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Elsberry, Missouri National Study Progress Report

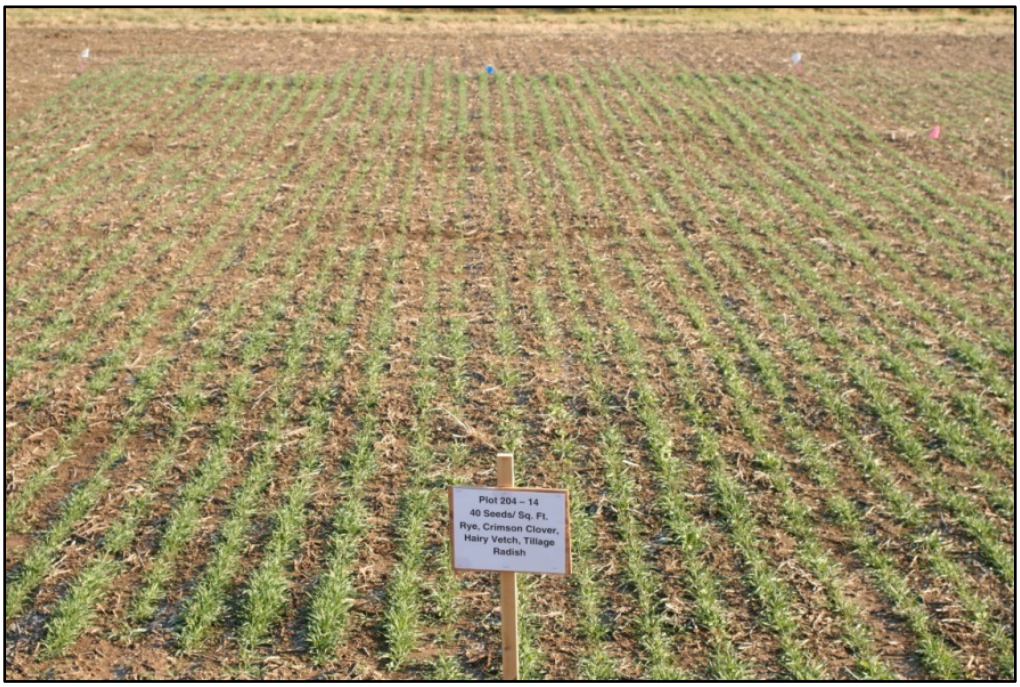
Effect of Mixed Species Cover Crops on Soil Health - Year 1

NRCS Biological Technician Nick Adams, left, and Soil Conservationist Allen Casey collecting baseline soil bulk density samples at USDA's Plant Materials Center at Elsberry, Missouri.

Helping People Help the Land

Introduction

Cover crops are grown in the time between the harvest of one commercial crop and the planting of another to improve the soil's health. Cover crops improve soil health by changing the physical, chemical, and biological properties of the soil (Fageria et al., 2005). However, soil health is a broad term that is composed of many different soil properties and qualities often difficult to measure and calculate. Generally, it takes time to detect the benefits gained by changes in management practices. This project report is a highlight of preliminary analysis of the first year of data from a USDA Natural Resources Conservation Service (NRCS) national soil health study that will last three years. This study attempts to gather quantitative data to determine how much of an effect, if any, management treatments have on soil health overtime. NRCS' National Soil Health and Sustainability Team and Plant Materials Program are working together to expand the agency's knowledge of using cover crop mixes to improve soil health. Results reported are expected to change over the course of the study as more data are collected and analyzed. This report summarizes data collected at the NRCS Plant Materials Center (PMC) in Elsberry, Missouri. Three seeding rates and three seed mixes are being evaluated. Similar studies are in progress at PMCs in California, Washington, Oregon, North Dakota, Maryland and Florida.



Plot of cereal rye, crimson clover, hairy vetch, and radish at 40 seeds/sq. ft on December 12, 2012 that was planted on October 10, 2012.

Methods

Plots are arranged in a randomized, complete-block design with four replications. Each plot is divided into subplots that will be sampled once in the three-year period. Before cover crops were planted, soil samples were taken to establish a baseline. Two-species, four-species, and six-species mixes were planted on October 10, 2012, with treatments of 20, 40, and 60 seeds/ft^2. There was also a control treatment consisting of no cover crop. The makeup of each mix is shown in Table 1. On April 22, 2013, the treatment plots were sampled for above-ground biomass, plant and residue cover, and botanical composition.. Cover crops were terminated April 22, 2013. Soil samples were collected May 14, 2013, for soil dynamic properties and biological assessment. Corn was planted May 14, 2013, as a response crop and to better mimic real application. Corn was grown without additional inputs (e.g. fertilizer, pesticides, and irrigation). Corn was harvested October 17, 2013, to determine grain yield.

Table 1. Cover crop mixes for the Effect of Mixed Species Cover Crops on Soil Health Study USDA-NRCS Missouri Plant Materials Center.			
Mix	**Grass**	**Legume**	**Forb**
2-species	50% 'Aroostook' cereal rye	50% 'Dixie' crimson clover	
4-species	45% 'Aroostook' cereal rye	22.5% 'Dixie' crimson clover	10% Tillage® radish
		22.5% 'Purple Bounty' hairy vetch	
6-species	22.5% 'Aroostook' cereal rye	22.5% 'Dixie' crimson clover	5% Tillage® radish
	22.5% 'Bob' oats	22.5% 'Purple Bounty' hairy vetch	5% canola

Summary Highlights of Preliminary Results

- Mean corn yield was significantly higher in the control (no cover crop) treatments than in the cover crop mix treatments, except in the six species plots planted at 40 and 60 seeds/ft^2 (Figure 1). As residual soil N is depleted, corn yield is expected to decrease.
- Cover crops reached above 90 percent canopy cover before termination in late April, 2014.
- At termination on April 22, there were no planted forbs present, and planted grass made up the greatest percent of the cover in the cover crop mixes.
- Fewer weeds were present in the cover crop treatments than in the control treatment.
- Of the grass components, cereal rye made up the majority of the cover with oats making up 1 percent or less in the six-species cover crop mix for all seeding rates.
- Some crimson clover survived the winter of 2012-2013, and was present in all of the cover crop treatments at termination. In the two-species mixes, crimson clover made up between 5 and 10 percent of the cover.
- In the four-species and six-species cover crop plots, crimson clover made up less than 5 percent of the cover.
- Hairy vetch was not planted in the two-species mix but accounted for 30 to 43 percent of the cover obtained with the four-species and six-species mix at termination.
- The total above ground dry biomass at termination ranged from 1,900 to 2,800 lb./acre for the cover crop treatment plots compared to 735 lb./acre in the control, which were primarily weeds (Figure 2).
- After one year, there was minimal change in soil properties such as mean bulk density, mean soil water content, mean soil resistance, and mean percent volumetric soil water content.
- The mean soil health calculations are summarized in Table 2.

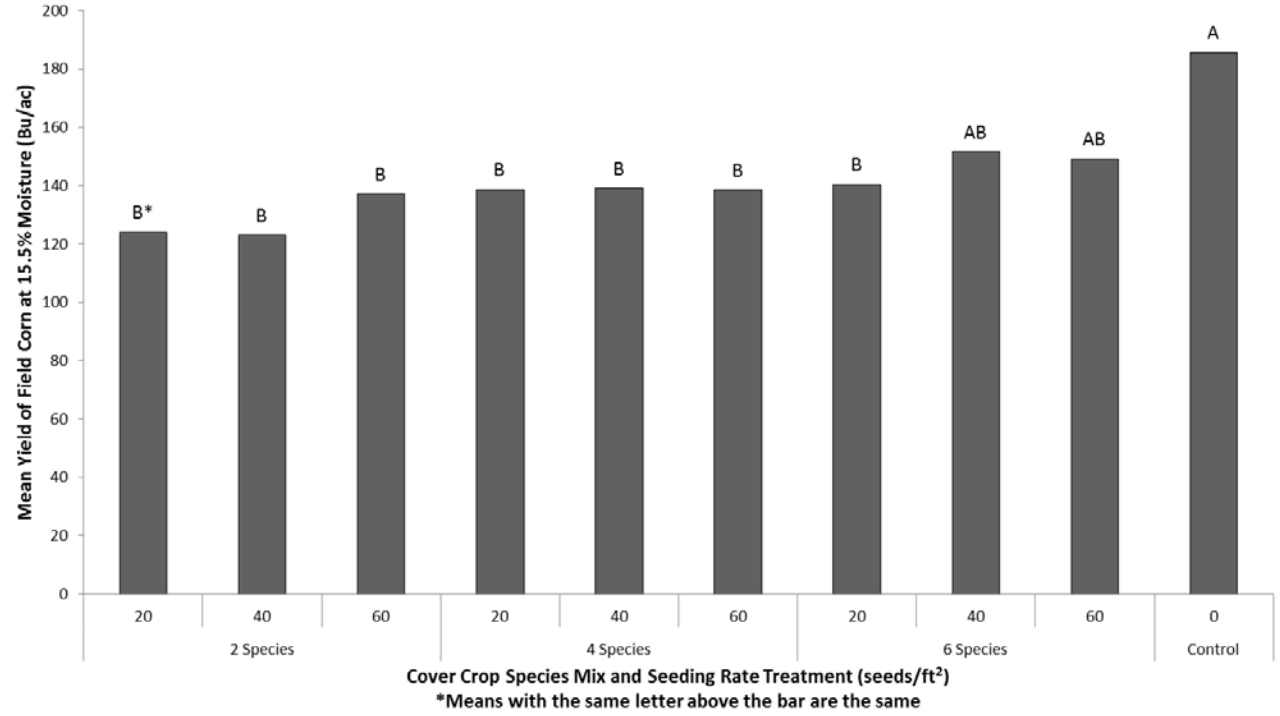


Figure 1. Corn yield following one year of cover crops for The Effect of Mixed Species Cover Crops on Soil Health Study
USDA-NRCS Missouri Plant Materials Center

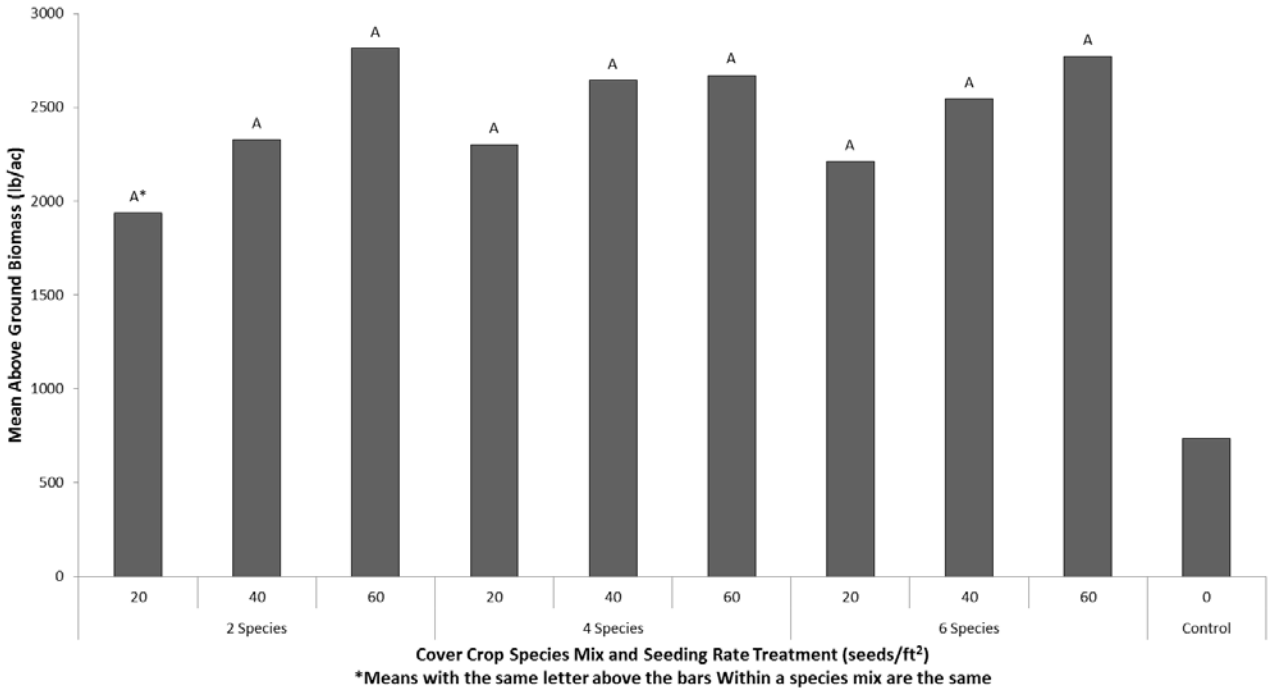


Figure 2. Biomass of cover crops and control at termination for The Effect of Mixed Species Cover Crops on Soil Health Study
USDA-NRCS Missouri Plant Materials Center

Table 2. Mean soil health calculation by treatment USDA-NRCS Missouri Plant Materials Center.			
Cover Crop Mix	Seeding Rate (seeds/sq.ft)	Sampling Period	Mean Soil Health Calculation
2-species	20	Before Study	6.11
		After 1st Year	6.63
	40	Before Study	4.85
		After 1st Year	6.85
	60	Before Study	5.66
		After 1st Year	7.97
4-species	20	Before Study	5.15
		After 1st Year	7.14
	40	Before Study	6.28
		After 1st Year	7.64
	60	Before Study	5.38
		After 1st Year	7.56
6-species	20	Before Study	5.98
		After 1st Year	8.90
	40	Before Study	6.06
		After 1st Year	7.98
	60	Before Study	6.44
		After 1st Year	7.18

Discussion

Cover crops in an agricultural cropping system can be used to accomplish many goals (Clark, 2007), and improving soil health is often one of those goals. Dr. Rick Haney, of the USDA-Agricultural Research Service in Temple, Texas, developed a process that analyzes soil and takes into account the relationship of microbial activity to the amount of soil organic carbon and nitrogen. This process renders a soil health calculation ranging from 0 to greater than 50, with a higher number indicating better soil health. Changes in this number will help gauge the effect of a management practice over time. There was a slight increase in soil health in the cover crop treatments as indicated by the positive increase in the biological assessment value (Table 2).

It is critical that cover crops are planted so that they have time to grow enough to provide the expected benefit, and that they are terminated at the appropriate physiological time to prevent them from becoming a problem in subsequent crops. Corn was selected as the commercial crop between the cover crops because it is a major commodity crop planted throughout the Midwest and Mississippi Valley and is responsive to differences in soil nitrogen. There were no differences in corn yield between the management treatments. We anticipate that the corn yield in the control plots will decrease as residual nitrogen is depleted.

Above ground biomass of cover crops is often used as a measure of the success of using cover crops in a crop management system. A high above-ground biomass of cover crops and subsequent canopy cover reduces the need for herbicides by suppressing weeds, conserving soil moisture by allowing increased infiltration, and by increasing soil organic matter content (Clark, 2007). Clark (2007) estimates that 4,000 lb./acre of dry above-ground biomass of cover crop residue is required in in a conservation tillage

system. Above-ground biomass for all of the cover crop species and seeding rate treatments produced 2,000 to 3,000 lb./acre. We anticipate that with continual use of cover crops, the soil health will improve and allow the above-ground biomass production of the cover crops to approach or exceed the 4,000 lb./acre "target." This "target" of cover crop above-ground biomass is general, and may not be attainable in some areas or may be easily exceeded in other parts of the United States. Many factors of soil properties and weather play major roles in the amount of above-ground biomass expected from any combination of cover crop species and seeding rates.

Literature Cited

Clark, A. editor. 2007. Managing cover crops profitably, 3rd ed. National SARE Outreach Handbook Series, Book 9. National Agric. Laboratory, Beltsville, MD.

Fageria, N.K., V.C. Baligar, and B.A. Bailey. 2005. Role of cover crops in improving soil and row crop productivity. Communications in Soil Science and Plant Analysis, 36:19-20.

Citation

Casey, A., R. Cordsiemon, and N. Adams. 2014. Elsberry, Missouri National Study Progress Report: Effect of Mixed Species Cover Crops on Soil Health – Year 1. USDA-Natural Resources Conservation Service, Plant Materials Center, Elsberry, MO 63343.

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