Soil $^{13}CO_2$ Signatures to Investigate Root Dynamics in a Loblolly Pine and Switchgrass Intercropped Bioenergy System

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Introduction

- Loblolly pine (*Pinus taeda* L.) and switchgrass (*Panicum virgatum* L.) intercropped systems may be a useful management strategy for growing biofuels, livestock forage, erosion control, and wildlife habitat (Fig. 1)
- For these intercropping systems to maximize productivity, the loblolly pine and switchgrass must largely utilize separate resources
- Many tree species change their vertical root distribution to avoid competition, studies have shown that some crop species may induce downward displacement of tree roots
- The longer temporal activity of tree roots also helps capture nutrients before the switchgrass becomes active in the spring and after it is harvested in the fall

Specific Objective

- To determine the spatial and temporal pattern of the $\delta^{13}CO_2$ signature in the soil profile in the intercropped treatment as species composition changes from predominately pine to predominately switchgrass

Site Description

- Lower Coastal Plain of North Carolina, U.S.A. (35° N, 77° W) (Fig. 2)
- Soils are classified as Pantego (fine, loamy, siliceous, semiactive, thermic Umbric Paleaquults) and/or Rains (fine, loamy, siliceous, semiactive, thermic Typic Paleaquults)
- Mean monthly temperatures range from 9.6 – 21.9°C
- Mean annual precipitation is 130 cm

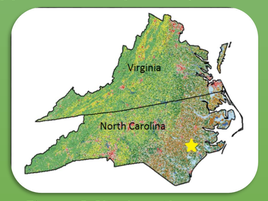


Figure 2 Site Location

Figure 1 Pine and switchgrass intercropped plot

Methods

- CO_2 sampling wells made from 2.54 cm PVC are installed in grids, from the center of the pine bed to mid-row in 76 cm (2.5 foot) increments, for four depths (15, 30, 45, and 60 cm), in four replications (Fig. 3)
- A 20 mL sample is collected from each gas well bimonthly to analyze for $\delta^{13}C$ and CO_2 concentration
- A vented static chamber is installed at the soil surface for each row position to sample surface gas fluxes (Fig. 4)
- Soil moisture and temperature are measured at each sampling well position

$\delta^{13}CO_2$ Signatures

- Due to different carbon fixation pathways of loblolly pine, a C3 species, and of switchgrass, a C4 species, we are measuring the $\delta^{13}CO_2$ soil atmosphere signature as a surrogate for the presence of loblolly pine and switchgrass derived carbon.
- C3 carbon fixation pathway: $\delta^{13}C$ = -21 to -30‰
- C4 carbon fixation pathway: $\delta^{13}C$ = -10 to -15‰

Design

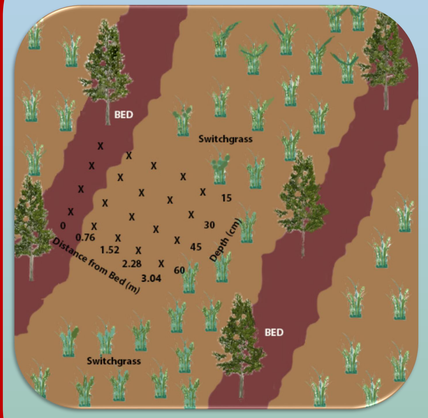
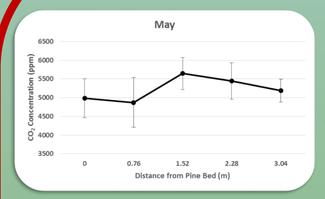
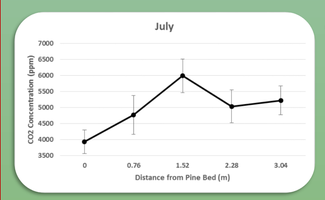


Figure 3 Experiment design showing grid layout of sampling wells in one plot of loblolly pine intercropped with switchgrass

Figure 4 One month after sampling well grids installed in pine and switchgrass intercropped plots

Preliminary Results





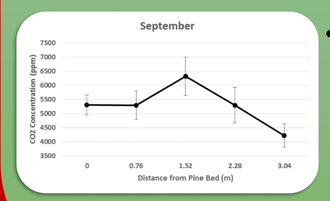


Figure 5 CO_2 concentrations by depth for three months

- Using our preliminary data from three months, CO_2 concentrations did not vary by depth
- In July and September, CO_2 concentrations were highest at five feet from the pine beds which is the interface between switchgrass and pine. This may be due to intense interspecific root competition.
- Future analysis will examine $^{13}CO_2$ discrimination patterns across depths and distances. Which will provide more specific information on soil carbon dynamics as influenced by species spatial root patterns

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