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Elevated carbon dioxide concentration impact on brassica rapa biomass and leaf growth

Our study aims to investigate the impact of increasing atmospheric CO_2 concentrations on the growth of C3 plants. This question is of particular interest due to the recent rise of carbon dioxide beginning in the 19th century industrial revolution and continuing into modern day. The United Nations' Intergovernmental Panel on Climate Change predicts atmospheric carbon dioxide concentration to reach 500-600 ppm by 2050, with some models predicting levels as high as 900 ppm by 2100. Investigations into organism response to predicted rises in CO2 levels are vital in order to reasonably prepare for human adaptation to these drastic environmental changes. Of particular importance is the response of plants, organisms which not only fix inorganic carbon but also support the vast majority of heterotrophic organisms.

Previous studies have found increased [CO_2] promotes plant growth: Omer and Horvath (1989) found significant biomass response to [CO_2] while Ackerly et al. (1992) found an increase in leaf initiation rate. Based on these studies and our understanding of photosynthetic carbon uptake, we expect a similar response in our inquiry. We will investigate the impact of [CO_2] on the growth of *brassica rapa* using two groups: a control group at ambient carbon dioxide concentration of 400 ppm and an elevated group at 800 ppm. We expect the elevated group to exhibit more growth through a greater total biomass and a greater number of leaves. We additionally expect the increased leaf growth in the elevated group to result in a greater percent biomass above-ground than the ambient group.

The study will be conducted over a period of 13 days. We will grow two groups (n=12) of turnip seeds at an ambient [CO_2] of 400 ppm and a treatment [CO_2] of 800 ppm. Both groups will be held at a constant 25 °C with a 24-hour lightsource for the duration of the experiment. Planting quads will be filled ½ full with moist planting media. Media will then be tamped down. 6-10 Osmocote fertilizer pellets will be planted and then additional media will be added and tamped down until ½ full again. More planting media will be added until 1cm from the top. *Brassica rapa* will be planted 1 seed in middle of each quad, 2-4 mm beneath surface. Quads will be labelled cell 1-24, and marked "control" or "treatment".

Quads will be watered once daily for 13 days. (Brassica rapa Planting Guidelines and Care Instructions). Leaf number, leaf size, biomass and biomass allocation will be measured for each plant and averaged. Leaf size will be determined by measuring the width and length of the four largest leaves on each plant. We will use a t-test to determine the statistical significance of any difference between control and treatment groups.

Table 1: Mock average number of leaves and average biomass of Control (400 ppm CO_2) and Treatment (800 ppm CO_2) groups

	Control	Treatment
Mean # of leaves	5	7
Mean biomass	18g	22g
% biomass shoot	65	75
% biomass roots	35	25

We predict that the average biomass will be greater for the treatment due to the carbon fixation mechanism in the Calvin cycle. We also predict that the number of leaves will increase due to the greater supply of CO_2. It is also possible that the leaves will not increase in number but the stomata will, which would be indicated by an increase in biomass but statistically insignificant results for the number of leaves. Given the short timescale of our study and the abundance of nutrients and water, we do not expect root growth to accelerate. Such increased root growth would be motivated by an inability to utilize all available carbon due to limitations in nutrients or water.

References:

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