Effect of Plant Shading on Greenhouse Gas Emissions

R.S. Tubbs[1] and J.S. Schepers[2]

[1]University of Georgia, Dept. of Crop and Soil Sciences; and [2]USDA-ARS AMRU, Lincoln, NE; E-mail: tubbs@uga.edu

Reason

Vented chambers are the most common method of evaluating greenhouse gas (GHG) flux because they are economical and practical to deploy. However, sample collection techniques can vary depending on the purpose of the research. If plants are included in the chamber, then the material from which hat the chamber is made from may affect fluxes based on the amount of light allowed into the chamber during deployment.

Objective

This experiment was designed to determine whether there is a difference in whole system GHG emissions depending on inclusion or exclusion of sunlight.

Introduction

Collection of gas samples is not a universally standardized process. The most popular sampling technique is a vented closed chamber. Despite the potential bias of under- or overestimation of flux over time by consistently hitting or missing peaks, this method will still do a fairly accurate job of comparing specific treatments when blocked in the field.

For evaluations requiring inclusion of the plant inside the chamber, some problems arise. The physiological processes of plants greatly affect gas exchange. For instance, amounts of sunlight influence photosynthesis and respiration by the plant. Thus, the materials used to build a vented chamber can have a large impact on the level of sunlight intensity inside the chamber. This may cause huge variance in the total headspace gases since presence of sunlight encourages photosynthesis, while exclusion of sunlight will cause respiration to occur.

Most chambers are made of opaque materials such as PVC or aluminum. Since plants are completely shaded during chamber deployment, there is not an accurate depiction of total ecosystem gas flux during daylight hours. Thus, transparent chambers were built to compare the shading effect of aluminum on GHG flux.

Materials and Methods

Dates: April to August 2006.
Location: Shelton, NE.
Crop: Seed Corn (*Zea mays*) – hailed out on June 16; replanted to Sorghum (*Sorghum bicolor*) on June 24.
Experimental Design: Randomized Complete Block.
Treatment Effect: chamber material
1. Aluminum chamber (bare soil, no plants)
2. Clear acrylic chamber (plants included)
3. Aluminum chamber (plants included)

Replications: 4
Sampling Method: vented chamber:
- Steel anchors (76.2 cm x 76.2 cm) were buried to a depth of 8 cm.
- Aluminum or clear acrylic lids (88.5 L) were placed over the anchors and sealed with water. - Aluminum or clear acrylic spacers (increments of 15 cm) were added over course of season to match plant height.

Sample Dates: May 26 and 31; June 7, 14, and 21; July 14; Aug 11.
Time Interval: gas samples were taken at 0, 15, 30, and 60 mins to determine flux.

Results

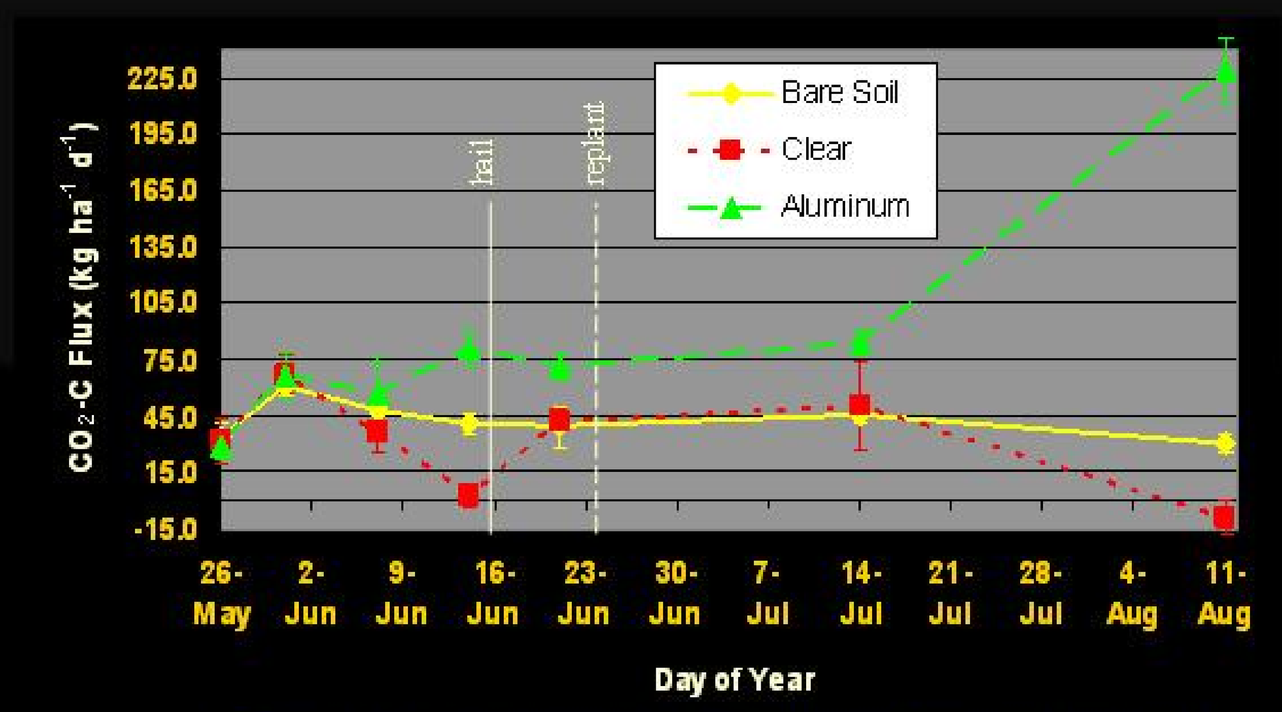

Fig. 1. Effect of plant shading - Carbon Dioxide emissions from seed corn/grain sorghum 2006, Shelton, NE.

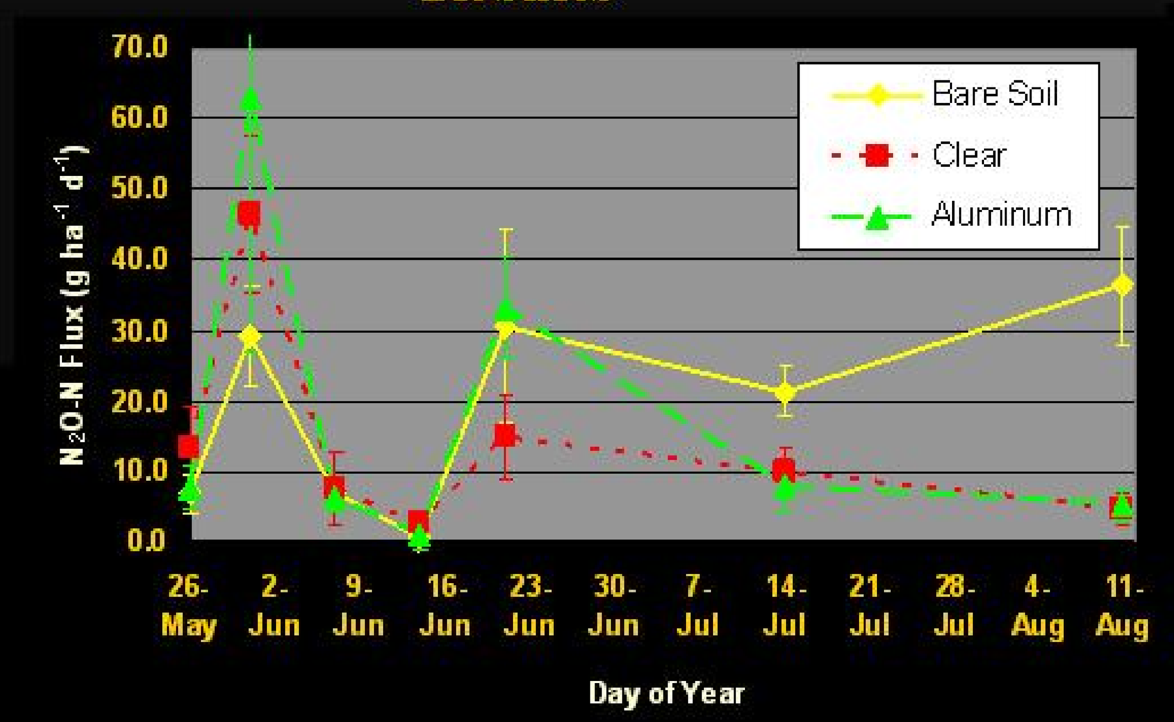

Fig. 2. Effect of plant shading - Nitrous oxide emissions from seed corn/grain sorghum 2006, Shelton, NE.

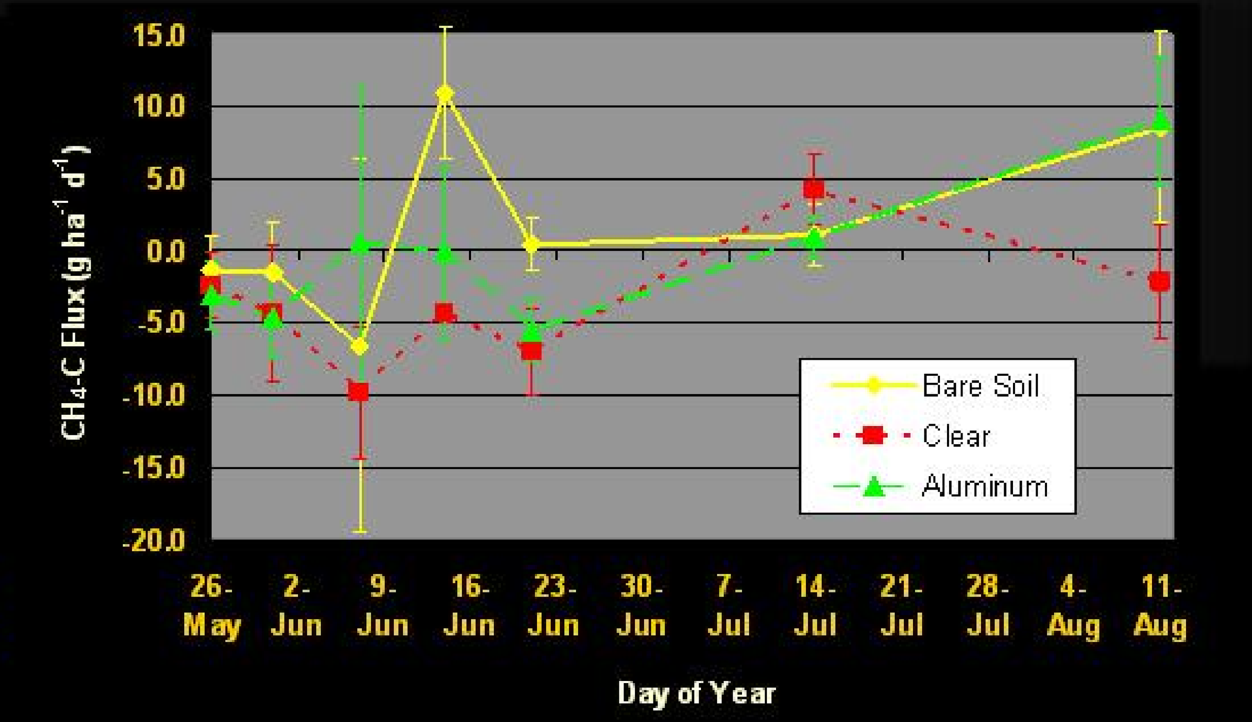

Fig. 3. Effect of plant shading - Methane emissions from seed corn/grain sorghum 2006, Shelton, NE.

Discussion and Conclusions

The most dramatic differences were in CO_2 levels (Fig. 1). The dark atmosphere inside the aluminum chamber causes the plant to respire, making CO_2 concentration increase at a much higher rate than when light can infiltrate the clear chamber. The effect was much more pronounced as the plants grew larger. There was actually a decrease in CO_2 flux in the clear chambers as the plants grew, since photosynthesis could still occur while the chamber was deployed. This trend started to occur early in the season on seed corn (up to June 14) prior to hail damage (June 16) and replanting (June 24). It was again seen on sorghum later in the season (Aug. 11). There were no notable differences in N_2O flux between the aluminum and clear chambers (Fig. 2). As the season progressed, differences were observed from the bare soil plots, since there were no plants to take up residual N in the soil. Methane emissions were inconsistent over treatments and time (Fig. 3). More data will need to be analyzed to evaluate potential trends.

If total GHG emissions from an agroecosystem are a goal, then emissions from both the soil and plant should be considered. This data indicates that CO_2 is being taken up by the plant when light is present (as photosynthesis continues) and CO_2 is being given off by the plant under dark conditions (as the plant switches from photosynthesis to respiration). Therefore, if opaque chambers are used for measuring GHG flux, an overestimation of CO_2 flux can occur when sampling during daylight (if plants are included).