The Responses of Soil Respiration to Climate across Biofuel Crops and Land Use Histories

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Introduction

Net ecosystem production (NEP) of a terrestrial ecosystem is largely determined by its carbon loss (i.e., respiration) instead of gain through photosynthesis. However, recent advancements in ecosystem carbon studies revealed that belowground carbon loss through soil respiration is cohesively linked to the aboveground carbon gain because of stimulated autotrophic soil respiration (SR_a). This study was designed to partition the portion of heterotrophic respirations (SR_h) and total respiration (SR_t) at three bioenergy systems (corn, switchgrass, and CRP prairies) by two land use histories (LUH: Conservation Reserve Program (CRP) and corn-soybean rotation agriculture land (AG)) and a non-disturbed reference prairies.

The difference between soil respiration rate at root elimination treatment (SRR_h) and non-root elimination treatment (SRR_t) is significantly higher in AG and reference sites than that in CRP sites in 2011.

In 2012, both SRR_h and SRR_t, as expected, are lower than that in 2011. In addition, the differences between SRR_h and SRR_t are disappear.

The study will be continued in 2013/2013 when we hypothesize altered seasonal dynamics.

Objectives

1. Partition the annual soil CO2 efflux (SRR) at the biofuel lands into flux from heterotrophic SRR (SRR_h) and total SRR (SRR_t);
2. Evaluate how climate impact the pattern of SRR_h and SRR_t.;
3. Explore the relationship between SRR (SRR_h and SRR_t) and temperature (T) and soil water content (VWC).

Scale-up sites

The sites used in this study were comprised of seven randomly selected geo-referenced sampling locations. Sites CRP-corn, CRP-switchgrass, and CRP-prairie were converted from the CRP to bioenergy crop production; sites AG-corn, AG-switchgrass and AG-prairie were converted from standard agriculture production to bioenergy crop production; site Reference does not disturb and was left as reference grassland.

Methods

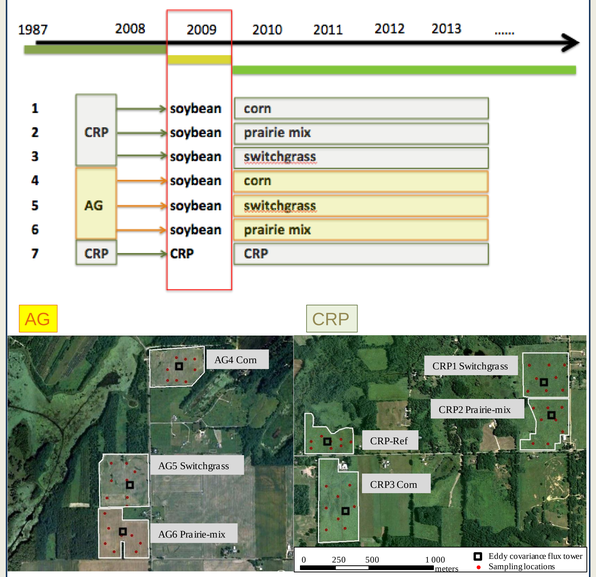

Fig 1. Study site location in southwestern Barry County, MI, USA and experimental layout of scale-up field sites with location of sampling plots and EC flux towers.

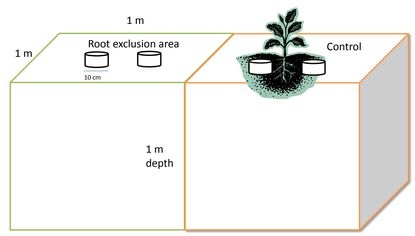

Fig 2. The sketch of the experimental design.

We randomly chose 4 of the 10 plots in each site to dig around and put in the net which can transfer water and nutrient but prevent the roots grow-in. The plant in the root exclusion plots were killed by herbicide. SRR was measured biweekly during growing season and monthly in non-growing period by placing standard collars of LI-8100. The total soil respiration includes autotrophic soil respiration and heterotrophic respiration.

$$SR_{total} = SR_{auto} + SR_{hetero}$$

Methods (conti.)

The climate variables (soil temperature and soil volumetic water content) were measured simultaneously. All the value (total soil respiration, soil microbial respiration, root respiration, soil temperature, and soil moisture) from the 4 plot at each site averaged by site to obtain the mean. The mean value represents the value of the whole site.

Results

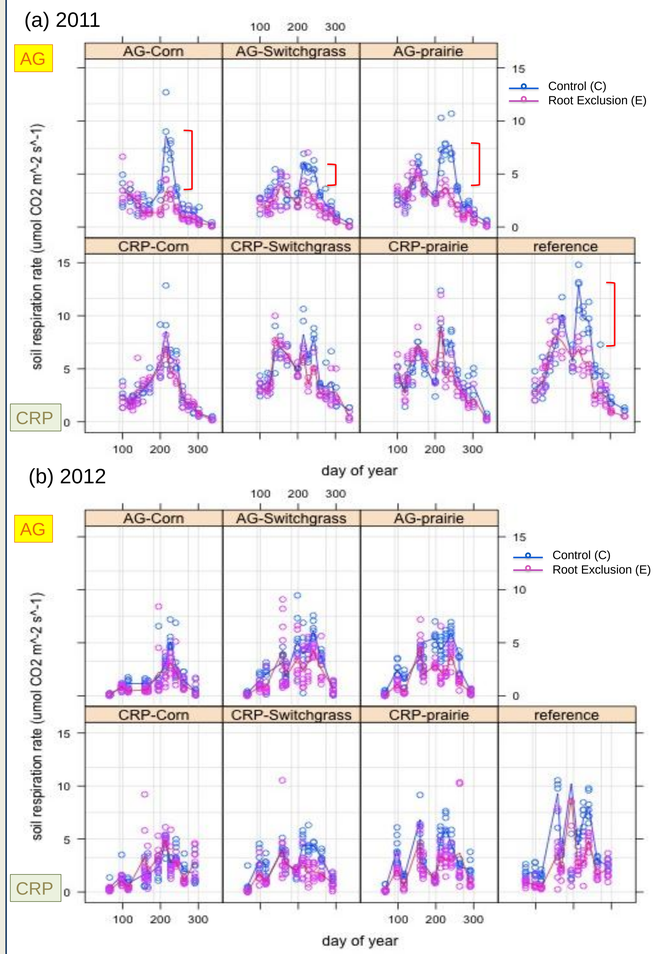

Fig 3. Total Soil respiration rate (SRR_t) and heterotrophic soil respiration rate (SRR_h) from no eliminated control (C) and the eliminated vegetation (E) in 2011 (a) and 2012 (b). Land use history (LUH) at upper layers are corn-soybean rotation agricultural land (AG) and lower layers are conservation reserve program (CRP).

Results (cont.)

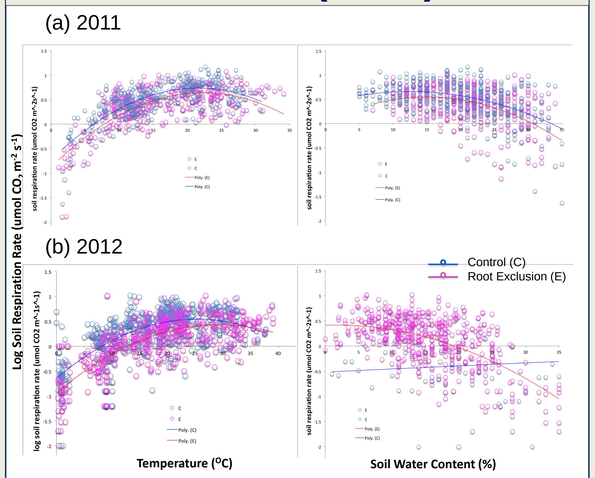

Fig 5. Relationships between log soil respiration and soil temperature (left), and soil water content (right) in the eliminated vegetation (E) and no eliminated control (C) in year 2011 (a) and 2012 (b).

Discussion

1. The total soil respiration rate (SRR_t) have a peak in late July to early August in all sites in 2011. The heterotrophic soil respiration rate (SRR_h) in AG and reference sites significantly lower than that in CRP sites. This imply that land use history (LUH) may affect SRR_h more than SRR_t.
2. In 2012, the weather is hot and soil water content is low. The patterns of soil respiration is different from that in 2011.
3. The relationship between both log SRR_t and log SRR_h and soil temperature are logarithmic when soil temperature is not over 30°C in both years. The relationship in 2012 are higher variety.
4. The relationship between log SRR_t and log SRR_h and soil water content are polynorminal in 2011. SRR drop when VWC are higher than 20-25. Most VWC in 2012 concentrated below 20 and have high log soil respiration.

Acknowledgements

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