ARPHA Conference Abstracts 8: e152699
doi: 10.3897/aca.8.e152699

Conference Abstract

Are we fertilizing crops to the point of reduced resilience to environmental stressors?

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Received: 11 Mar 2025 | Published: 28 May 2025

Citation: Tschurr F, Werner RA, Buchmann N (2025) Are we fertilizing crops to the point of reduced resilience to environmental stressors? ARPHA Conference Abstracts 8: e152699. https://doi.org/10.3897/aca.8.e152699

Abstract

The ongoing climate change poses central challenges for food production. Stable crop yields, despite highly variable and changing environmental conditions are critical to providing enough food. Agricultural yields depend on environmental factors, such as temperature and precipitation, as well as inputs, such as fertilizers or irrigation. These environmental factors regulate crop growth due to their impact on plant ecophysiology. The interplay between carbon dioxide (CO_2) uptake via photosynthesis (A) and water vapor (H_2O) loss via transpiration, often expressed as water-use efficiency (WUE), is critical under changing environmental conditions.

Using stable carbon isotope analyses of crop foliage and atmospheric CO_2, the ratio between the intercellular CO_2 concentration in the leaves and the atmospheric CO_2 concentration (*ci*/*ca*) can be estimated, and a plant's intrinsic water use efficiency (iWUE, the ratio of *A* over stomatal conductance (*gs*)) calculated. iWUE is a complex physiological trait influenced by environmental factors and nitrogen (N) inputs. Factors such as temperature, precipitation, atmospheric CO_2 concentration, light intensity, and soil moisture interact to shape a plant's ecophysiology as well as its water use strategy. Thus, environmental conditions create a sophisticated network that determines how efficiently plants utilize available water, how resistant they are against water shortages, and how fast and to what extent they recover, i.e., how resilient they are. Nitrogen availability further modifies this complexity, with N fertilization or atmospheric N deposition affecting metabolic processes and iWUE. Studying these intricate interactions

holds the potential to unravel the drivers of crop physiological responses to a changing climate, offering novel insights for developing more resilient agricultural practices.

We hypothesize that iWUE in crops underlies such an interaction between N supply, i.e., fertilization, and environmental factors, as has previously been shown for beech and spruce trees (Gharun et al. 2021). Since such interaction might influence efficiency and performance of crops under adverse weather conditions, current fertilization regimes might not be beneficial for the resilience of crops against heatwaves and drought, projected to increase in the future.

Unravelling such interconnected processes requires vast amounts of experimental data. Different environmental conditions undoubtedly influence the effect of N input and, consequently, iWUE values. Ideally, data on diverse N treatments conducted over several years and across multiple locations for major crops should be available. Although many such experiments have already been conducted, identifying and accessing them is a challenge. Nevertheless, changes in iWUE might hold a clue to crop performance resilience. This conference offers a valuable opportunity to connect with potential collaborators (maybe you?) who hold data or archived samples from crop fertilization experiments. Please contact us if you are interested in this topic.

Keywords

intrinsic water use efficiency, nitrogen, environmental impact, crops

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Presented at

POSTER

Conflicts of interest

The authors have declared that no competing interests exist.

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