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Assessing the Effect of a Deep-Rooted Grass on Belowground Carbon Storage in Cultivated Land: Insights From a Multi-Site US Study

Background/Objective

Planting deep-rooted perennial plants on former cropland has been proposed as a strategy for building soil organic matter. Deep-rooted plants are thought to store more organic carbon in soil than shallow-rooted plants because root biomass stores carbon and helps build soil organic matter over time. In this study, researchers tested this hypothesis by studying switchgrass, a deep-rooted perennial grass, at 12 sites across the U.S. where it had been planted and maintained for 8-30 years.

Approach

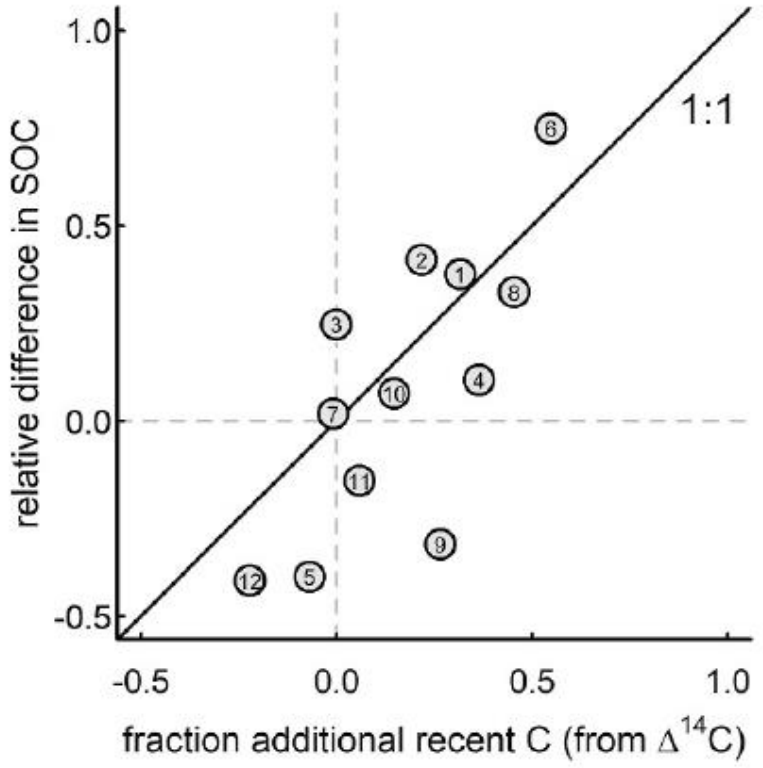
2.5 m-deep soil cores were collected at 12 mature switchgrass plots paired with neighboring plots of shallow-rooted annual crops at sites across the U.S. Root mass was quantified in depth-sectioned cores. Soil analyses included particle size, pH, exchangeable Ca, Mg, K, Na, and Al, total organic C, and ^{13}C. ^{14}C analysis was used to trace newly added C deeper in the soil column. Data was summarized from each core on a mineral mass equivalent basis.

Results

The effect of switchgrass on SOC in the top 100 cm of soil was positive at most sites, but the average effect was not statistically significant (difference in SOC = 0.6 kg C m^{-1} [95% CI = -0.8 to + 1.9 kg C m^{-2}]). However, root C was consistently more abundant under switchgrass, yielding an additional 0.6 kg C m^{-1} [95% CI = +0.5 to +0.7 kg C m^{-2}] in the surface 100 cm. ^{14}C measurements suggested that root C inputs added to existing SOC without stimulating decomposition. The effect of switchgrass on belowground C was not strongly related to any of the soil properties that were evaluated.

Significance/Impacts

This work shows that root carbon can contribute substantially to belowground C stocks when deep-rooted perennials replace shallow-rooted crops.



Relative difference in SOC (switchgrass – shallow rooted annual crop)/(switchgrass) versus the fraction of additional recent C under switchgrass, estimated by applying a mixed model to the ^{14}C data.

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