EFFECTS OF COVER CROPS ON SOIL BIOLOGICAL AND CHEMICAL QUALITY PARAMETERS

Chathuri S. Weerasekara[1], Ranjith P. Udawatta[1,2], Clark J. Gantzer[2], Kristen S. Veum[3], and Shibu Jose[1]

[1]The Center for Agroforestry, [2]Department of Soil, Environmental and Atmospheric Sciences, and [3]USDA-ARS Cropping Systems and Water Quality Unit, University of Missouri, Columbia, MO

Introduction

- Human abuse of soil resources has caused disappearance of several earlier civilization
- Farming practices have caused the rate of soil loss to be greater than the rate of soil formation (Amundson et al., 2015)
- Better agricultural management practices that sustain soils are required to conserve soil resources (Montgomery, 2007)
- Cover crops (CC) provide numerous environmental benefits while enhancing the sustainability of corn (*Zea mays* L.) and soybean (*Glycine max* L. Merr.) production systems (Delgado and Gantzer, 2015)
- Benefits of CC include;
    - Reduced soil erosion and nutrient loss via leaching or runoff, weed suppression, carbon sequestration, integrated pest management, soil moisture conservation, reduced non-point source pollution
- Soil physical, chemical, and biological properties are improved by CC because of increased organic C content, cation exchange capacity, aggregate stability and water infiltration (Dabney et al., 2001)
- Soil enzymes such as β-glucosidase, β-glucosaminidase, and fluorescein diacetate (FDA) hydrolase are considered good indicators of soil biological quality (Dick, 1994; Karlen et al., 1997, Gregorich et al., 2006)

Objectives

- Evaluate the aboveground biomass production of hairy vetch (*Vicia villosa* Roth.) and cereal rye (*Secale cereale*) cover crops
- Determine the changes of soil chemical and biological properties including total C, N, and P contents and soil enzyme activities of CC grown Menfro silt loam, Mexico silt loam, and sand under two irrigation methods

Methods

Location

- University of Missouri-Columbia green house complex; March - May 2016

Experimental Design

- Randomized complete block design (RCBD)

Method

- 4 seeds were seeded into each pot
- Irrigation water amount was calculated using bulk density and plant available water content of each soil
- CC were harvested at 6, 9, and 12 weeks after seeding

		Irrigation Methods			
		Full volume of water		Half volume of water	
Soil type	Menfro silt loam	HV Rep=4	CR Rep=4	HV Rep=4	CR Rep=4
	Mexico silt loam	HV Rep=4	CR Rep=4	HV Rep=4	CR Rep=4
	Sand	HV Rep=4	CR Rep=4	HV Rep=4	CR Rep=4

Table 1. Treatment combinations applied in the experiment, where HV= Hairy vetch and CR= Cereal rye

Results and Discussion

- Menfro silt loam resulted the highest aboveground biomass for hairy vetch while Mexico silt loam had the highest biomass yield for cereal rye (Fig. 2)
- CC type and water treatment were not significant for the three enzymes and total C, N, and P
- β-glucosidase activity was significantly increased as 21.5% for Mexico silt loam, 27% for Menfro silt loam, and 45% for sand at the end of the study period (Fig. 3)
- Total C, N, and P amounts were significantly decreased with time (Fig. 4)

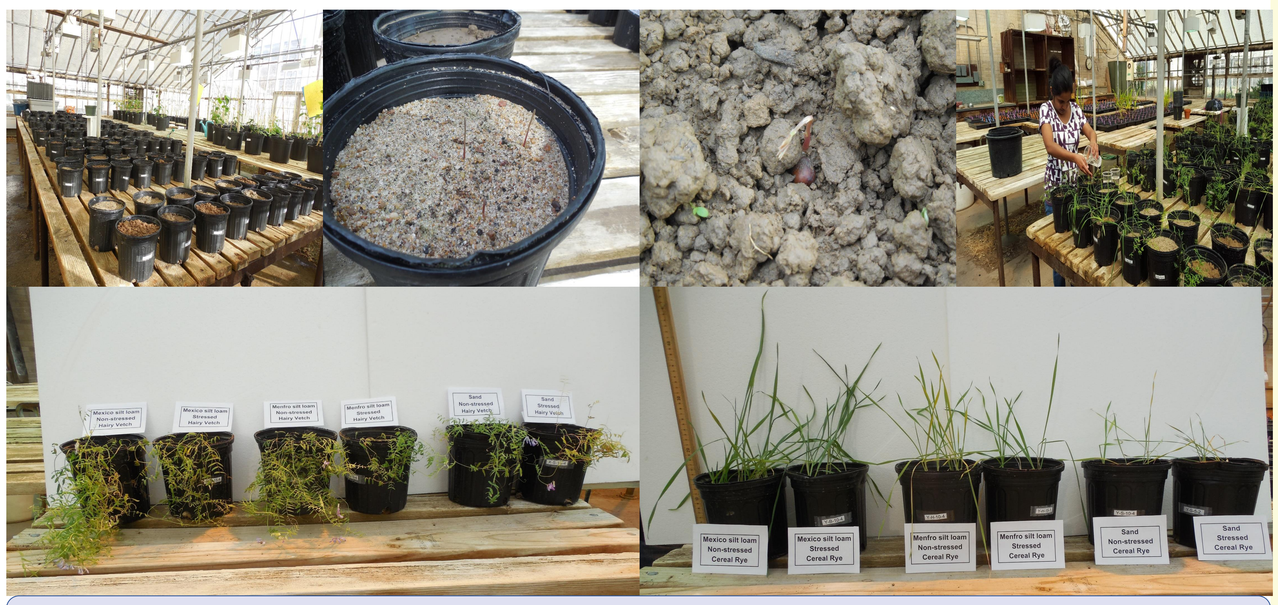

Figure 1. Growth of Hairy vetch and Cereal rye in Mexico silt loam, Menfro silt loam, and sand under stressed and non-stressed conditions at six weeks after planting

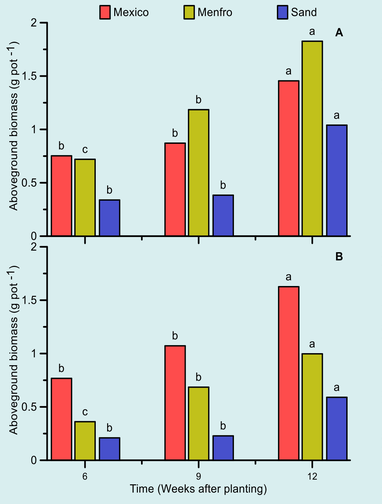

Figure 2. Mean aboveground biomass yield of (A) hairy vetch and (B) cereal rye in Mexico silt loam, Menfro silt loam, and Sand. Different letters denote significant differences among treatments at α ≤ 0.05.

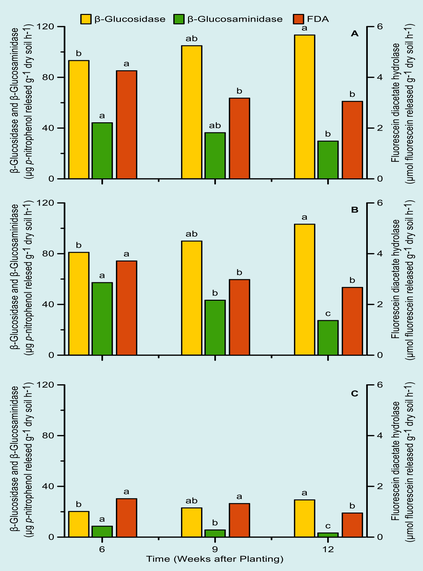

Figure 3. Changes of β-glucosidase, β-glucosaminidase, and fluorescein diacetate (FDA) hydrolase activities in (A) Mexico silt loam, (B) Menfro silt loam, and (C) Sand with time. Different letters denote significant differences among treatments at α ≤ 0.05.

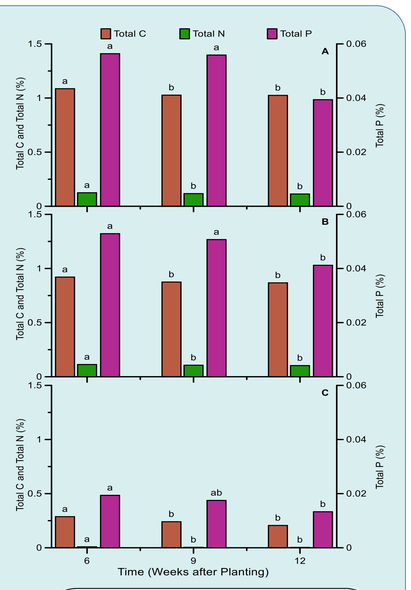

Figure 4. Changes of total C, total N, and total P contents in (A) Mexico silt loam, (B) Menfro silt loam, and (C) Sand with time. Different letters denote significant differences among treatments at α ≤ 0.05.

Conclusions and Suggestions

- Enzyme activities and total C, N, and P contents decreased with time in all soil types with the exception of β-glucosidase
- Long-term studies conducted for the above soil types are required for making better management decisions when using CC for improving soil productivity and row crop yield

References

- Amundson, R., A.A. Berhe, J.W. Hopmans, C. Olson, A.E. Sztein, and D.L. Sparks. 2015. Soil and human security in the 21st century. Science 348(6235): 1261071.
- Dabney, S.M., J.A. Delgado, and D.W. Reeves. 2001. Using winter cover crops to improve soil and water quality. Commun. Soil Sci. Plan. 32:1221-1250.
- Delgado, J.A., and C.J. Gantzer. 2015. The 4Rs for cover crops and other advances in cover crop management for environmental quality. J. Soil Water Conserv. 70(6): 142A–145A.
- Dick, R.P., 1994. Soil enzyme activities as indicators of soil quality. In: Doran, J.W., Coleman, D.C., Bezdicek, D.F., Stewart, B.A. (Eds.), Defining soil quality for a sustainable environment. Soil Science Society of America, Madison, Wisconsin. pp. 107-124.
- Gregorich, E.G., M.H. Beare, U.F. McKim, and J.O. Skjemstad. 2006. Chemical and biological characteristics of physically uncomplexed organic matter. Soil Science Society of America Journal 70(3): 975–985.
- Herrick, J.E. 2000. Soil quality: an indicator of sustainable land management. Applied Soil Ecology 15(1): 75–83.
- Karlen, D. L., M. J. Mausbach, J. W. Doran, R. G. Cline, R. F. Harris, and G. E. Schuman. 1997. Soil Quality: A Concept, Definition, and Framework for Evaluation (A Guest Editorial). Soil Sci. Soc. Am. J. 61:4-10. doi:10.2136/sssaj1997.03615995006100010001x
- Montgomery, D.R. 2007. Soil erosion and agricultural sustainability. Proceedings of the National Academy of Sciences 104(33): 13268–13272.