Nutrient and Water Stress Alters *Avena sativa* Disruption of Soil Carbon Storage Potential

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BACKGROUND

A better understanding of carbon cycling in soils is critical for projecting climate change impacts on soil fertility and C storage. Most carbon that remains sequestered long term in soils and sediments is in the form of mineral-associated organic matter (MAOM)(3). Association with mineral surfaces protects soil carbon from microbial mineralization to CO_2 (1). However, MAOM is destabilized by reactive compounds released by plant roots and associated microbes, referred to as rhizodeposits (2). This destabilization of MAOM can occur via direct and indirect mechanisms based on rhizodeposition (1). It is well known that rhizodeposition dramatically changes in response to nutrient or water stress, with unclear consequences for root-driven MAOM destabilization. To combat climate change, we need to improve our understanding of how environmental stress may further drive variations in plant-soil carbon dynamics in the context of these complex ecological systems.

METHODS

- 5 combinations of nutrient and watering levels were tested, controls with the same treatments but without plants were also used
- Plants over grew 9 weeks in a growth chamber with controlled light, humidity, and temperature
- Carbon 13 (^{13}C) was used to track carbon movement, ^{13}C labeled glucose was sorbed to synthesized iron minerals, which were mixed with each pot's soil prior to seed planting

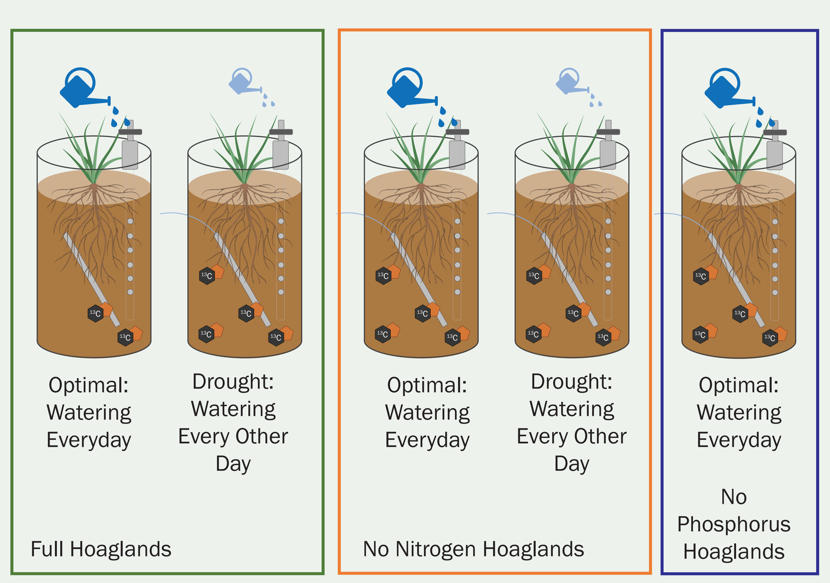


Figure 2. Diagram of experimental pot set up with nutrient and watering treatments. Each treatment group included 5 replicate pots.

Research Question:

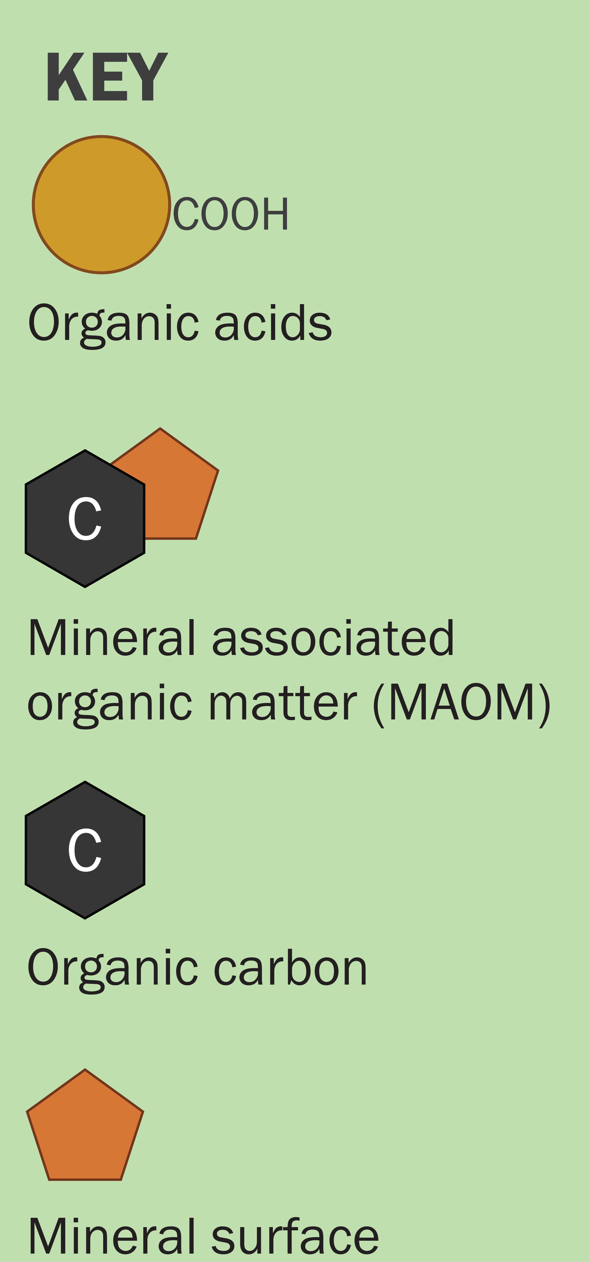
What is the influence that nutrient and drought stress have on MAOM destabilization of *Avena sativa*'s rhizosphere environment?

Hypothesis:

Growing conditions with nutrient and water limitations will mobilize more mineral associated organic matter (MAOM) than growing conditions with optimal nutrient and watering levels.

Objective:

Use ^{13}C to trace MAOM destabilization and mobilization during the growth of *Avena sativa*.



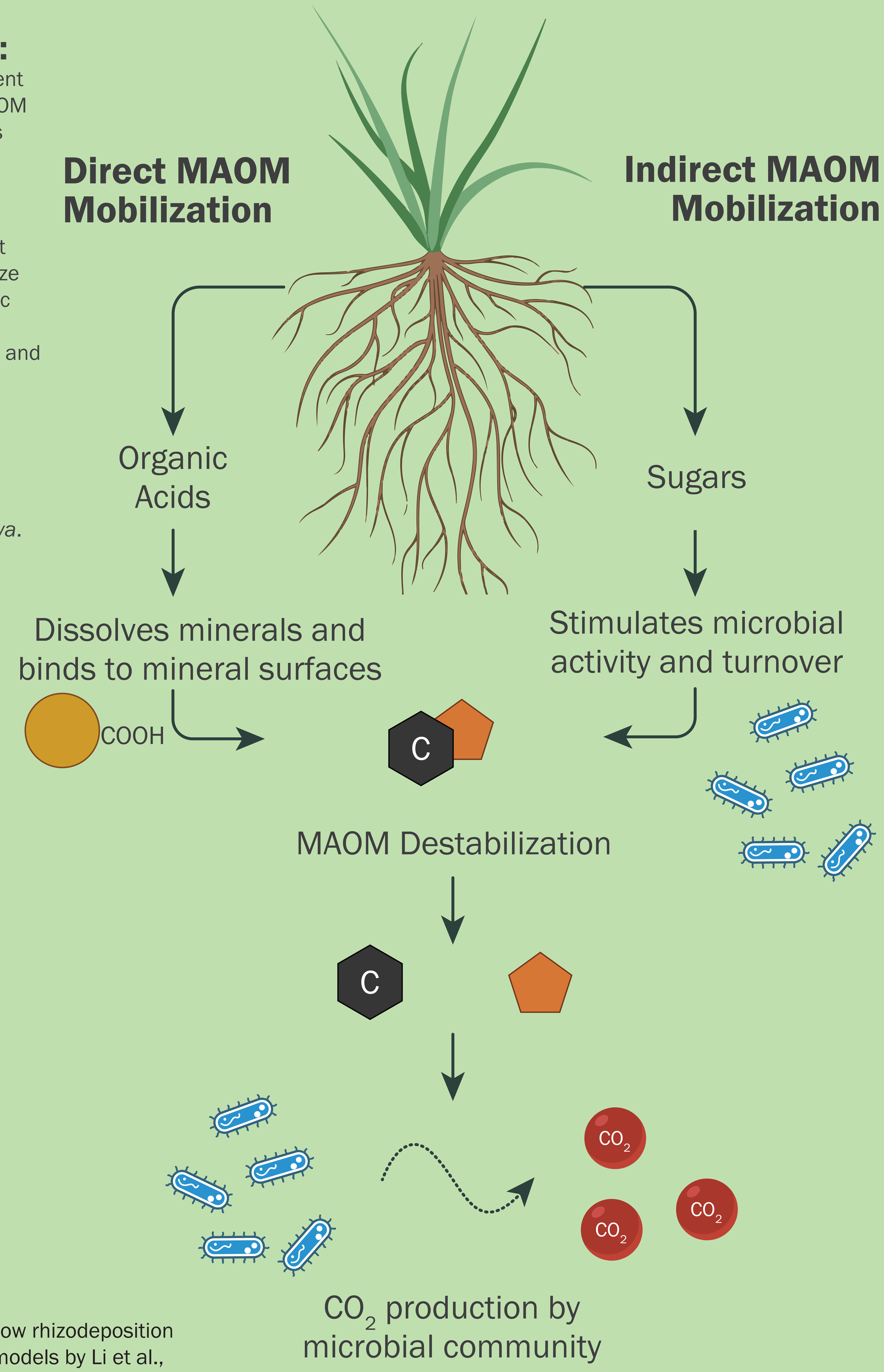


Figure 1. Conceptual model of how rhizodeposition can mobilize MAOM. Based on models by Li et al., 2021.

RESULTS

Cumulative CO_2 Released Over Time

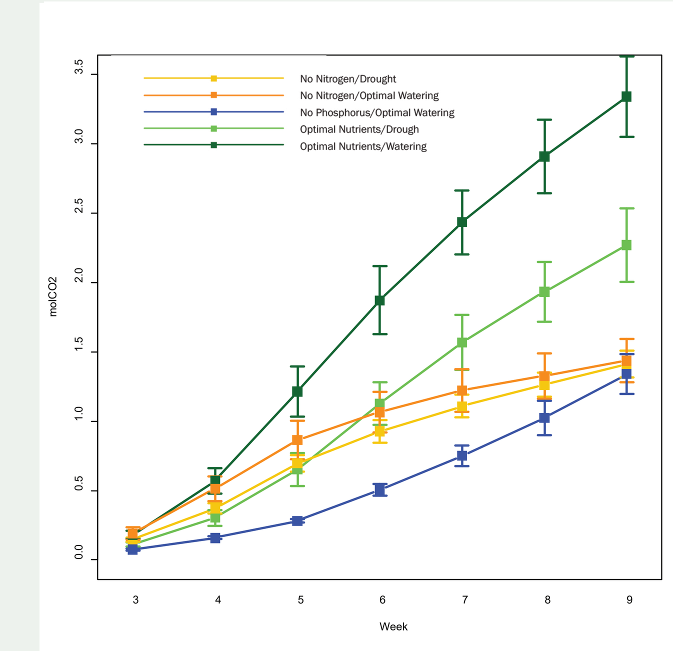


Figure 3. Moles of CO_2 released over time starting from when all pots had seedlings. Each time point is additive, and includes all CO_2 produced at the present time point plus all previous time points. produced previously.

Cumulative MAOM Released As CO_2 Over Time

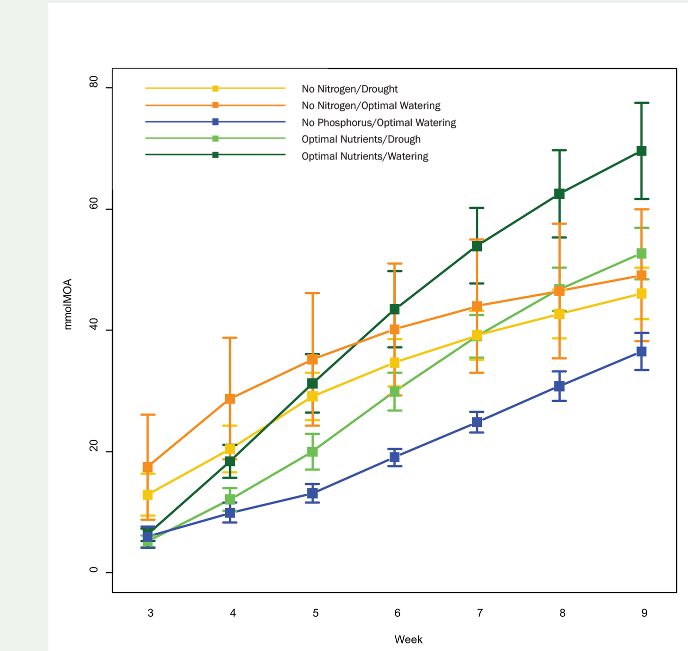


Figure 4. Millimoles of CO_2 from the ^{13}C-labelled MAOM released over time. Each time point is cumulative, and includes all CO_2 produced at the present time point and all previous time points.

Percentage of Total CO_2 Containing MAOM

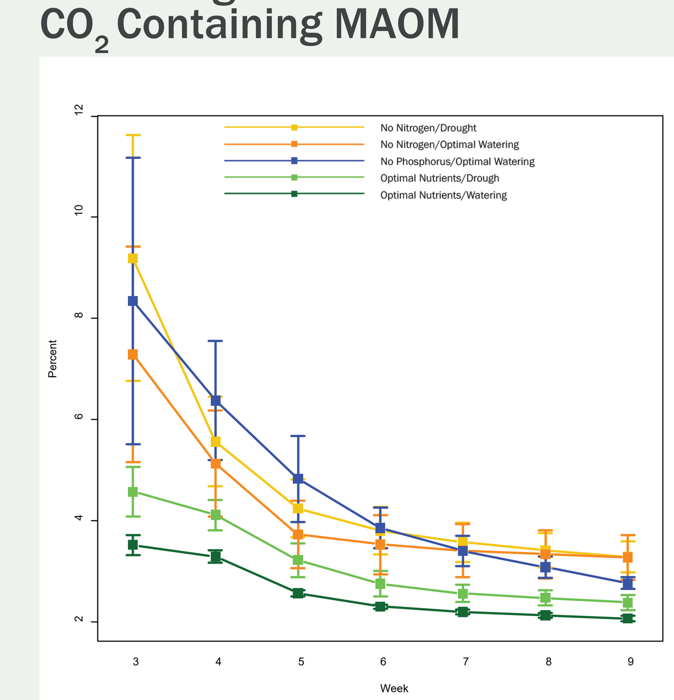


Figure 5. Percentage of MAOM derived CO_2 from the total CO_2 released over time. Each time point is cumulative, and includes the CO_2 produced at the present time point and all CO_2 produced previously.

Ongoing Analysis:

- Microbial biomass extraction ^{13}C analysis
- Sequential mineral extractions with carbon, metal, & ^{13}C analysis
- Porewater carbon and metal analysis

CONCLUSION

Although we don't have the whole picture yet, the data we've collected thus far indicates that plants experiencing a nutrient deficiency induce the highest rates of MAOM destabilization and mineralization, leading to comparitively higher loss in in previous stabilized and protected soil carbon.

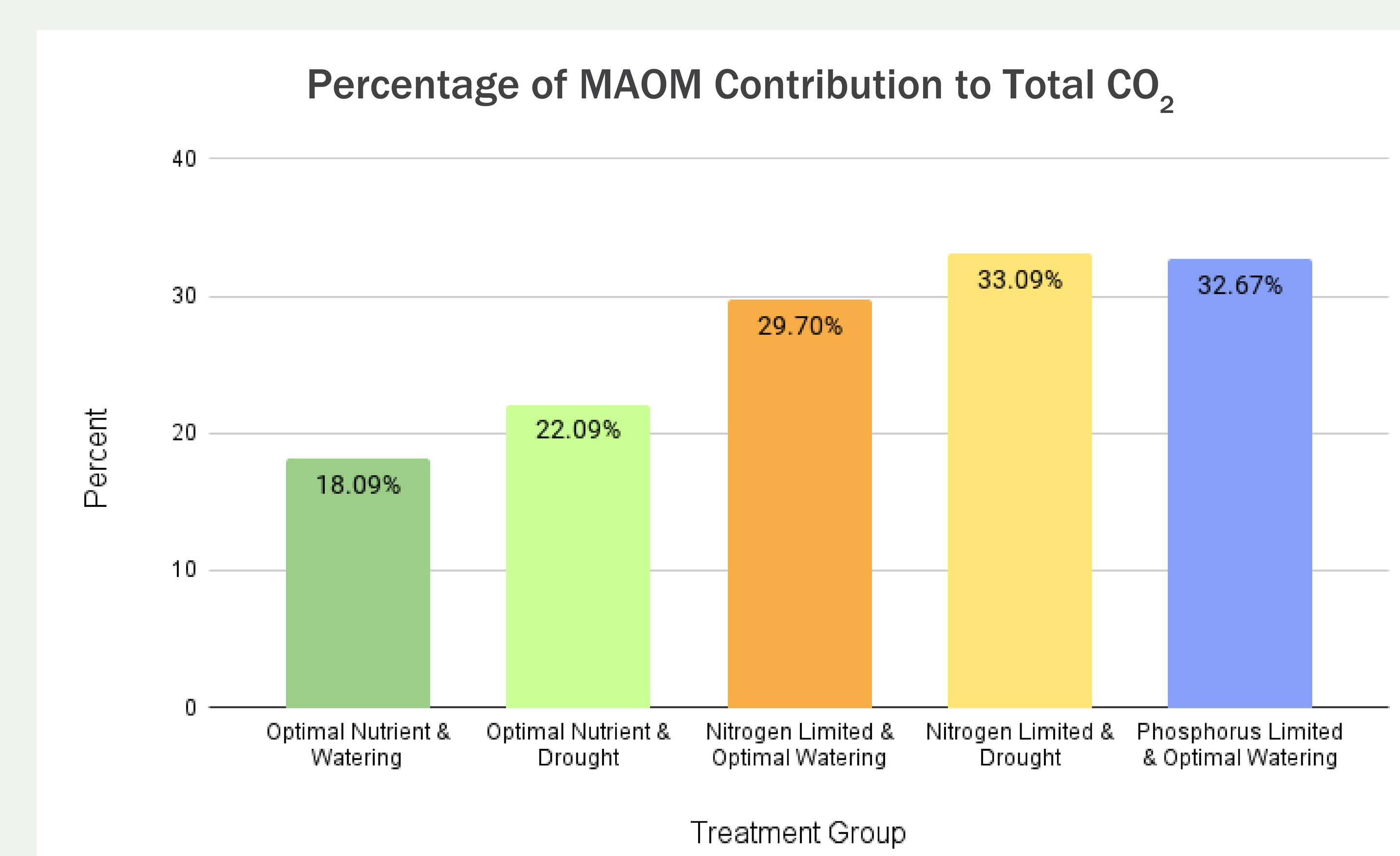


Figure 6. Percentage contribution of MAOM CO_2 released from the total CO_2 mineralized from experimental treatments.

Li et al., 2021 Environmental Science and Technology.
References:
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