

Similar Photosynthetic but Different Yield Responses of C₃ and C₄ Crops to Elevated O₃

Background/Objective

Current ground-level ozone (O₃) pollution significantly reduces global crop productivity. Understanding how different crops respond to elevated O₃ concentration ([O₃]) is critical to improve crop production and resilience under atmospheric change. The objectives of this study were to 1) examine the extent of leaf trait variation in C₃ and C₄ crops, 2) analyze how elevated [O₃] affects crop performance in C₃ and C₄ crops, and 3) explore whether inbred and hybrid lines of rice and maize exhibit a similar O₃ response.

Approach

We compiled 46 journal articles and unpublished datasets that reported leaf photosynthetic and biochemical traits, plant biomass, and yield in five C₃ crops (chickpea, rice, snap bean, soybean, and wheat) and four C₄ crops (sorghum, maize, *Miscanthus × giganteus*, and switchgrass) grown under ambient and elevated O₃ concentration ([O₃]) in the field at free-air O₃ concentration enrichment (O₃-FACE) facilities over the past 20 years.

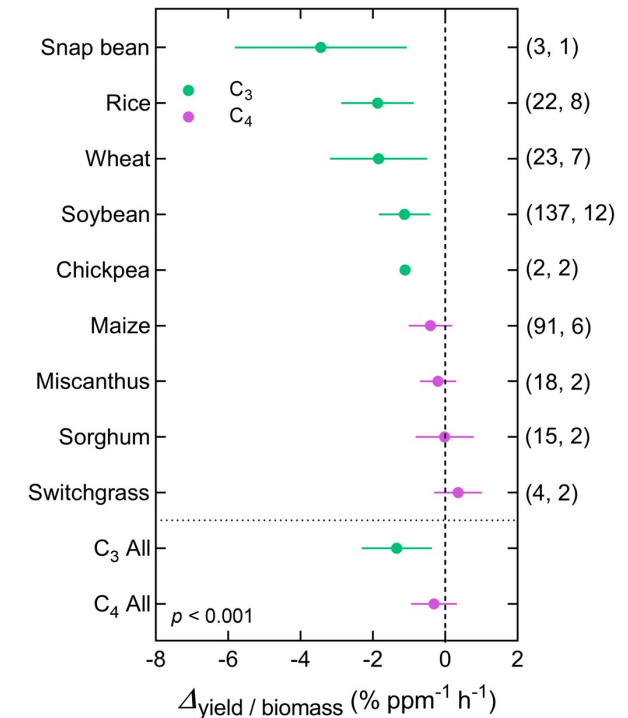
Results

When normalized by O₃ exposure, C₃ and C₄ crops showed a similar response of leaf photosynthesis, but the reduction in chlorophyll content, fluorescence, and yield was greater in C₃ crops compared with C₄ crops. Additionally, inbred and hybrid lines of rice and maize showed different sensitivities to O₃ exposure.

Significance/Impacts

We quantitatively show that C₃ crops are more sensitive to elevated [O₃] than C₄ crops. Our results provide key insights into O₃ response in crops with different photosynthetic pathways. This understanding could help maintain cropland productivity in an increasingly polluted atmosphere. C₄ crops, in particular bioenergy feedstocks, could provide sustainable biomass yields and energy in high O₃-polluted regions.

Li et. al, 2023. "Similar Photosynthetic but Different Yield Responses of C₃ and C₄ crops to elevated O₃." *Proceedings of the National Academy of Sciences*. DOI: 10.1073/pnas.2313591120.



Quantitative comparison of crop yield or biomass responses to elevated [O₃] enrichment in C₃ and C₄ crops.