Soil CO_2, CH_4 and N_2O Fluxes in a Switchgrass (*Panicum virgatum* L.) and Loblolly Pine (*Pinus taeda* L.) Intercropping System

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Introduction

The US Department of Energy has chosen switchgrass as the model herbaceous energy crop to be used for biofuel production. Switchgrass is a fast growing herbaceous crop having low nutrient requirements and high water use efficiency. Utilizing the available space under traditionally managed pine plantation for switchgrass can provide several benefits to this managed forest system including increased belowground carbon (C) storage, increased nutrients retention and suppressing the growth of competing woody species which includes volunteer loblolly pine trees.

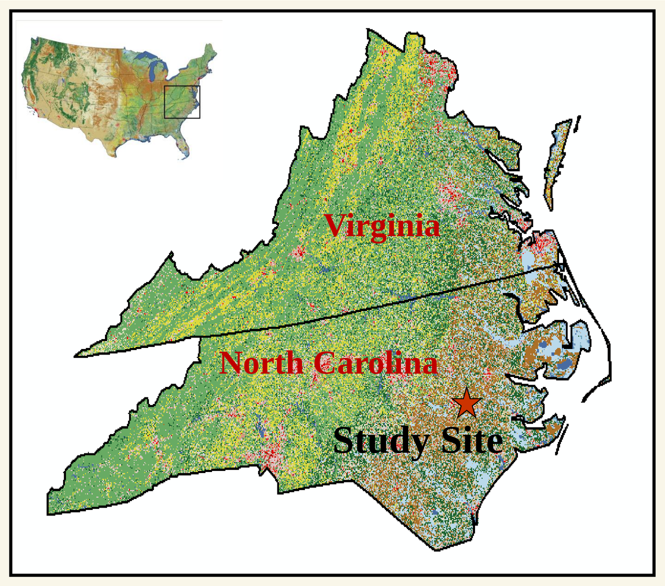
A novel bioenergy system of traditional loblolly pine for solid wood products and switchgrass for biofuel production is being studied intensively by an interdisciplinary team of researchers in the southeastern U.S. We are investigating how this intercropping system influences soil greenhouse gas (GHG) fluxes of carbon dioxide (CO_2), nitrous oxide (N_2O) and methane (CH_4). Changes in C pools and fluxes will have profound influences on the nutrient cycling in this system and in the long term will influence the net ecosystem productivity and sustainability of this intercropping system.

Our specific objectives are to:

1) Quantify soil GHG fluxes in this novel bioenergy system, and

2) Characterize the distribution of loblolly pine and switchgrass roots

Experimental Design and Method



- 28 ha field experimental site in Lower Coastal Plain of North Carolina.
- Established in 2009 and maintained by Catchlight Energy LLC, a joint venture between Chevron Corporation and Weyerhaeuser Company.
- A randomized complete block design with 4 replications.
- 0.8 ha size treatment plot with 0.4 ha measurement plots.
- Fertilization applied on switchgrass and intercropped plots in June 2010 and April 2012 at 56 kg ha^{-1} rate using Arborite.
- 3 subsamples collected from each of the treatments.

We are measuring soil CO_2 efflux using a modified Li-COR 6200 and 10 cm diameter soil chamber. N_2O and CH_4 are being measured using 25 cm diameter vented static chambers. Roots are sampled at 0–15 cm and 15–35 cm soil depths with a 10 cm diameter core .

Measurements were made in the following six treatments:

- Pure Pine on the bed (**P-B**)
- Pure Pine in the interbed (**P-I**)
- Pure Switchgrass (**SG**)
- and 3 microsites on Pine-Switchgrass intercrop (PSG):
  - Pine on Bed (**PSG-B**)
  - PSG Edge (**PSG-E**)
  - PSG Interbed (**PSG-I**)

Figure 1. PSG treatment before (left) and after mowing of switchgrass (right).

Results

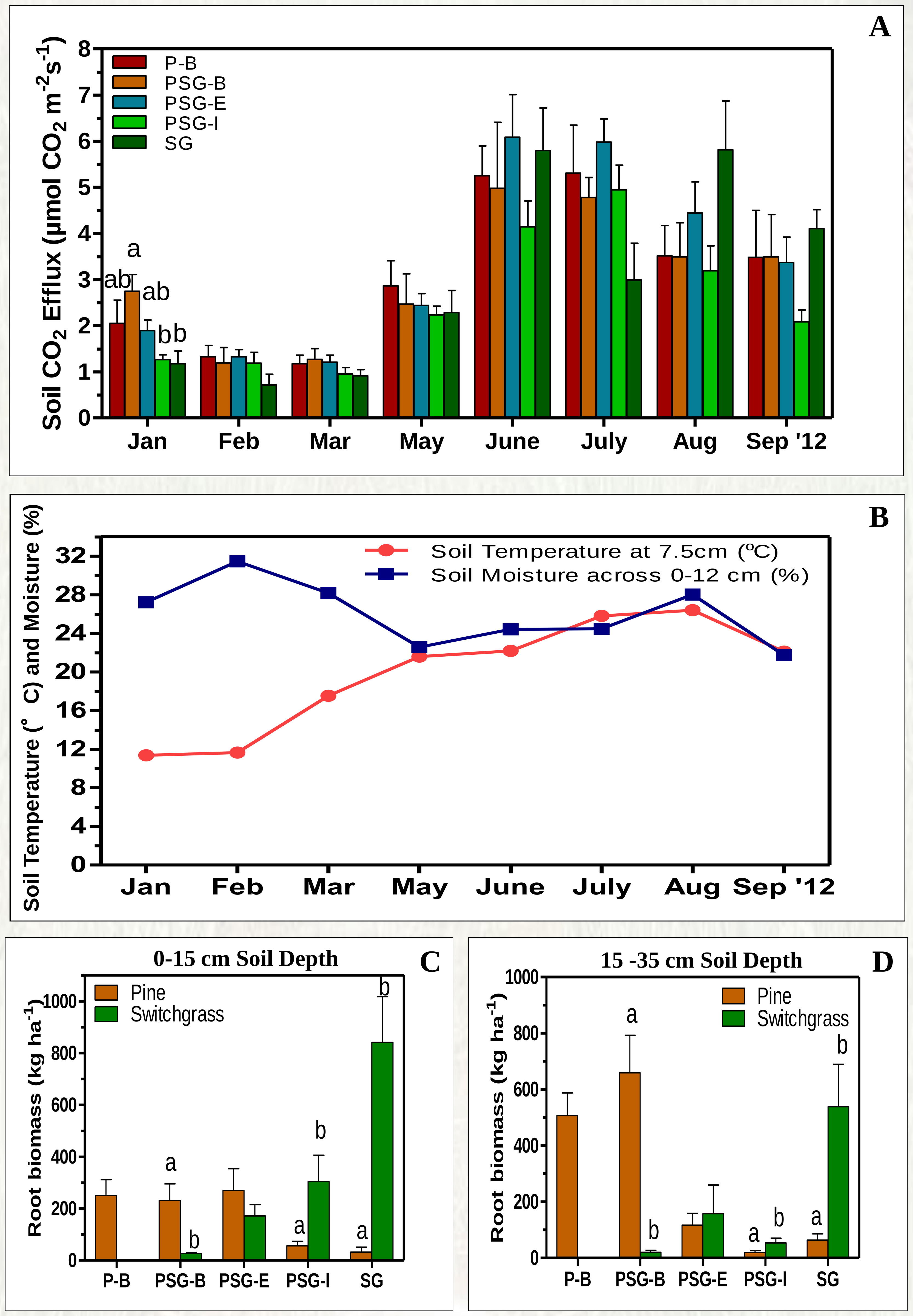


Figure 3. Mean soil CO_2 efflux (A); Mean soil temperature and volumetric soil moisture (B); Loblolly pine and switchgrass root biomass sampled in July at 0-15 (C) and 15-35 cm (D) soil depths. Error bars indicate one standard error of the mean. Means followed by different letters within a treatment differ significantly (α = 0.05).

Figure 2. Measuring soil CO_2 efflux (left); Loblolly pine roots and switchgrass roots, respectively (middle); Vented static chamber in the interbed of PSG plot for GHG sampling (right).

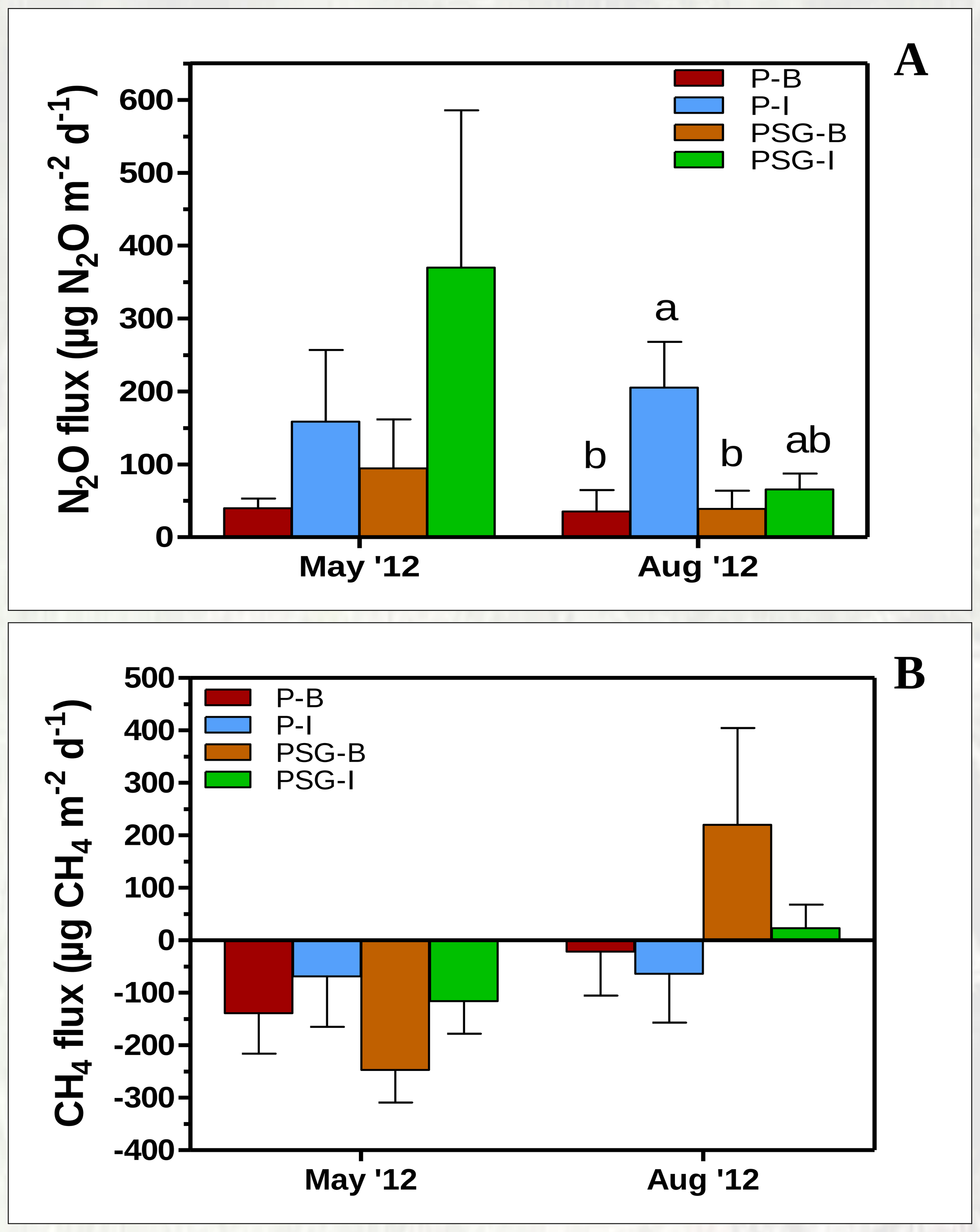


Figure 4. Mean N_2O (A) and CH_4 (B) fluxes. Error bars indicate one standard error of the mean. Means followed by different letters within a month differ significantly (α = 0.05).

Discussions and Future Work

- Soil CO_2 efflux does not appear to differ consistently with treatment, but varies seasonally (Fig 3 A).
- During the growing season however, soil CO_2 efflux appears lower in intercropped (PSG) than pure (SG) switchgrass (Fig 3 A).
- Switchgrass root biomass in 0-15 and 15-35 cm soil depth is significantly higher (P<0.01, P<0.001) in SG than PSG-I suggesting that competitive interactions with loblolly pine could affect belowground productivity of the switchgrass (Fig 3 C and 3 D).
- There also appears to be an increase of loblolly pine roots at 15-35 cm in bed of the intercropped treatment (PSG-B) relative to bed of the pure pine (P-B), suggesting increased root competition that forces pine roots deeper in the profile (Fig 3 D).
- Soil CH_4 fluxes do not differ significantly by treatment; however, the source-sink dynamics appear to be influenced by soil moisture which may vary differentially by treatment throughout the year (Fig 4 B).
- Soil N_2O fluxes appear highest in the interbed of the pine only treatment (P-I), potentially indicating higher rates of nitrification (Fig 4 A).
- Increased N_2O fluxes in the intercropped treatments (PSG-I and PSG-B) in May are most likely due to an April N fertilization that only occurred in the intercropping system (PSG) (Fig 4 A).

Future work involves:

- Using $^{13}CO_2$ to identify switch grass contributions to soil CO_2 efflux.
- Estimates of autotrophic and heterotrophic components of soil CO_2 efflux.

Acknowledgements

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