The Decomposition Rates and Nutrient Release of Different Cover Crops in Organic Farm Systems

Jianru Shi[1], J. R.Brandle[1], K. Koehler-Cole[1], C. McFadden[2], C. Shapiro[3], T. Loecke[1], E. Blankenship[4]

University of Nebraska-Lincoln

[1]School of Natural Resources, [2]School of Biological Sciences, [3]Department of Agronomy & Horticulture, [4]Department of Statistics

Cover crops act as green manure adding nutrition into organic soil. For green manure to be an effective and significant N source for organic farming systems, their N release must be in synchrony with crop N demand. In this study, we assessed the decomposition rates and chemical composition of three cover crops (soybean, red clover, and white clover) in a certified organic field. Cover crops samples were taken and air dried in fall 2011 and spring 2012. Litterbags containing plant samples were buried at a depth of 15 cm in soil in December 2011 and March 2012. Bag samples were removed periodically and sampling will continue until November, 2012. Soil samples from each experimental plot were taken at the same time. Extracted litterbags were oven-dried and samples were analyzed for biomass fractions and total C and N content. Based on the initial analysis, soybean fixed the highest N and has the most mass-loss. All of the three crops decomposed rapidly during the first extraction.

Introduction

Soil fertility is a decisive factor in determining the productivity of farming systems[1]. Different from conventional farming systems, organic farming systems rely on the management of soil organic matter to optimize crop production[2]. Nitrogen is commonly considered to be the key factor limiting crop growth in organic systems[3]. The amount and timing of mineralization determines N availability. To study both sides of this question we address two questions: (1) which cover crop contributes the most N? and (2) when is most N released after incorporation?

Previous studies show that soil conditions, climate, and litter chemistry are the main factors controlling litter decomposition rates[4]. Under similar soil conditions, we hypothesize that: (1) the three target crops will have different performances according to their chemical properties; (2) soybean will contribute the most N into soil; and (3) most N will be released in earliest stage of decomposition.

Methods

Study site and samples

This field study is being conducted at the Agricultural Research and Development Center (ARDC) near Mead, NE. Three cover crops were over seeded in March 2011 onto a wheat crop. In October, 2011, and in March, 2012, clover plants were cut randomly from each plot.

Litter bag study

Nylon bags (50 μm mesh) stapled with aluminum tag were filled with about 4g air dried plant samples. We randomly chose four plots for each species and each plot has 4 replications. Litter bags were buried to a depth of 15cm in each plot on December 1, 2011 and on May 11, 2012. The nine extraction times for fall treatment are 0, 4, 16, 20, 24, 28, 32, 36, 44 weeks after burial; for spring treatment samples were dug up every four weeks.

Analytical Procedure

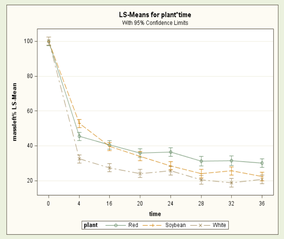
Air temperature, **precipitation**, and **soil temperature**, **moisture** data are acquired by Campbell Scientific data logger (Model CR10X, Campbell Scientific).

Soil samples(15 cm deep) were taken at three points in the plot at each sampling time. Samples were then combined, air dried and sent to a commercial laboratory for **N content** determination.

Extracted bags were oven-dried to a constant weight and remaining mass was calculated to get **decomposition rates**. **Total C and N** concentrations were measured with COSTECH Analytical Elemental Combustion System 4010 (ESC 4010). **Biomass fractions** were determined after extraction of structure biomass using the Ankom Fiber Analyzer.

Results

a. Decomposition constant



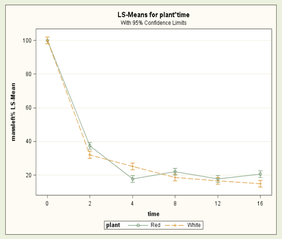
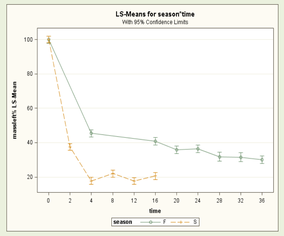


Fig.1. Remaining mass of red clover, white clover and soybean during the decomposition time (weeks) for fall treatment (left) and spring treatment (right). Data were expressed as percentage of the initial mater before burial. Bar indicates standard error.



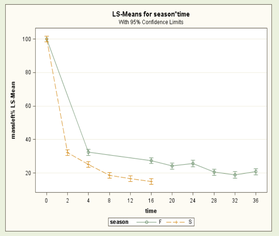
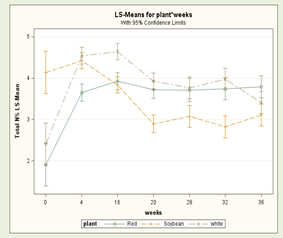


Fig.2. difference of remaining mass during decomposition time (weeks) between fall treatment and spring treatment for white clover (left) and red clover (right). Data were expressed as percentage of the initial mater before burial. Bar indicates standard error.

Species	Season	Decomposition Constant k
Soybean	Fall	0.59
White clover	Fall	0.54
	Spring	0.42
Red clover	Fall	0.63
	Spring	0.42

Table1: Decomposition constant of different species cover crops

b. Nitrogen remaining



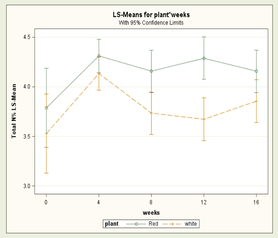
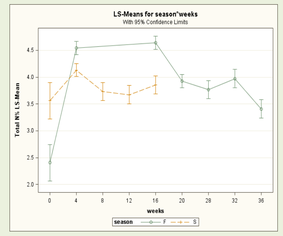


Fig. 3. Nitrogen content in remaining sample for fall treatment and spring treatment during decomposition time (weeks). Data were expressed as percentage of total N in the whole remaining litter. Bar indicates standard error.



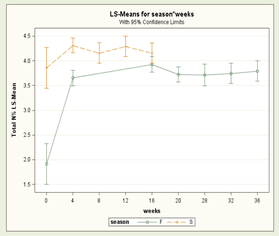


Fig. 4. Difference of nitrogen content between fall treatment and spring treatment during decomposition time (weeks) for white clover (left) and red clover (right). Data were expressed as percentage of total N in the whole remaining litter. Bar indicates standard error.

c. Conclusion

There are no significant changes of nitrogen remaining concentrations for red clover in either spring or fall treatment. White clover in fall treatment decreased significantly in the first 20 weeks, and decreased rapidly in the first 8 weeks for spring treatment. Nitrogen remaining in soybean changes the most among three crops. For white clover, it has more nitrogen left in fall; while red clover remains more nitrogen in spring.

Future Questions & Objectives

- To study cover crop's N contribution to soil by testing soil samples
- To explore the factors that affect cover crop's nitrogen release considering weather conditions, plant's lignin fractions.
- In practice, cover plants are cultivated into soil directly, but in this study, we bury the samples after being dried. Is there a difference? and does the difference matter?

References

(1) Badgley C., Moghtader J., Quintero E., Zakem E., Chappell M.J., Aviles-Vazquez K., Samulon A., Perfecto I. (2007) Organic agriculture and the global food supply. Renewable Agriculture and Food Systems 22:86-108.
(2) Watson C., Atkinson D., Gosling P., Jackson L., Rayns F. (2002) Managing soil fertility in organic farming systems. Soil Use and Management 18:239-247.
(3) Berentsen P., Giesen G., Schneiders M. (1998) Conversion from conventional to biological dairy farming: economic and environmental consequences at farm level. Biological agriculture & horticulture 16:311-328.
(3)Möller K., Stinner W., Deuker A., Leithold G. (2008) Effects of different manuring systems with and without biogas digestion on nitrogen cycle and crop yield in mixed organic dairy farming systems. Nutrient Cycling in Agroecosystems 82:209-232.
(4) Grandy A.S., Sinsabaugh R.L., Neff J.C., Stursova M., Zak D.R. (2008) Nitrogen deposition effects on soil organic matter chemistry are linked to variation in enzymes, ecosystems and size fractions. Biogeochemistry 91:37-49.