Impacts of Cover Crops on Soil Health and Soil Microbial Ecology

Edwin K. Akley, Charles W. Rice, Peter J. Tomlinson, and P.V.Vara Prasad

Department of Agronomy, Kansas State University, Manhattan, KS 66506

Introduction

Soil management associated with sustainable intensification, such as cover cropping, can help maintain soil quality, enhance crop productivity, and protect the environment. In the past, soil quality assessment focused on soil's physical and chemical properties, but several recent studies have emphasized soil biology as an important indicator of soil quality. Soil quality enhances soil biological activity, which affects key soil properties such as soil structure, soil organic matter and nutrient cycling. Assessment of some key soil quality indicators can be useful to determine soil health. However, there is no minimum data set on soil biology that can be used as indicators of soil quality and soil health.

Objective

To evaluate the effects of different cover crops on soil health and soil microbial ecology using selected biological indicators.

Materials and Methods

- Location: Ashland Bottoms, Kansas
- Soil Type: Wymore silty clay loam soil (fine, smectic, mesic Aquertic Argiudoll)
- Experimental Design: Split plot in a Randomized Complete Block Design (RCBD)

Treatments:

- Main Plot: Six (6) different cover cropping systems -
  - Chemical Fallow (CF)
  - Double Crop Soybean (DCSB)
  - Summer Non-legume (SNL) (sorghum-sudan grass)
  - Summer Legume (SL) (late-maturing soybean)
  - Winter Non–legume (WNL) (tillage radishes)
  - Winter Legume (WL) (crimson clover)
- Sub Plots: Two Nitrogen fertilizer rates (0 & 80 N kgha^{-1}) from Urea Ammonium Nitrate (UAN) applied at planting
- Soil Sampling Depths: 0-5 and 5-15 cm

Analyses

- Microbial Respiration (evolved CO2)
- Microbial Biomass Carbon & Nitrogen (MBC & MBN)
- Dissolved Organic Carbon (DOC)
- Potentially Mineralizable Nitrogen (PMN)

Statistical Analysis

- Proc mixed in SAS 9.4 and means separated by Tukey-Kramer at a significance level of 0.05

Photo. TOC-L SHIMADZU machine used for DOC analysis.

Results and Discussion

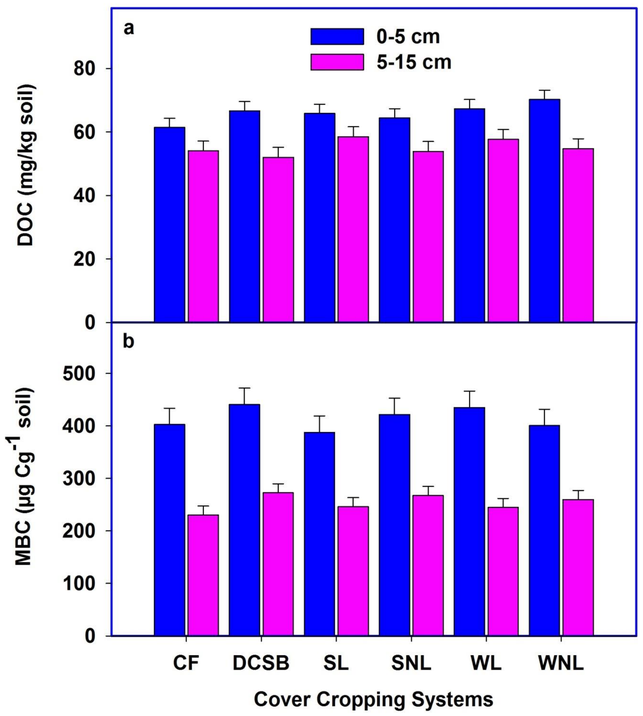

Figure 1. Effects of different cover cropping systems and two soil depths on (a) dissolved organic carbon (DOC), and (b) microbial biomass carbon (MBC).

- DOC and MBC were not significantly different ($P < 0.05$) among the different cover crop systems at 0-5 cm and 5-15 cm depths (Fig. 1).

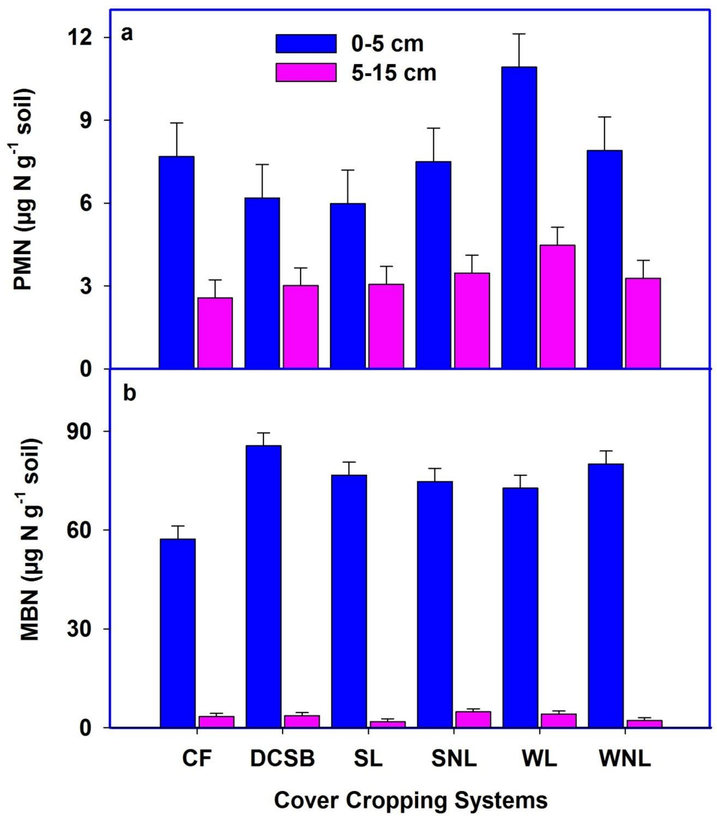

Figure 2. Effects of different cover cropping systems and two soil depths on (a) potentially mineralizable nitrogen (PMN) , and (b) microbial biomass nitrogen (MBN).

- DCSB, SL, SNL, and WNL had the highest MBN compared to CF ($P < 0.05$) at the 0-5 cm depth. PMN was not significantly different ($P < 0.05$) among the different cover crop systems irrespective of depth (Fig. 2).

Results and Discussion (cont.)

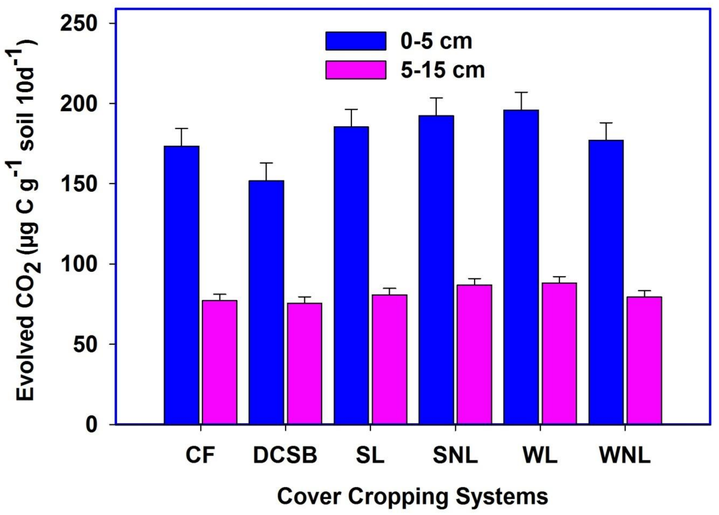

Figure 3. Effects of different cover cropping systems and two soil depths on evolved CO_2 levels.

- SNL and WL had increased microbial activity compared to DCSB in the 0-5 cm depth ($P < 0.05$).
- This signifies higher microbial activities such as decomposition and mineralization taking place in these treatments (Fig. 3).

Table 1. Means of MBN (µg N g^{-1} soil) and PMN (µg N g^{-1} soil) under different cover cropping systems at different N fertilizer rates at Ashland Bottoms , Kansas, May, 2014.

Treatment	MBN (µg N g-1 soil)		PMN (µg N g-1 soil)	
	0-5 cm	5-15 cm	0-5 cm	5-15 cm
CF + 0 N	61.3	4.0	7.1	2.9
CF + 80 N	53.4	2.8	8.3	2.3
SL + 0 N	79.4	1.0	5.8	3.4
SL+ 80 N	74.0	2.7	6.2	2.8
SNL + 0 N	70.7	3.5	5.9	3.4
SNL+ 80 N	78.9	6.2	9.1	3.5
WL + 0 N	79.1	5.7	13.4	5.6
WL+ 80 N	66.4	2.7	8.5	3.4
WNL + 0 N	77.3	2.8	9.7	3.1
WNL + 80 N	82.9	1.5	6.1	3.4
DCSB + 0 N	89.2	1.9	5.8	3.1
DCSB + 80	82.0	5.4	6.5	3.0
Tukey (p=0.05)	27.0	5.5	7.9	3.7
SED	5.6	1.2	1.6	0.8

- N fertilizer application had no affect on the soil microbial indicators except MBN where DCSB + 0 N kg/ha had a significantly higher MBN compared to CF + 0 N kg/ha and CF + 80 N kg/ha in the 0-5 cm depth (Table 1).

Conclusions

- DCSB, SL, SNL and WNL can potentially improve soil fertility by adding N from microbial sources within the top 0-5 cm depth.
- SNL increased MBN as well as microbial activity; thus, SNL appeared to be the most effective cover cropping regime to enhance soil health.

Acknowledgements

- USAID/BHEARD program – Michigan State University
- CSIR–Savanna Agricultural Research Institute (SARI)
- Kansas State University (KSU)