



Fertilization decreases soil CO₂ efflux of mid-rotation loblolly pine (*Pinus taeda* L.) stands in southeastern Oklahoma



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Introduction

Managing pine forests across the southeastern US will likely become more challenging as temperature increases and precipitation becomes more variable. Understanding the interaction of fertilizer and soil water availability will improve management in response to climate changes and modify management to increase carbon sequestration. As part of PINEMAP, a Tier III installation was established in Broken Bow, OK (McCurtain County) to determine the effects of fertilization and ~30 % reduction in throughfall on stand growth and physiology.

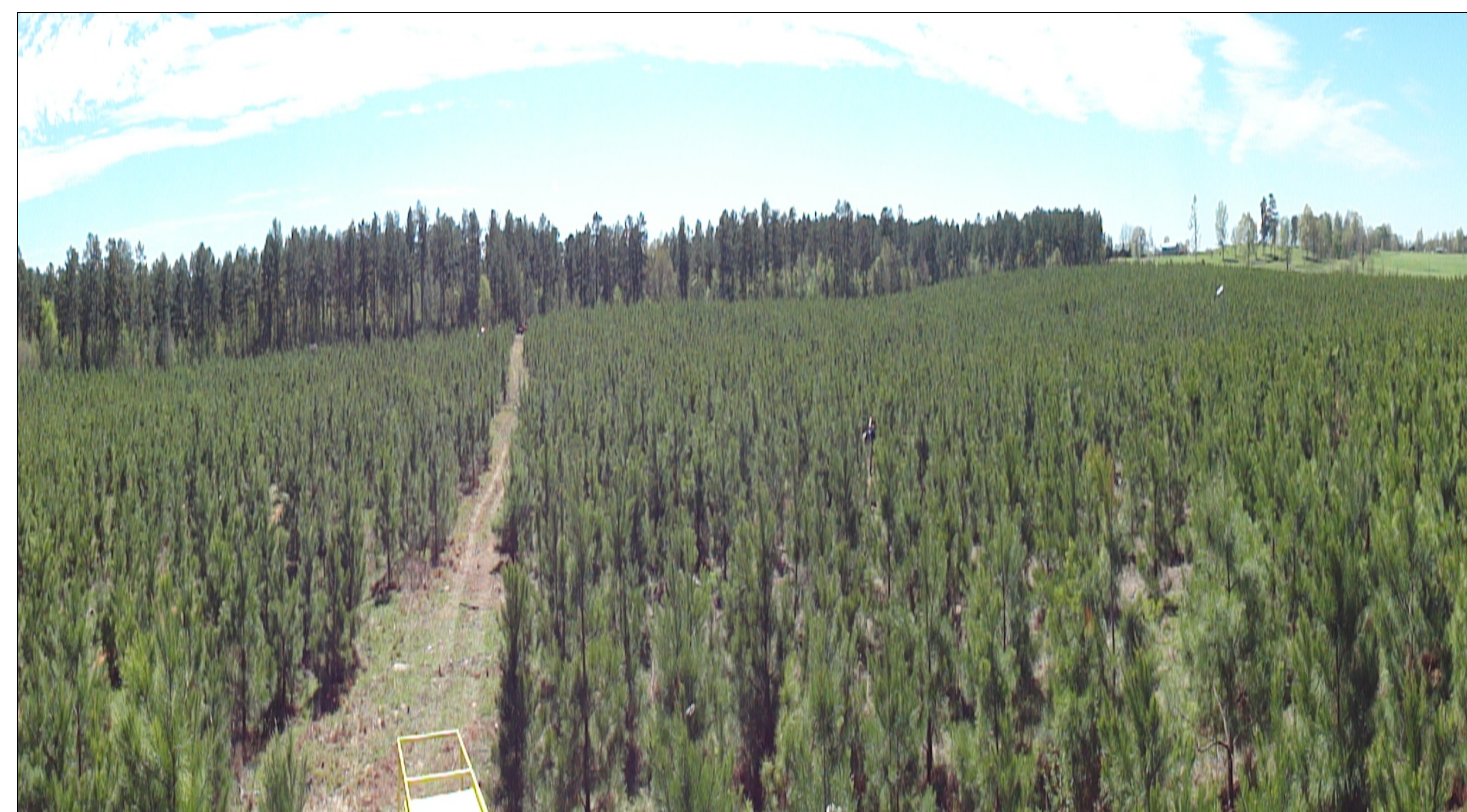


Figure 1. Tier III site in McCurtain county near Broken Bow, Oklahoma.

Methods

- Soil CO₂ efflux in mid rotation loblolly pine stands was compared using a factorial design consisting of throughfall reduction excluders (Figure 2) and fertilizer treatment.
- Treatments consists of :
 - Throughfall reduction (~30%) with fertilizer
 - Throughfall reduction (~30%) without fertilizer
 - No throughfall reduction with fertilizer
 - No throughfall reduction without fertilizer
- Soil CO₂ efflux was measured with an infra-red gas analysis system (Li-Cor 6200, Li-Cor Environmental, Lincoln, NE) and attached cuvette (20 cm diameter). Measurements were conducted approximately every 4-8 weeks between May 2012 and October 2014 concurrent with measurements of soil temperature at 10 cm depth and volumetric soil moisture between 0 and 12 cm (Figure 3).



Figure 2. Rainfall reduction excluders on the Tier III site in Oklahoma.

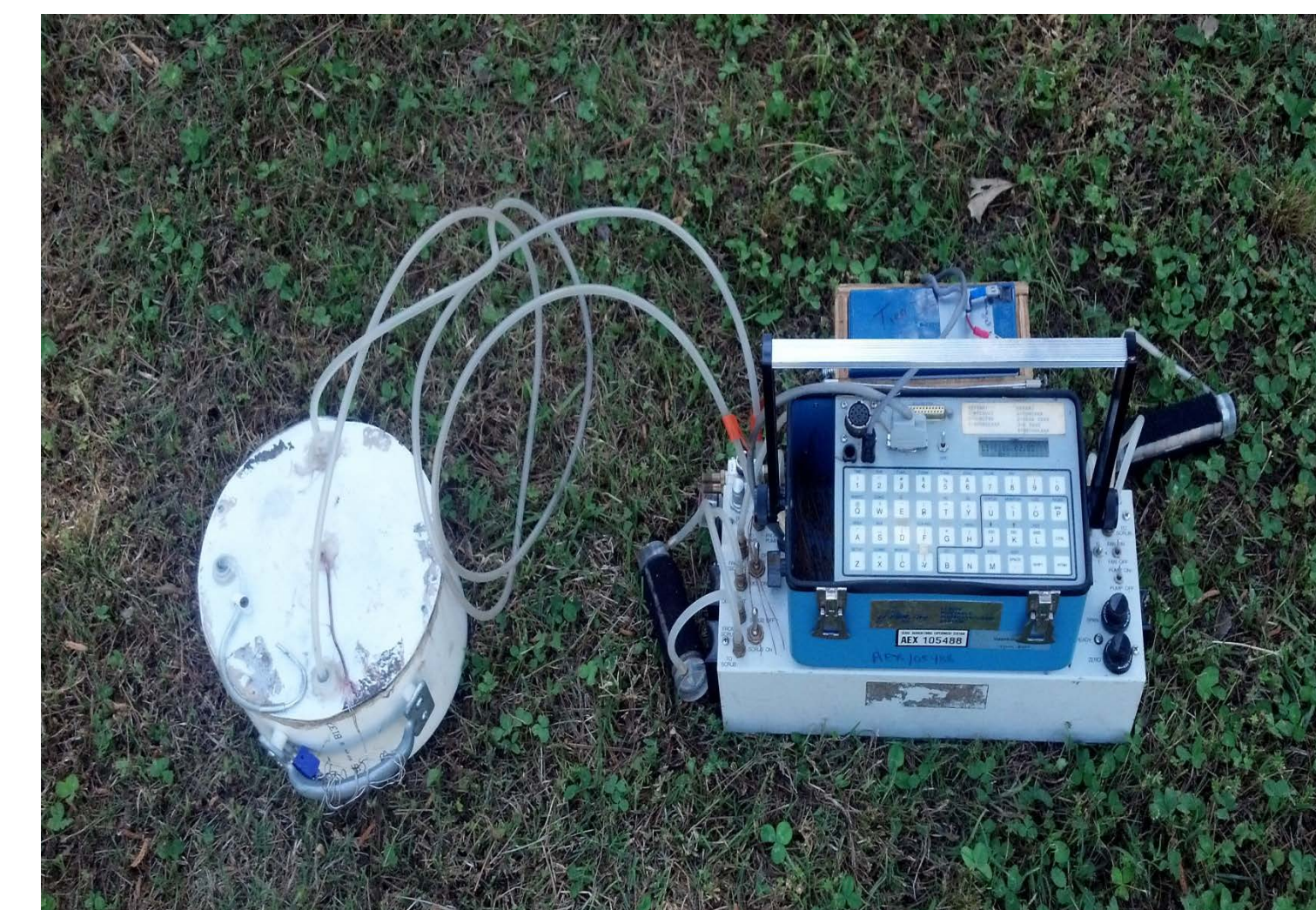


Figure 3. Soil CO₂ efflux was measured with the Li-Cor 6200.

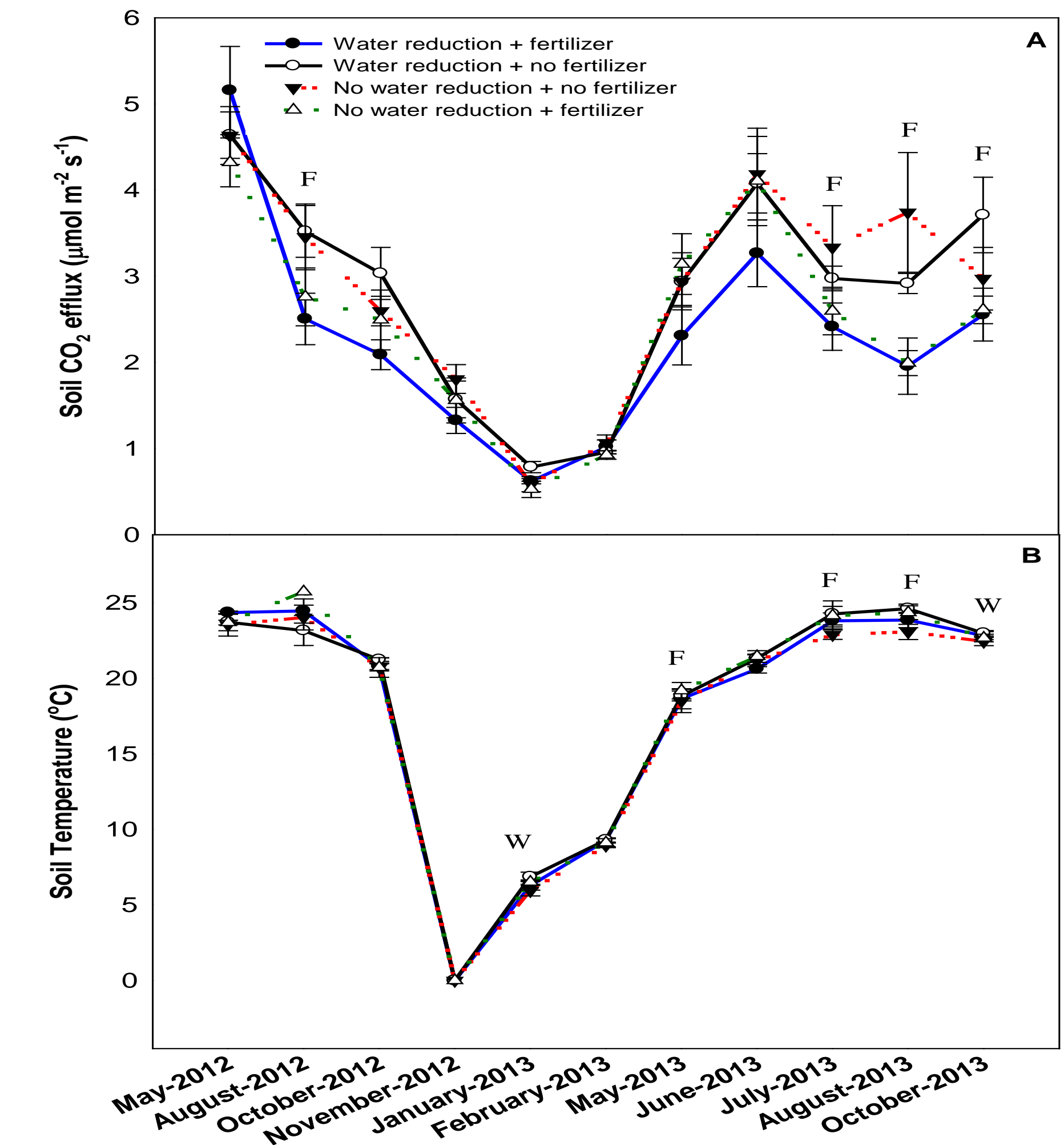


Figure 4. Soil CO₂ efflux ($\mu\text{mol m}^{-2} \text{s}^{-1}$) (A) and soil temperature ($^{\circ}\text{C}$) (B) by treatment over time. W = water effect, $P < 0.05$; F = fertilizer effect, $P < 0.05$

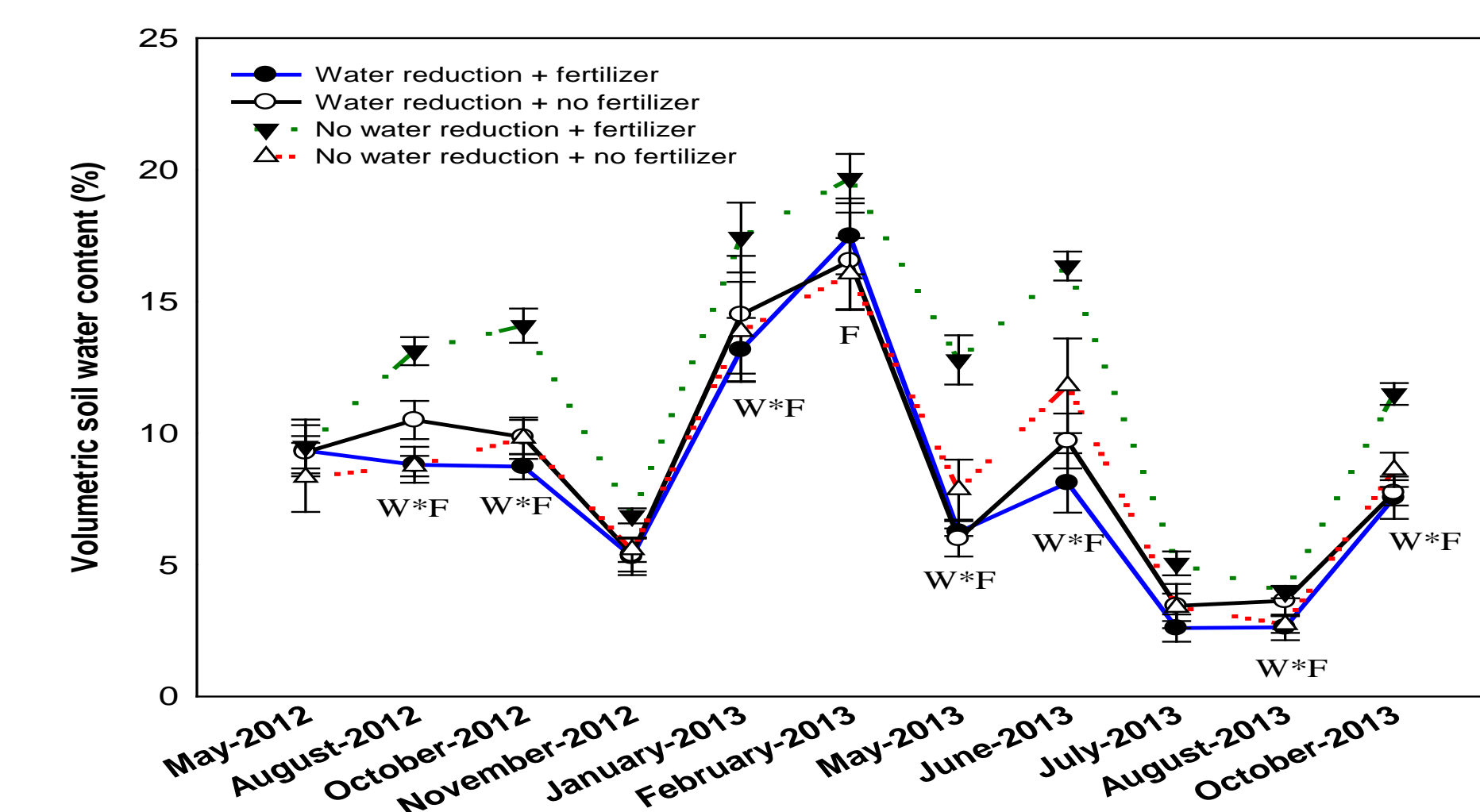


Figure 5. Volumetric soil water content (%) by treatment over time. W*F = water x fertilizer interaction, $P < 0.05$ effect, $P < 0.05$ and F = fertilizer effect, $P < 0.05$

Hypothesis

Fertilization and/or rainfall exclusion reduces soil CO₂ efflux.

Preliminary Results

- The mean soil CO₂ efflux of the fertilized treatment was $2.37 \mu\text{mol m}^{-2} \text{sec}^{-1}$ while the unfertilized treatment mean was $2.84 \mu\text{mol m}^{-2} \text{sec}^{-1}$ (Figure 4A).
- The difference between the fertilized and unfertilized stands has been increasing with time (time x fert interaction; $p = 0.008$) (Figure 4A).
- Seasonal changes in soil CO₂ efflux mirrored changes in soil temperature (Figure 4B).
- No strong relationship between CO₂ efflux and volumetric water content was observed.

Conclusion

- Fertilization suppressed soil CO₂ efflux during the two years after application.
- Fertilization may be increasing carbon content of the soil by reducing respiratory losses (depending on how fertilization also affects autotrophic respiration and allocation to belowground biomass).

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