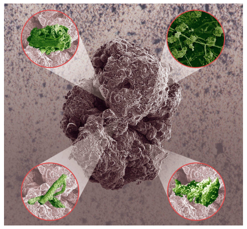

Relationships between Carbon Input, Aggregation, and Soil Organic Carbon Stabilization in Sustainable Cropping Systems

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Introduction

Approximately 10% of the earth's soil C is stored within agricultural ecosystems. Because farming systems hold promise for sequestering C, their sustainability, environmental impact, and potential role in mitigating rising atmospheric CO_2 concentrations must be addressed. Our current challenges are to quantify the mechanisms, capacity, and longevity of agricultural lands as C sinks. Agronomic practices that influence yield and, therefore, affect the proportion of crop residues returned to the soil (e.g. cover cropping, irrigation, fertilizer addition, and compost application) are likely to influence soil organic carbon (SOC).

Objectives

Determine the influence of C input on C sequestration in SOC fractions and evaluate how aggregation (MWD) relates to SOC and cumulative C input across 10 different cropping systems at LTRAS/SAFS.

Hypotheses

Hypothesis$_1$: Total soil organic carbon (SOC) increases with increased carbon input.

Hypothesis$_2$: Increased C input results in greater aggregate stability.

Hypothesis$_3$: Soil Carbon is preferentially stabilized in microaggregates within macroaggregates.

Methods

- Sampled soils (0-15 cm depth) from all ten cropping systems at the LTRAS/SAFS in April 2003.
- Soils were analyzed for organic C content and aggregation stability by the slaking methodology.
- Archived soils from year of establishment (1993) of experiment were analyzed for organic C content.

Cropping Systems at LTRAS

Cropping System	Even Years	Odd Years
Rainfed wheat control (RWC)	unfertilized rainfed wheat	fallow
Rainfed wheat/legume (RWL)	unfertilized rainfed wheat	rainfed legume cover crop
Rainfed wheat/fallow (RWF)	fertilized rainfed wheat	fallow
Irrigated wheat control (IWC)	unfertilized irrigated wheat	fallow
Irrigated wheat/legume (IWL)	unfertilized irrigated wheat	rainfed legume cover crop
Irrigated wheat/fallow (IWF)	fertilized irrigated wheat	fallow
Conventional wheat/tomato (CWT)	fertilized irrigated wheat	fertilized irrigated tomato
Conventional corn/tomato (CCT)	fertilized irrigated corn	fertilized irrigated tomato
Legume/corn/tomato (LCT)	winter legume / irrigated corn	fertilized irrigated tomato
Organic corn/tomato (OCT)	winter legume / irrigated corn compost / no pesticides	winter legume / irrigated tomato compost / no pesticides

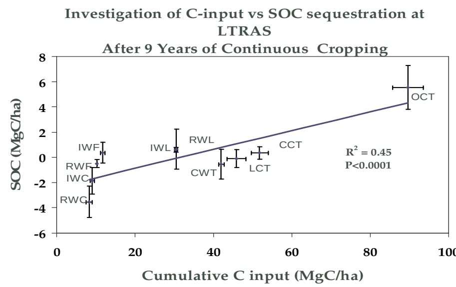
Carbon Input Calculations

corn residue (kg DW/ha) = 1.0577× grain DW + 503.37 (R^2 =.78)
corn roots (kg DW/ha) = 0.23 × aboveground biomass DW

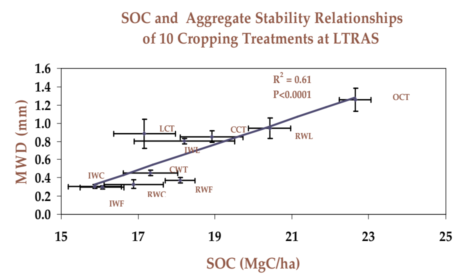
tomato residue (kg DW/ha) = 0.001 x (tomato yield DW)^2 + 0.049 x tomato yield DW + 0.33 (R^2= 0.97)
tomato roots (kg DW/ha) = 0.22 x aboveground biomass DW

winter wheat residue (kg DW/ha) = 1.06 × grain DW + 388.97 (R^2 =.68)
wheat roots (kg DW/ha) = 0.22 × aboveground biomass DW

Results



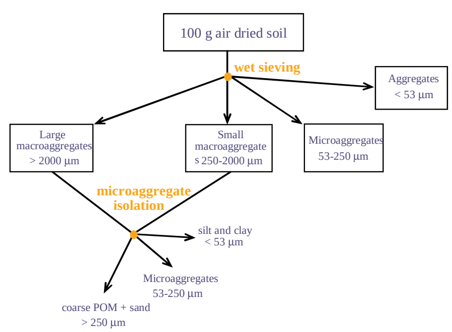
SOC sequestration was linearly related to C input levels across cropping systems in this typical Californian soil characterized by low soil carbon levels. The low input systems rather lost SOC than sequestered SOC over the 9 years of the experiment. The organic cropping system accumulated the greatest amount of SOC, but had also a disproportional higher level of C inputs.

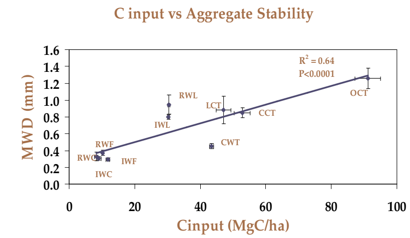


The linear increase in mean weight diameter (MWD) with increasing SOC level indicates the close relationship between aggregate stability and the accumulation of SOC.

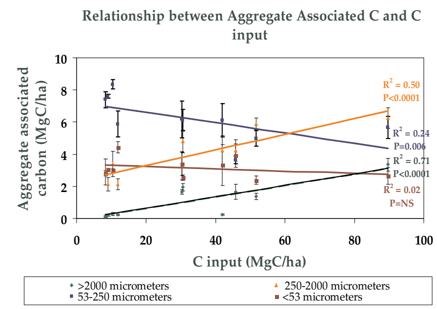
Methods (continued)

Soil Fractionation

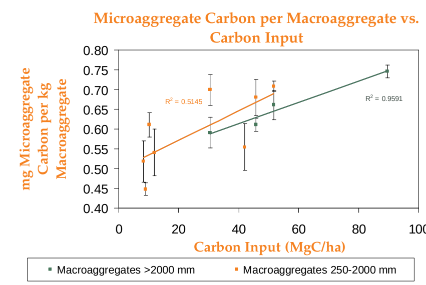




Increased C input results in a greater aggregate stability, probably through an increased microbial activity and concomitant production of microbial-derived binding agents.



The relationship between C input and SOC sequestration is dominated by an increase in SOC associated with the macroaggregates, especially small macroaggregates.



The majority of the increase in SOC associated with the macroaggregates was within the microaggregates occluded within the macroaggregates.

Conclusion

All 3 of our hypotheses are corroborated by the results and indicate that the potential of C sequestration across cropping systems is strongly controlled by C inputs and governed by the stabilization of SOC in microaggregates occluded within stable macroaggregates.