Coupling Computed Micro-Tomographic Images and Stable Isotopes to Elucidate the Relationship between Soil Carbon and Soil Structure

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Introduction

Increasing soil carbon improves soil health, which boost plant productivity, but also stores atmospheric carbon, which mitigates global climate change. The amount and fate of newly added carbon, primarily from plant roots, are affected by many underlying factors. Three underlying factors this study address are: 1) inherent soil properties, such as microbial diversity, amount of already present carbon, management history, which was studied using two different long term managements, conventional and biologically based managements; 2) Soil protection of newly added carbon, specifically the effect pore structure has on newly added carbon turnover; and 3) the source of the newly added carbon, whether it is directly from plant roots or new carbon that has been processed by microorganisms.

Research Hypotheses

1. ***Greater microbial diversity and more soil carbon in biologically based management lead to increased turnover in newly added carbon as compared to conventional management.***
2. ***Due to the sieving, due to loss of physical protection more older carbon is available for microbial decomposition resulting in a lower newer carbon turnover rate for the destroyed soil.***
3. ***The source of newly added carbon will affect its turnover rate: higher turnover rate will be in C that comes from roots exudates than for new carbon that has been already processed by microorganisms.***

Figure 1: Diagram of the experimental set-up.

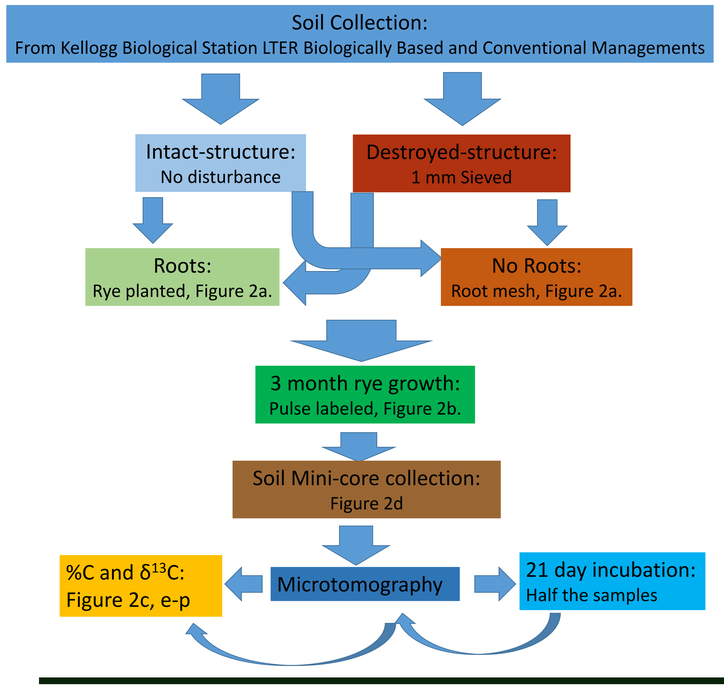
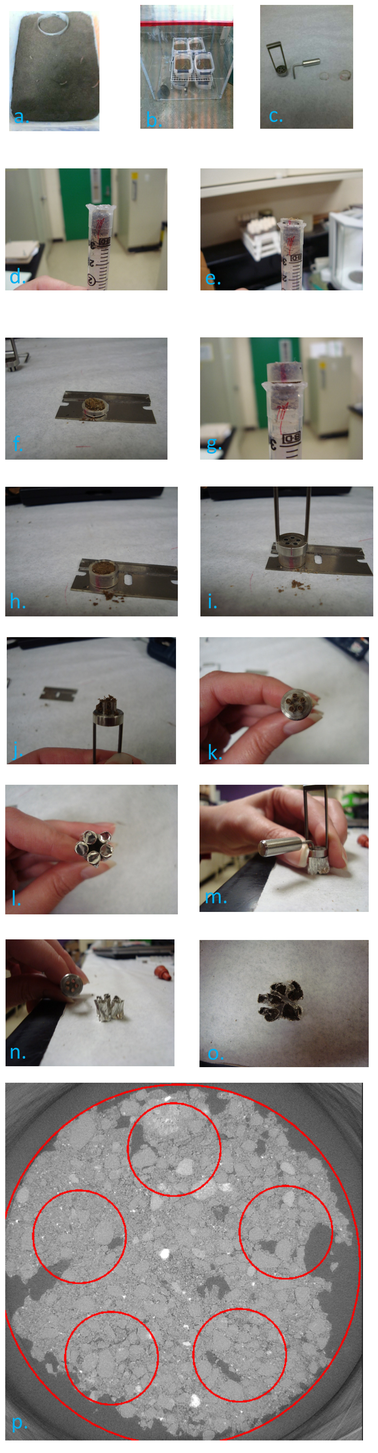
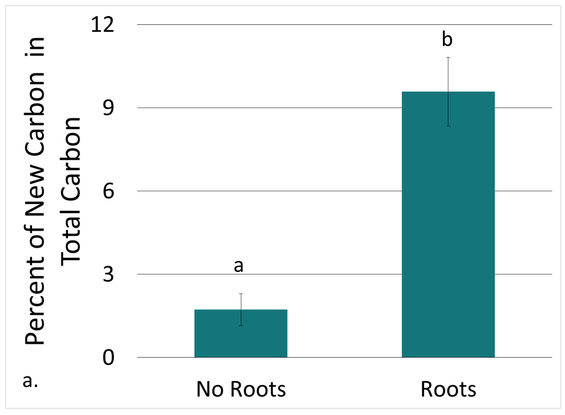
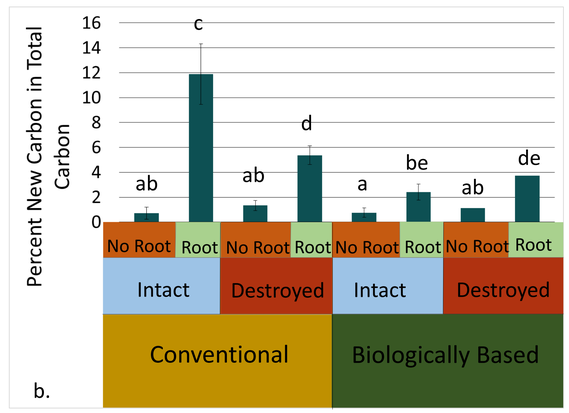
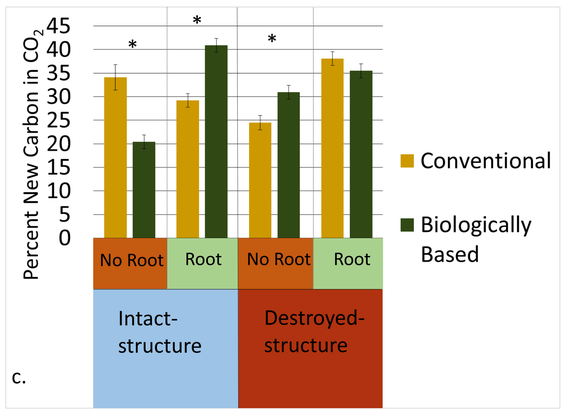


Figure 2.









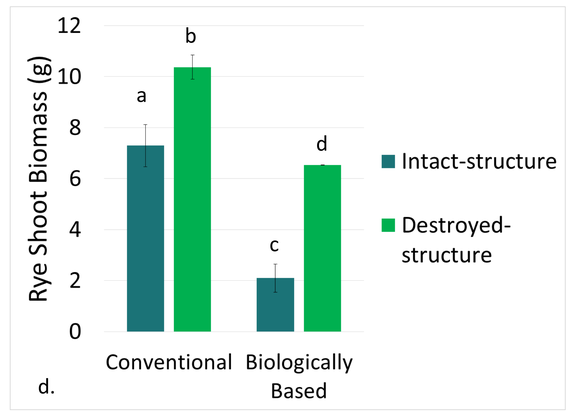


Figure 3: a. Percent of new carbon in the total carbon of the soil after 3 months of rye growth. Letters indicates significant differences at α=0.05. b. Percent of new carbon in total carbon of the soil after the 21 day incubation. Letters indicate significant differences at α=0.05. c. Percent of new carbon in the CO_2 produced during the 21 day incubation. Stars indicate significate differences between T1 and T4 at α=0.05. d. Difference in total above ground dry biomass of rye grown for 3 months in grams for all treatments. Letters indicate significant differences at α=0.05.

Results and Conclusions

- Hypothesis 1 is supported by the large loss of newly added carbon during incubation of biologically based management as compared to conventional management. This loss was seen both in the CO_2 data, where biologically based management had a higher percent of the CO_2 derived from new carbon, and the soil carbon data where the post incubation change in percent new carbon was greatest.
- Hypothesis 2 is not supported by the data. The expected pattern of more newer carbon in the CO_2 in intact structure was not observed. This indicates that pore structure alone does not drive new carbon turnover.
- Hypothesis 3 is supported by the increased newly added carbon loss in all treatments except conventional with intact structure with roots present. The newly added carbon was also more present in the CO_2 from all treatments except conventional with intact structure when roots are present. This may indicate that newly added carbon processed by microbes might reside in active biomass.

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