Testing the responses and interplay of leaf physiological and morphological traits at elevated CO₂ levels in six common crop species

Introduction
Biochemical framework
Fig. 1 Schematic drawing of stomata and gas exchange. Optimality modelling describes the trade-off of carbon gain (A) and water loss (E), described in the formula above. A = photosynthesis, E = transpiration, and a and b are unitless cost factors.

Morphological preliminary results

Fig. 2 Conceptual framework after Franks et al. (2012). Operational stomatal conductance (Gc(op)) operates on Gc(max) ... new curve to return to high sensitivity region (a to b to c for elevated levels, a to d to e for subambient levels).

Biochemical preliminary results

Fig. 3. Boxplot of maximum photophosphorylation capacitance (Cmax) of leaves from six species measured under ambient (AC) and elevated (HC) CO₂ levels. There is a significant treatment effect on both AC and HC, with HC > AC (p < 0.05).

Methods

Host facility: University of Western Australia, Perth
Two climate controlled growth rooms:
● 12 hours day length
● 700 PAR
● 30 degrees Celsius
● CO₂ concentration: 400 and 1000 ppm
● 6 species (see table A)

Literature


Further analysis

Plants adapt their biochemistry and morphology at elevated CO₂ levels. Photosynthesis traits, Vcmax and Gsmax, are key concepts. Combining biochemical and morphological responses: preliminary conceptual framework

Conclusions

Plants adapt their biochemistry and morphology at elevated CO₂ levels. Photosynthesis traits, Vcmax and Gsmax, are key concepts. Combining biochemical and morphological responses: preliminary conceptual framework

Further analysis

• Analyse the other species
• Analyse leaf mass per area per species
• Compare a new framework to combine morphology and biochemistry
• Compare species responses
• Compare to a model simulations interpreted in optimality context

Eco-evolutionary optimality (EEO) states that plants adapt to their environment, thereby eliminating non-viable plant strategies by natural selection. EEO has been proven successful for explaining hypotheses and models of the terrestrial biosphere. On a plant leaf level, EEO theory is used to analyse and model plant processes including photosynthesis, gas exchange, and stomatal behavior. Plants regulate their gas exchange by dynamically adjusting their stomata on a short term scale (opening and closing) and long-term scale (stomatal size and density), which also influences photosynthetic output. The stomatal conductance (Gs) of the stomata during transpiration is typically the amount of gas exchange through the stomata. At different growth conditions, the stomatal conductance is measured at different high sensitivity/water loss, ~0.2*Gsmax. Gopt = optimal stomatal conductance (derived from optimality model)