Organic Vegetable Farming Promotes Physically Protected Soil Carbon Accrual

P. Toonsiri[1], M.F. Cotrufo[1], and J.G. Davis[1]

[1]Department of Soil and Crop Sciences, Colorado State University, Fort Collins, CO

pst.Toonsiri@colostate.edu

Background and Rationale

Accrual of carbon (C) in soil is a means for greenhouse gas (GHG) emissions mitigation. Protected C in soil is associated with many factors, especially agricultural management. Due to management, soil organic carbon (SOC) stocks and soil aggregate distribution can be reduced or enhanced.

Organic amendments enhance soil C inputs and may affect the formation and stabilization of aggregates due to increasing binding agent, thus potentially resulting in more and more physically protected SOC.

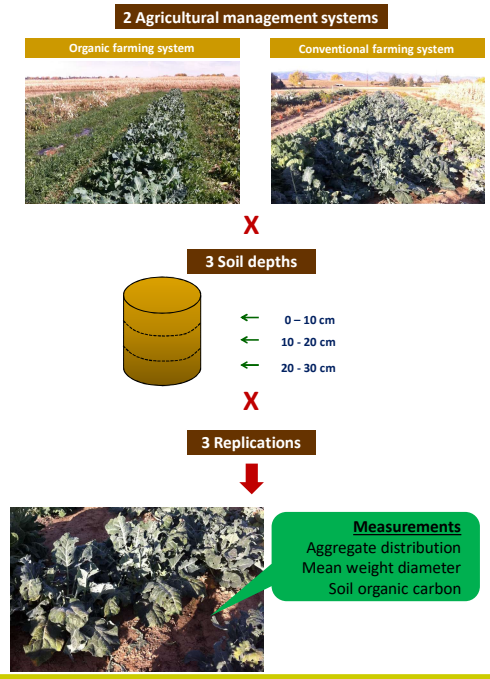
In this study we wanted to test if: (H1) soil physical protection (e.g., aggregation) and SOC amount under organic farming system are higher than under conventional farming system due to high C inputs, and (H2) this beneficial effect of organic farming decreases with soil depth

Goal

To improve the understanding of SOC stocks and aggregation associated with organic agricultural management.

Approach

The study was conducted on conventional and certified organic broccoli fields at the Colorado State University Horticulture Field Research Center in 2014. A randomized split plot design was applied to this study.



Results

Site description:

Table 1. Details of farming systems at Colorado State University Horticulture Field Research Center in 2014

Farming system	Conventional farm	Organic farm
Latitude	40º 39′ 6″N	
Longitude	104º 59′ 57″W	
Soil series	Nunn clay loam	
Slope (%)	1-3	
Annual precipitation (mm)*	323.85	
Average temperature (ºC)*	8.56	
Crop	Broccoli	
Tillage management	Roto-till once per year (15 cm)	
Year that organic farming began	-	2003
Cover crop management	None	Yes
Pesticide or herbicide application	Yes (Glyphosate)	None
Fertilizer application	Urea	Compost
Irrigation	Furrow/Gated pipe	Drip and solid set

* Weather data were taken from http://www.coagmet.colostate.edu/rawdata_form.php

Soil aggregate distribution and stability:

- Aggregate size distributions were dominated by macroaggregates (>250 µm) under the organic farming system and by free microaggregates (53-250 µm) under the conventional farming system.
- Aggregate stability based on mean weight diameter (MWD) ranged from 0.89 to 2.76 mm, and MWD under the organic farming system was greater than under the conventional farming system.
- All aggregate sizes and MWD did not significantly decreased with depth, except for the free microaggregates.

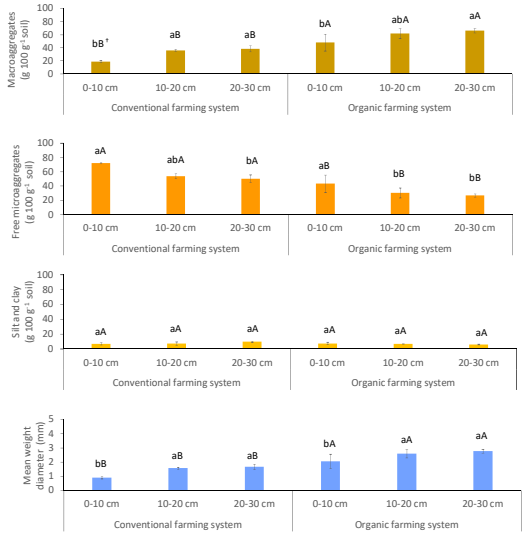


Figure 1. Aggregate size distribution and mean weight diameter at 3 depths in conventional and organic farming systems.

† Values followed by the same lowercase letter indicate that the means of the parameter across depth within the same system and values followed by the same uppercase letter indicate that the means of the parameter across system within the same depth are not significantly different according to the least square means with a Tukey-Kramer test ($p < 0.05$).

Results

Soil organic carbon (SOC):

- SOC of bulk soil, macroaggregates, and silt and clay tended to be greater under the organic farming system than under the conventional farming system, but SOC of free microaggregates was not.
- SOC of all aggregate sizes tended to decrease with depth, except macroaggregates.

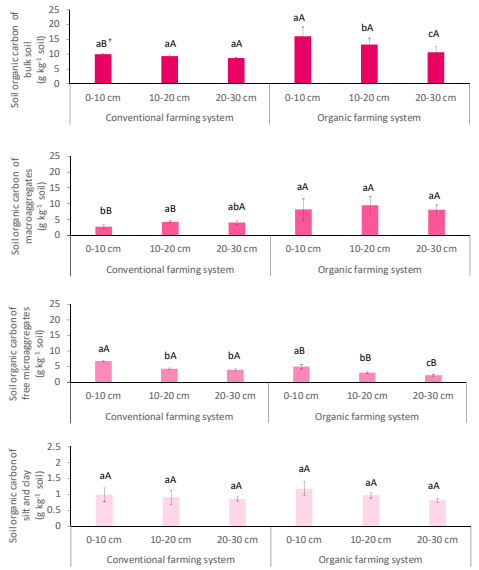


Figure 2. Soil organic carbon (SOC) in bulk soil and each aggregate size at 3 depths in conventional and organic farming systems.

† Values followed by the same lowercase letter indicate that the means of the parameter across depth within the same system and values followed by the same uppercase letter indicate that the means of the parameter across system within the same depth are not significantly different according to the least square means with a Tukey-Kramer test ($p < 0.05$).

Conclusions

Our comparison of C stocks and aggregates distribution between paired organic and conventional farms demonstrated that:

- **Organic farming increases total soil C stocks.**
- **This increase is associated to an enhanced soil aggregation and protection of C in macroaggregates.**
- **The effects of organic farming can still be found down to 30 cm depth.**

According to our finding, we propose that organic farming practices have a higher potential for sequestering C and promote soil aggregate stability in vegetable systems compared to conventional farming.

Acknowledgements

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