Root Biomass Production and Decomposition of Perennial Bioenergy Grasses in the Southeastern USA

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Introduction

Second generation biofuels and bio-based products derived from lignocellulosic biomass are likely to replace current fuels derived from simple sugars and starch because of greater yield potential. However, the ideal biofuel cropping system would not only be capable of high aboveground dry matter yields, but also enhance or at least minimize negative effects on other ecosystem services such as soil carbon and nitrogen cycling.

Perennial bioenergy grass harvest (left) and soil carbon sequestration (right, from www.newswise.com/images/uploads/2012/08/16/CarbonCycle2.png)

Despite similar aboveground biomass production of perennial grasses in the southeastern USA , we know very little about their root productivity, root distribution patterns, root morphological characteristics, and root chemical composition, which could lead to variation in root decomposition rates and in soil carbon accumulation over time.

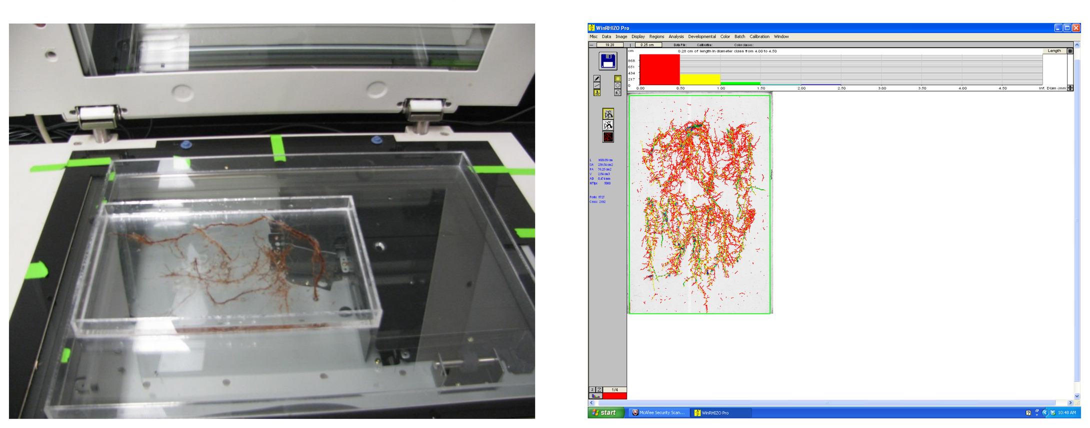
Objective

- To quantify standing root biomass production and soil carbon accumulation
- To characterize root morphological and chemical differences

Materials and Methods

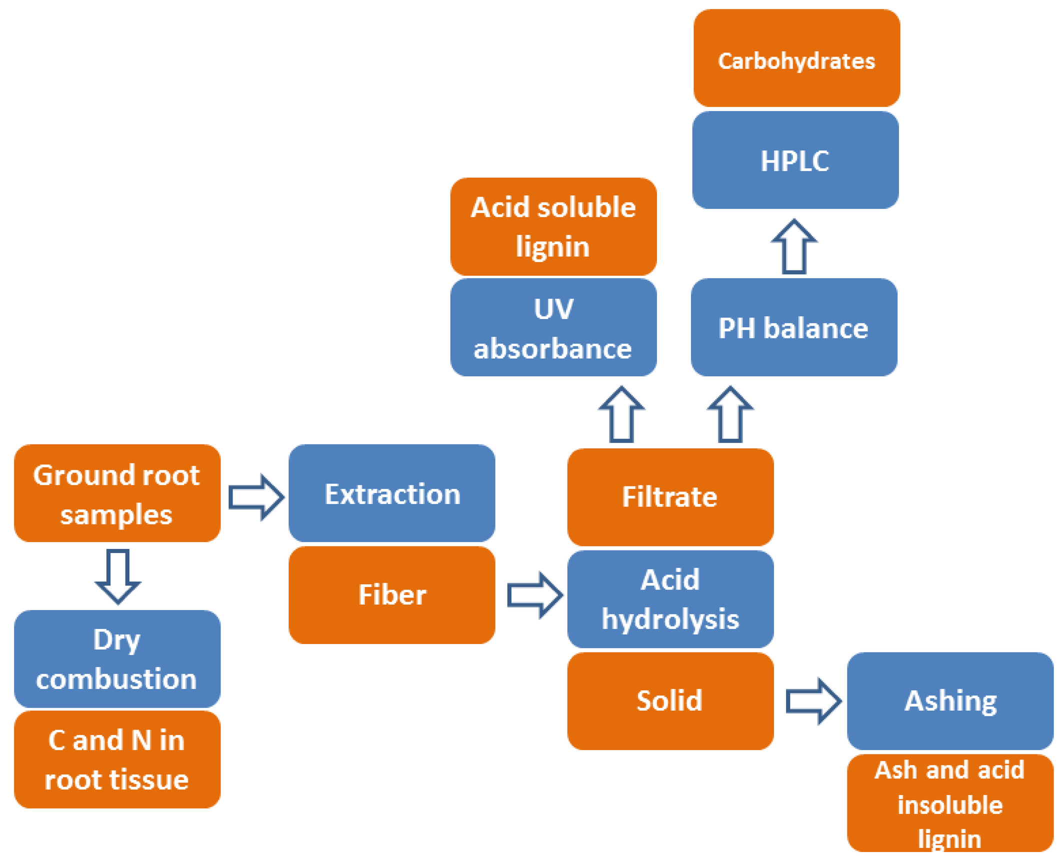
Giant reed [*Arundo donax* (L.)], elephantgrass [*Pennisetum purpureum* (Schum.)], energycane (*Saccharum* spp.), sugarcane (*Saccharum* spp.), sweetcane [*Saccharum arundinaceum* (Retz.) Jesw.], and giant miscanthus [*Miscanthus × giganteus* (Greef and Deuter ex Hodkinson and Renvoize)] were established in a randomized complete block design with four replicates in Fall 2008 near Gainesville, Florida.

Root decomposition rates were measured *in situ* over 12 months (Dec. 2011 – Dec. 2012). Four incubation bags were installed in each plot.



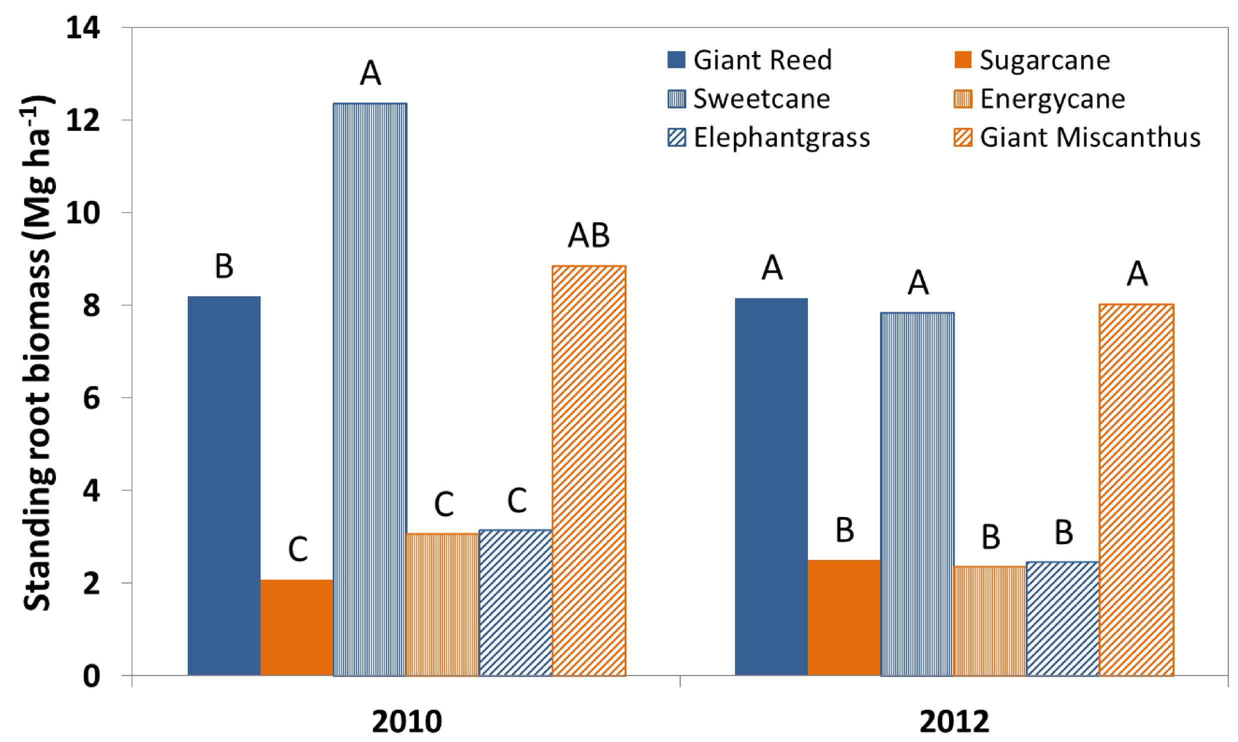
Root scanner equipped with top lights (left) and WinRHIZO software (right) used for analysis of root length, surface area and volume.

Materials and Methods

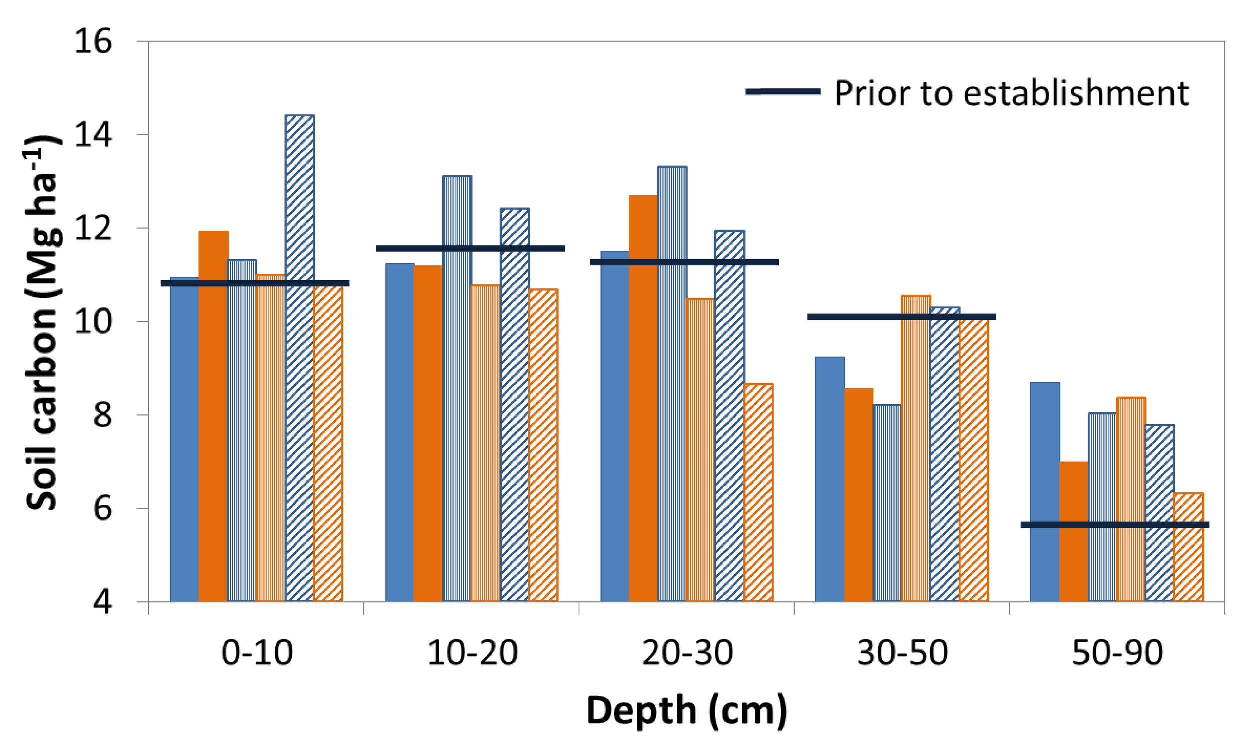


Procedure of root chemical component analysis. Color blue represented steps of the procedure, and color orange represented the products from the corresponding step.

Results - Biomass Production

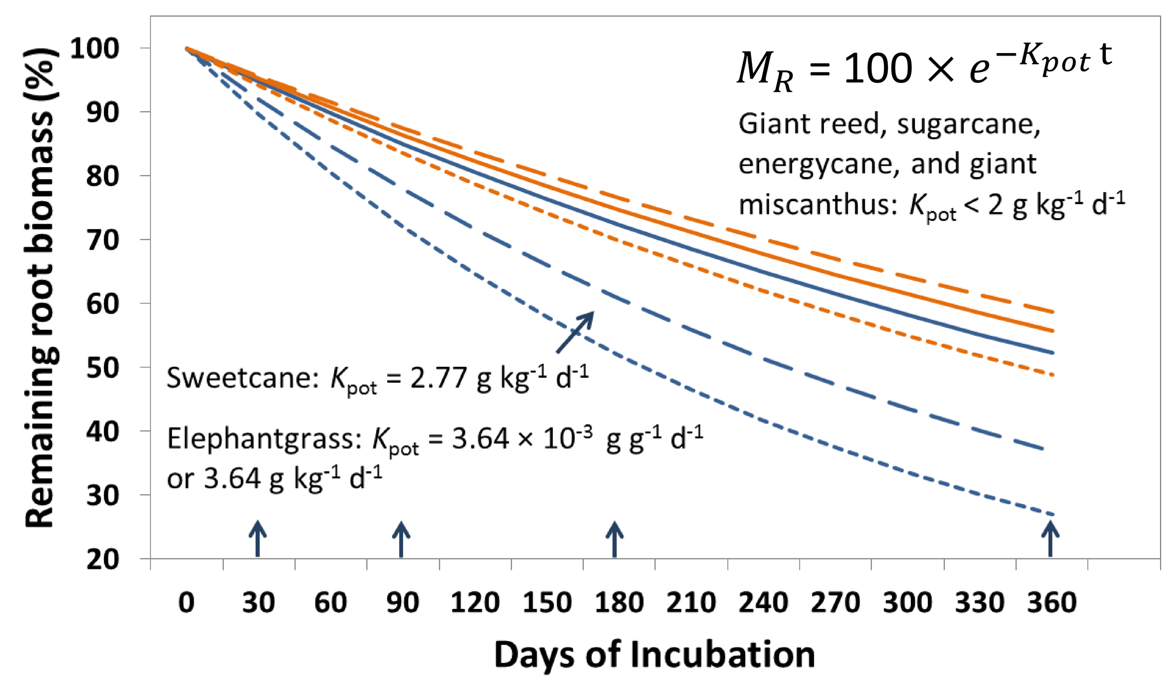


Standing root biomass was harvested after the seasons of 2010 and 2012. Root biomass was collected between planting rows and rhizomes were not included.

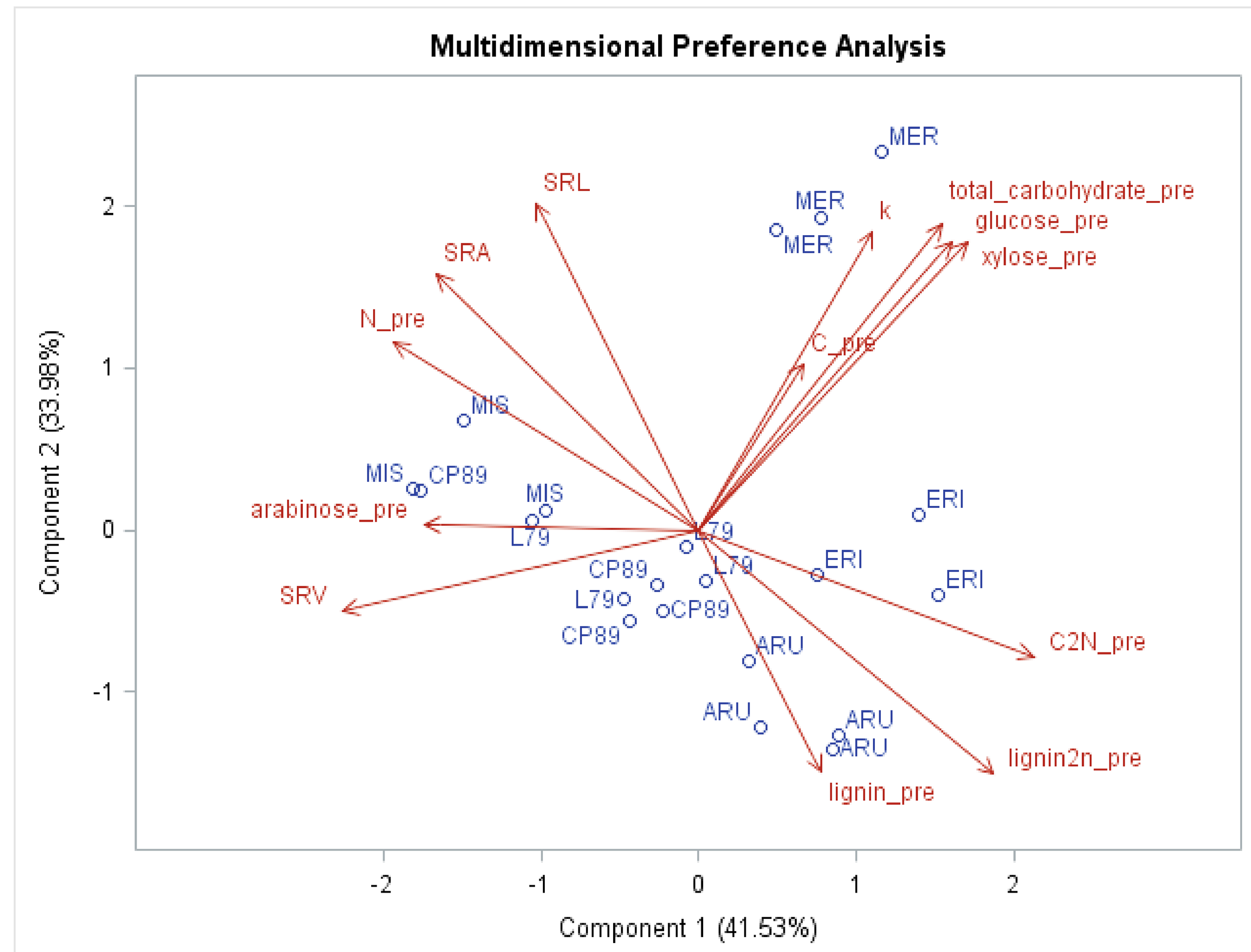


Soil carbon by depth in 2012 compared to 2008 (dark blue line) after four seasons of perennial grass growth. Soil carbon was measured by dry combustion.

Results - Root Decomposition



Remaining root biomass (M_R) decreased over incubation time (t). The arrows represented the time incubation bags were collected in the field.



The first two axes of the PCA performed with 12 root traits and K_{pot} accounted for 75.7% of the variance. The first PCA axis (Component 1) was defined by root chemical and morphological traits. The second PCA axis (Component 2) was defined by K_{pot}.

Conclusions

- Giant reed, sweetcane, and giant miscanthus produced more root biomass than the other three species.
- Soil carbon increased after four growing seasons under perennial grasses, especially at 50-90 cm.
- Elephantgrass exhibited the fastest decomposition rate, followed by sweetcane. The differences in decomposition rate were due to root chemistry and morphology.
- Overall, giant reed had relatively high root biomass production with low root decomposition rate, thus offering the potential for enhanced belowground carbon accumulation.

Acknowledgement

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