bushels/acre, respectively. The check plot, with no cover crop seeding in 2012, averaged 99 bushels/acre.



Table 3. Mean barley yield (bu/ac) by cover crop treatment. USDA-NRCS Bismarck Plant Materials Center, Bismarck, ND.

Mix species	Seeding Rate seeds/ft ²	Barley Yield bu/ac ^{1/}
2	20	101
2	40	119
2	60	112
4	20	111
4	40	98
4	60	107
6	20	110
6	40	114
6	60	98
Control	none	99
P<0.05		NS ^{2/}

1/Barley harvested August 6, 2013.

2/ Not significant.

Soils 2012 and 2013

The field site at cover crop planting was excessively high in N as determined by soil tests. Limited rainfall and lawn clipping mulch applied in previous years likely contributed to the high fertility.

Soil resistance at 6 inches ranged from 200-300+ psi in 2012. The site was extensively tilled and plowed for several decades. The dense layer is probably the “plow layer”. Planting large rooted crops, such as brassica species and eliminating tillage should break this layer over time and allow greater infiltration and better root growth. It will likely take several years for drastic changes.

A Soil Health Tool developed by Dr. Rick Haney of USDA, ARS uses the balance of soil carbon and nitrogen and their relationship to microbial activity (Solvita test) to calculate overall soil health. The score can range from 0-50 or more. As soil health improves, the score increases. Initial soil health calculations in 2012 before cover crop planting averaged 10.5 to 13.9 among all plots. Soil health and Solvita averages were greatest in the spring of 2013 after soil thaw and before barley (commodity crop) planting. The higher readings in the spring of 2013 were found across all species mixes and seeding rates.

Moisture readings were fairly consistent across all seeding rates at all dates. It is expected that plots with higher seeding rates may build up more residue and hold more moisture in future years.

Average temperatures were very consistent for a specific date across all mixes and seeding rates. Temperature in the plot with no planted cover crop was also consistently the same as the planted plots. Temperatures averaged 82-83 degrees F on July 30, 2012; 53-55 degrees F on September 25, 2012; and 57-60 degrees F on May 13, 2013.