

Potential Implications of Elevated CO₂ for Enhanced Rock Weathering in Croplands

Hannah Maher,¹ Megan Allen,² and Lisa Ainsworth³

Black Hawk College East Campus, Galva, Illinois¹, Department of Crop Sciences, University of Illinois at Urbana-Champaign² USDA ARS, Department of Plant Biology, University of Illinois at Urbana-Champaign³

Introduction

- Atmospheric carbon dioxide (CO₂) levels are increasing by 2.37 ppm year, and levels have increased from about 370 ppm in 2000 to about 420 ppm in 2023¹
- Increased CO₂ levels result in climate change, including increased temperatures and drought which impacts soybean crops
- Enhanced Rock Weathering (ERW) is the process of spreading basalt on fields to accelerate the natural reaction between rocks, CO₂, and water²
- Enhanced Rock Weathering is a possible way to combat increasing CO₂ levels because of its carbon sequestration properties²

Project Aim

Investigating the potential interaction between elevated CO₂ and enhanced weathering in an agronomic setting.

Hypothesized Outcome of Basalt: Increased available nutrients, potentially increasing plant growth

Hypothesized Outcomes of CO₂: Increased carbon sequestration

- Decreased stomatal conductance → increased soil moisture → faster weathering
- Improved crop performance, potentially increasing plant growth and biomass

Acknowledgments

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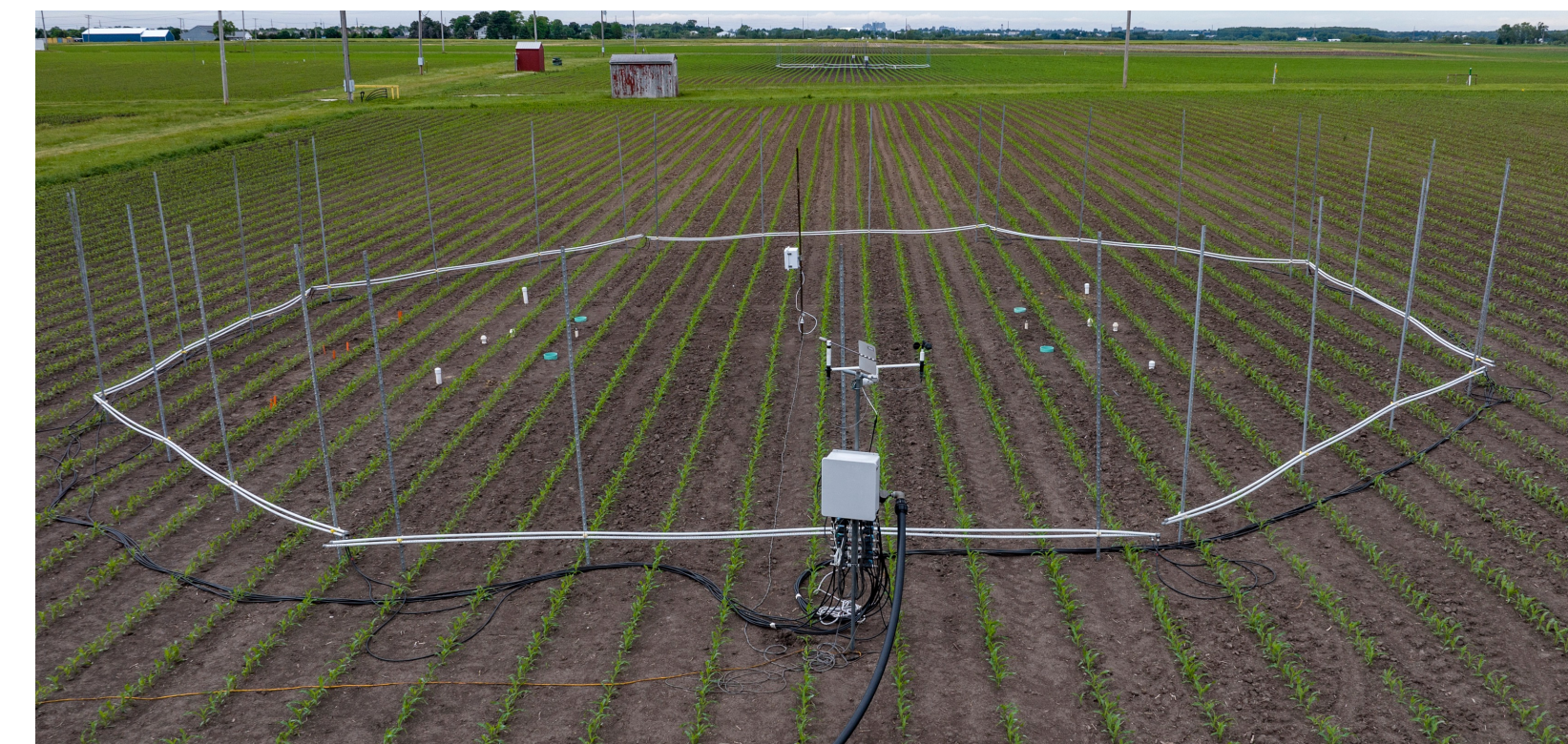
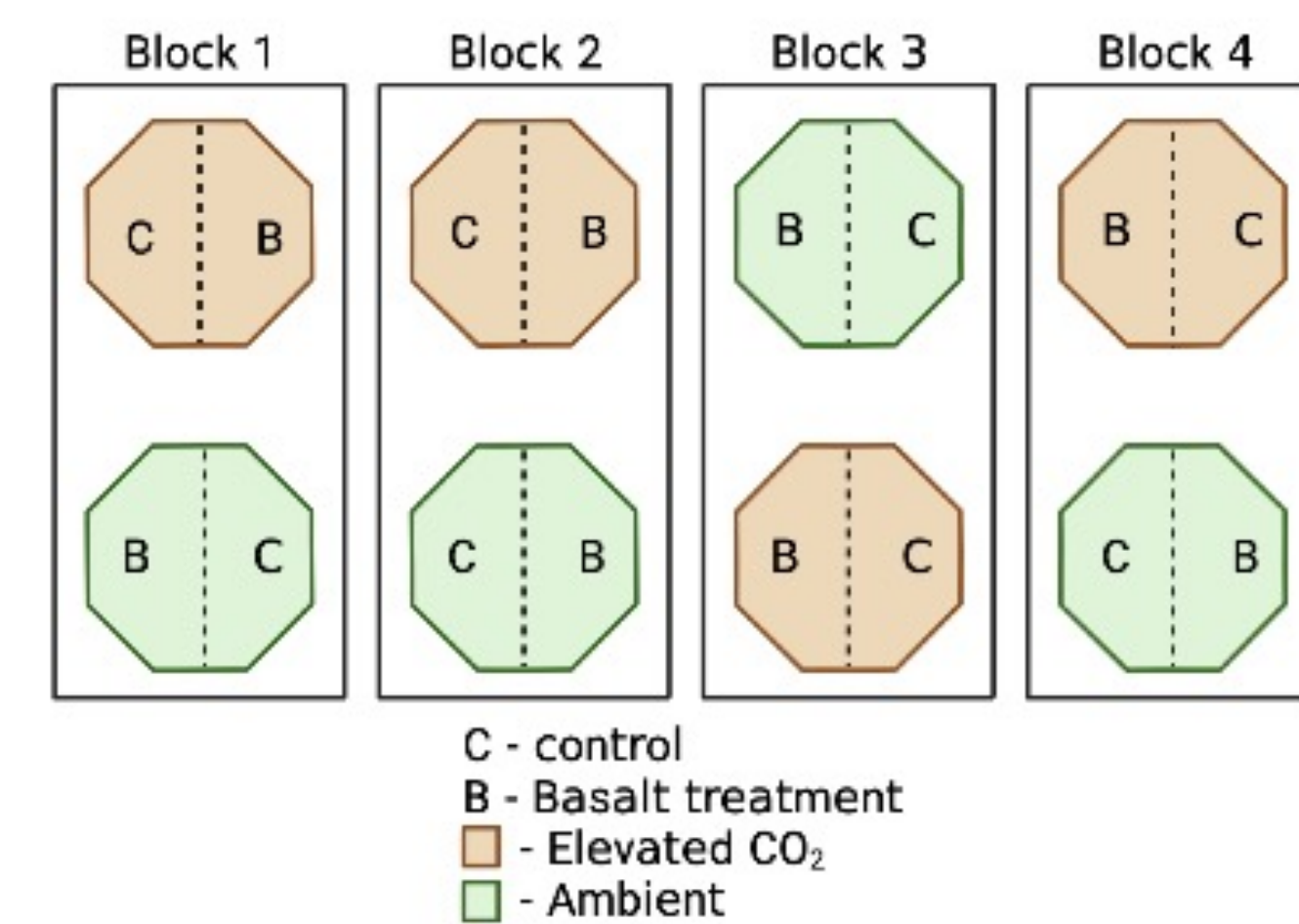
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Methods

SoyFACE Farm

- Soybean Free Air Concentration Enrichment
- 8 rings in a split-plot RCB (randomized complete block) arrangement that are blocked by field location
- 4 rings in elevated CO₂ (600 ppm); 4 rings ambient (400-450 ppm)
- Half of each ring received 50 tons per hectare (123.6 tons per acre) of basalt treatment the past two years in the fall

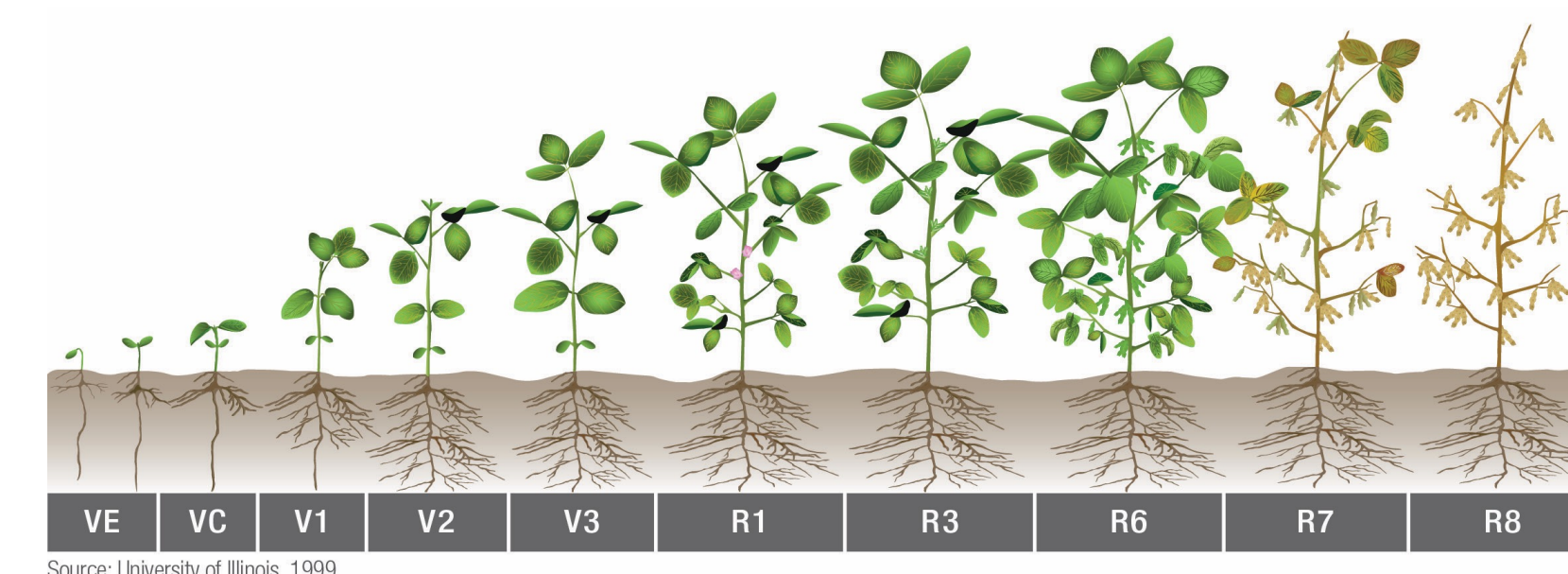


Soil Moisture

- 4 measurements were collected from both the basalt and control side, totaling 64 measurements
- The probe takes a measurement at every 10cm from a depth of 10-90cm into the ground
- Measured twice a week using the Diviner 2000 probe

Development

- Plants were scored twice a week in the vegetative stages and three times a week in the reproductive stages
- Stages are determined by number of mature trifoliates, flowering position, and pod maturity on the plant³



Stomatal Conductance

- Stomatal conductance measures the water vapor flux coming from the stomata on the bottom side of leaves
- The youngest fully expanded trifoliolate was measured
- LI-600 Porometer is used to measure conductance

Conclusions

- Stomatal conductance is significantly reduced when exposed to elevated CO₂ conditions
- This does not appear to translate to increased soil moisture
- Further research should be conducted to quantify the impact of elevated CO₂ on ERW

Future Work

- Basalt treatment will be replicated in future years to see effects of weathering over extended time period
- Yield data will allow understanding of basalt treatment and elevated CO₂ levels
- Comparing data to years with growing seasons without drought conditions

References

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- Beerling et al. (2018) 'Farming with crops and rocks to address global climate, food and soil security', *Nature Plants*, 4, p138-147.
- Soybean Growth and Development. July 1, 2021. <https://cloudprod.dekalbasgrowdeltapine.com/en-us/agronomy/soybean-growth-stages.html>

Results

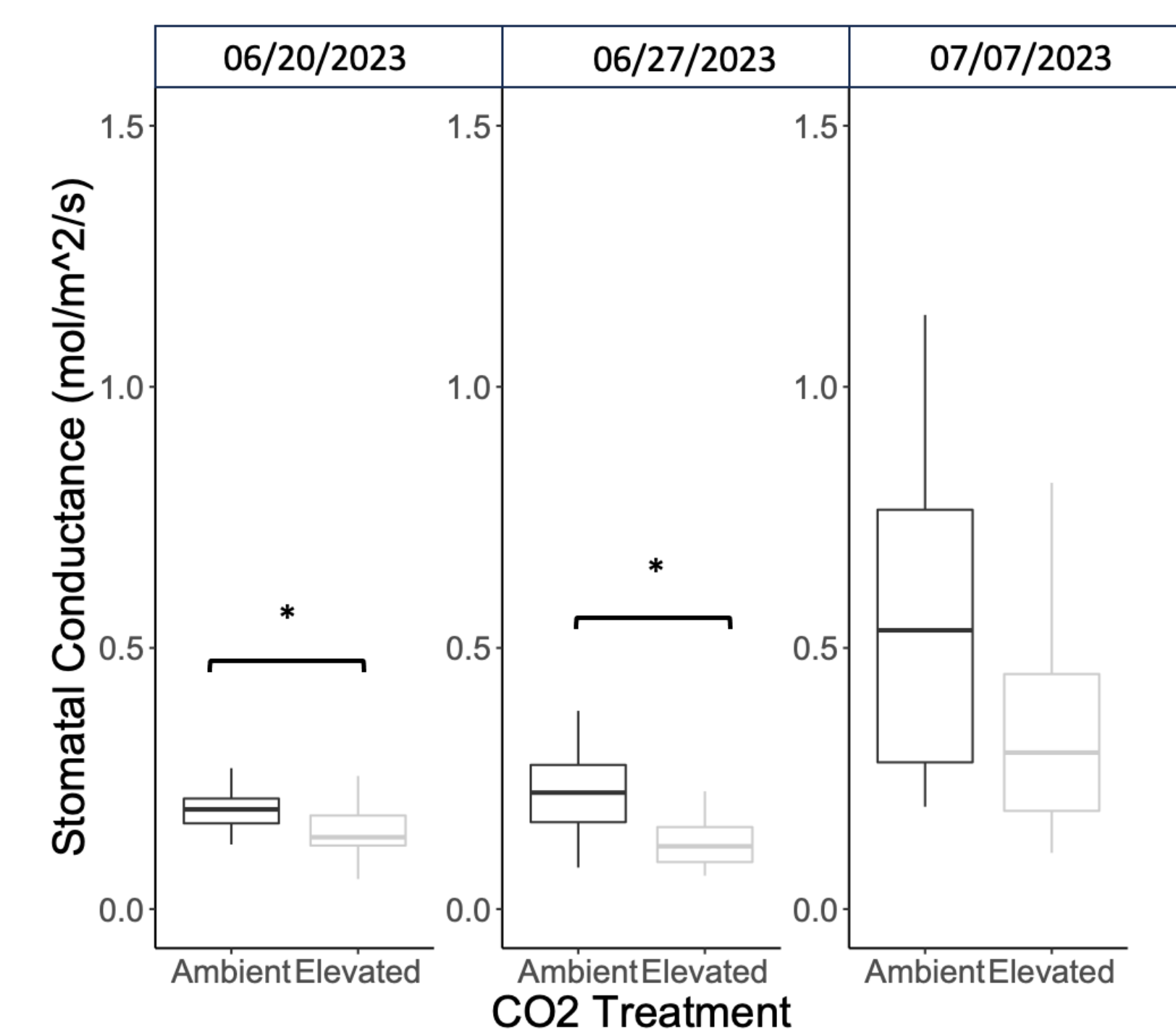


Figure 1. Mid day conductance was on three days. The asterisks denotes P-value < 0.05

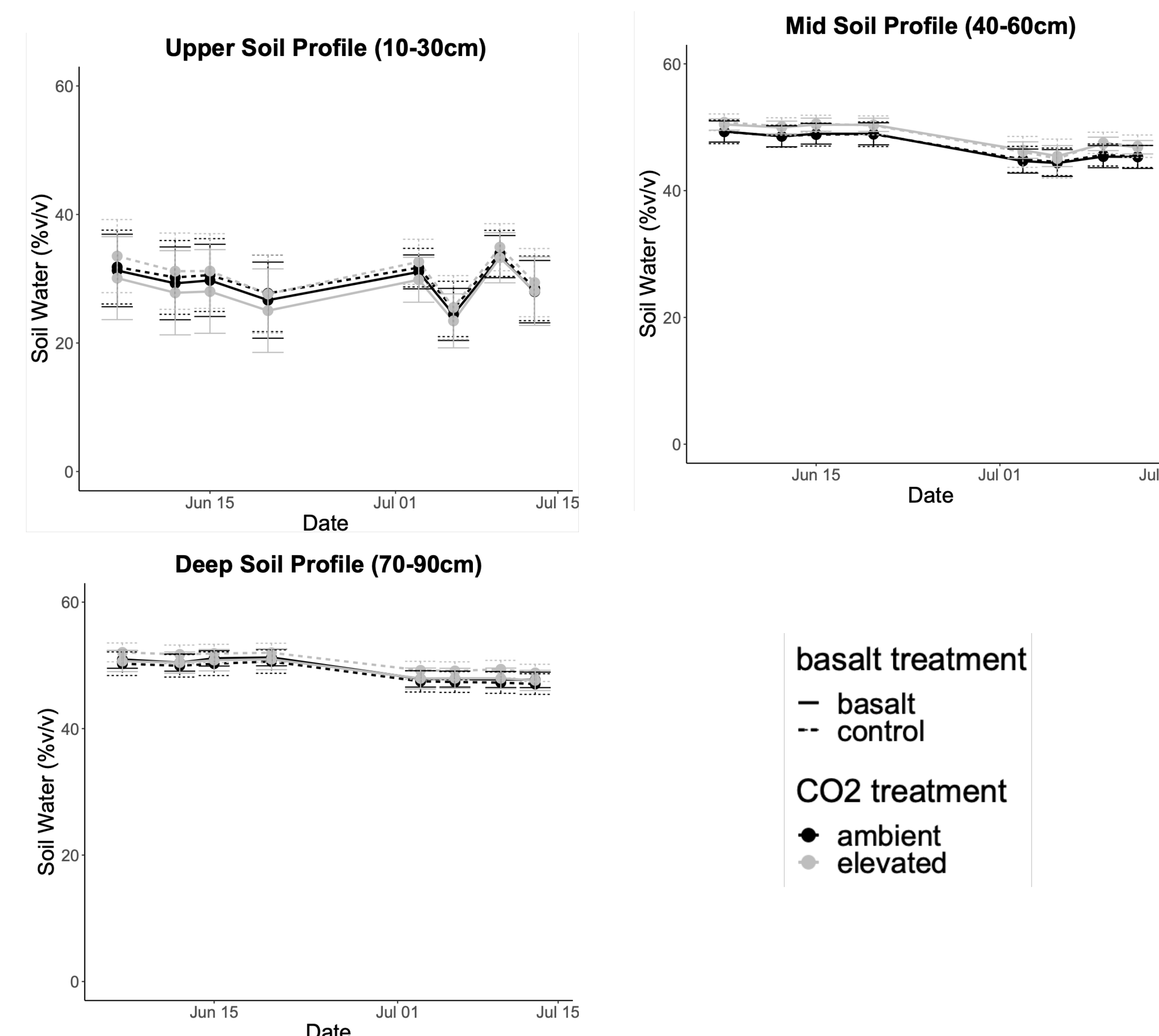


Figure 2. Soil moisture was measured from 10-90cm on 8 days. The points were averaged based on upper, mid, and deep soil profiles.

Table 1. Days until plants reached V6 and R1 stages.

	Mean	Standard Deviation	P-Value
Days to V6			
Ambient	38.8	2.2	>0.05
Elevated CO ₂	37	2.4	>0.05
Days to R1			
Ambient	53.4	3.3	>0.05
Elevated CO ₂	53.1	3.6	>0.05

Stomatal conductance is significantly reduced when exposed to elevated CO₂ on two out of the three days as seen in Figure 1. Although the third date isn't statistically significant, it still follows the trend seen in the previous days. However, figure 2 shows this doesn't translate to increased soil moisture. Further research should be conducted to see if an impact is noticeable under non drought conditions.

There is no statistically significance in development rates between plants in ambient and elevated CO₂ rings as might be expected. The drought conditions likely stressed the plants and influenced their growth rates because limited water is a more influential factor in determining growth and flowering time.