Interrelationships of Soil Properties in Organic Farming Systems

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A study of soils of 14 organic farms located across Nebraska is underway to:

- Compare soil properties such as nutrient availability of organic and conventional farms
- Determine interrelationships of soil properties for organic fields, and
- Relate organic management practices to soil properties.

This study will provide a baseline for monitoring changes in soil properties over time. The results presented here are from 57 fields of 6 farms sampled for the 0 to 7.5-cm soil depth. The samples were collected in May-June 2013. Soil microbial community composition was measured using FAME (fatty acid methyl ester) methodology with specific FAMEs serving as biomarkers for microbial groups.

Results

Organic vs. conventional farms (Table 1)

Estimates for conventional farms were derived independently from diverse sources with >1400 samples for chemical properties but only 20 for the FAME comparison.

- Median nutrient availability was approximately twice as high compared with conventional farms in Nebraska.
- Total and particulate organic matter and pH were higher on organic farms.
- It needs to be considered that the organic soil was sampled to 7.5 cm while conventional soils were commonly sampled to 20 cm depth, but nutrient availability is not likely to be highly stratified with soil depth for organic fields because of regular tillage.
- Many but not all organic farms imported manure.
- The high P availability poses an environmental concern on tilled, highly erodible land.

Table 1. Comparison of median soil property values for conventional and organic farms in Nebraska (57 fields).

	Conventional†	Organic
Organic matter (SOM),%	2.5	2.9
Particulate OM (POM), %	0.42	0.87
pH	6.4	7.2
Bray P1, mg kg^{-1}	18	70
Exchangeable K, mg kg^{-1}	320	621
Zn, mg kg^{-1}	1.4	2.3
Saprophytic fungi	10.0	13.4
Bacteria	49.8	42.2
Mycorrhizae	7.0	5.8
Water stable aggregates >53µ, %	83	80

- The estimates for microbial group biomass for conventional farms are from five site-years of study for a no-till corn (or sorghum) – soybean rotation in eastern Nebraska sampled at 0- to 5-cm depth. Considering that microbial biomass typically decreases with soil depths, the results indicate little or no difference in bacterial or mycorrhizal biomass but lower saprophytic fungi with conventional compared with organic farms.
- Percent of soil in water stable aggregates (WSA) was similar for organic and conventional farms.

Soil property interrelationships for organic fields

Microbial. Mycorrhizal biomass was not correlated with soil chemical and physical properties. Biomass of most microbial groups increased with more SOM and POM, but decreased with higher sand content, while the fungi:bacteria ratio was inversely affected (Table 2). Microbial biomass was negatively correlated with total WSA and positively correlated with CEC and available P.

Table 2. Pearson correlation coefficients of microbial group biomass with other soil properties.

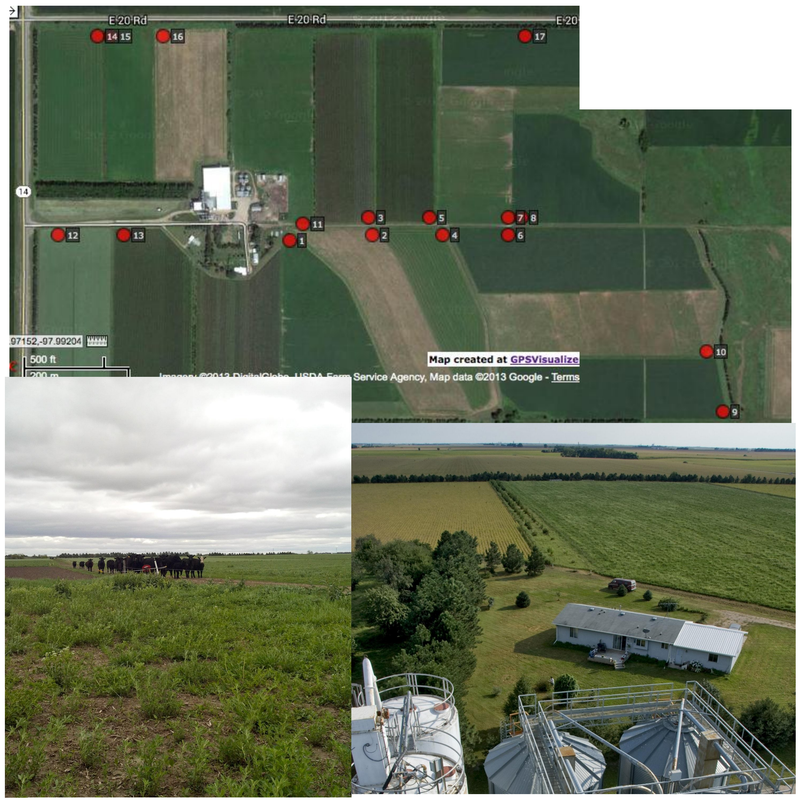
Microbial group	SOM	POM	Sand	Total WSA	CEC	Available P
Saprophytic fungi	0.40	0.43				0.58
Bacteria	0.85	0.69	-0.71	-0.35	0.45	0.51
Actinomycetes	0.75	0.60	-0.68	-0.42	0.37	0.40
Eukaryotes	0.56	0.54	-0.35			0.41
Total FAME	0.79	0.65	-0.60	-0.30	0.38	0.57
Fungi:bacteria	-0.34		0.51		-0.39	

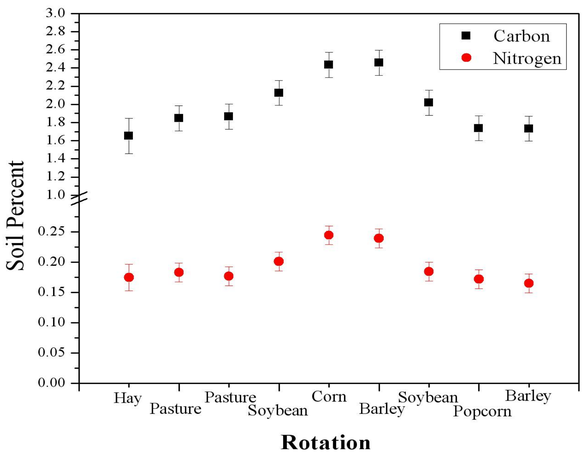
Physical. Mean diameter of WSA increased as SOM and fine POM increased.

Chemical. Nutrient availability was generally greater with higher SOM and lower sand content. Nutrient availability was generally not related to WSA or POM fractions.

Management practices

The Grain Place in south central Nebraska is of special interest because of its 9 year rotation with two fields in each stage of the rotation. The rotation is 3 years of perennial grass-legume forage for hay or grazing followed by the sequence of soybean, corn, barley, soybean, popcorn, and barley. Each of these fields was sampled at geo-referenced points.





Summary

- Nutrient availability was high for organic compared with conventional farms. Median values for WSA and microbial biomass were similar.
- Microbial biomass was greatly affected by SOM, sand content, and some soil chemical properties.
- Mycorrhizal biomass varied independently of soil chemical and physical properties.
- Soil organic C and N were higher with the second and third crops following termination of the 3-year perennial grass-legume phase.

Acknowledgement: *Funding for this research was provided by Organic Agriculture Research and Extension Initiative for the project "Improving Organic Farming Systems and Assessing their Environmental Impacts across Agroecoregions"*