

Evaluating the effects of light and N distribution on plant C allocation in *Poa annua*

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Introduction

Nutrients are unevenly distributed in soil both spatially and temporally. Since plants are sessile, they compete for resources through developing and elongating their organs, specifically their roots. Previous studies have shown that biomass allocation to roots is mainly related to light levels, with N supply having little effect. However, within the root system, local N supply strongly influences root growth, with increased root growth within nutrient patches coming at the cost of root growth outside the patch. Conversely, shoot growth is mainly a function of N supply, although light intensity mediates growth rates. Biomass allocation patterns have been explained by reference to various models; the Transport Resistance Model predicts that excess resources are exported from source organs, with new growth occurring in sink organs which have access to limiting resources. In this model, photosynthate in excess of that required for shoot maintenance respiration will be sent to roots, with higher export under high light conditions. Similarly, root to shoot N transport will scale with N supply. Within the root system, we expect C to be allocated to roots supplied high N levels, leading to locally increased growth rates. We expect the roots to continue growing until they deplete the excess C supply, at which point root maintenance respiration will equal the shoot to root C flux, and growth will cease.

To assess this hypothesis, we conducted an experiment using *Poa annua* plants grown in split root boxes. We grew the plants under high or low light levels and used a ^{13}C / ^{15}N dual isotope labelling approach to quantify C and N allocation in young and old plants, where the old plants had been able to acclimate to the growth conditions for 20 days.

Materials & Methods

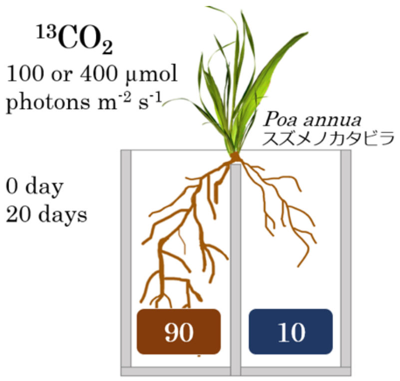

Fig1. Experimental design.

Poa annua plants were grown in split root box which has a partition in the middle, allowing roots to grow in two separate chambers. After a 38-day establishment period, treatments were imposed with the left side roots given 9 times more ammonium sulfate than right chamber roots. Half the plants were grown in high light (HL, ≃400 µmol photons m^{-2} s^{-1}), and the other half in low light conditions (LL, ≃100 µmol photons m^{-2} s^{-1}). ^{13}C/^{15}N dual labelling was carried out on young plants (0d of treatment) or old plants (20d of treatment) which had time to acclimate to the treatment conditions. Plant roots were labelled with the corresponding concentration (90 or 10) of ^{15}N and placed in a clear acrylic box containing ^{13}C for 10 hours. Plants were then harvested, and their dry masses measured. After milling samples into powder, the samples were analysed by mass spectrometry.

Results

■Dry mass：No significant differences in shoot or root mass were noted between HL vs LL nor HN vs LN for 0d plants. After 20 days of treatments, shoot and root masses were significant higher in HL than LL conditions, while the root masses were higher in the 9N than 1N roots (Fig 2).

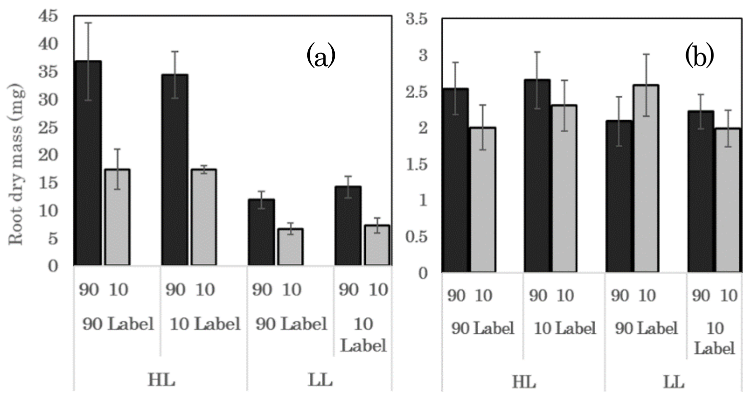

Figure 2. (a) Root dry mass of Day20 plants. (b) Root dry mass of Day0 plants.

■^{13}C concentration：We hypothesize that the root ^{13}C concentration will be higher in the HL plants, due to a greater shoot to root C flux. We also hypothesize that the 9 roots will have a higher ^{13}C concentration than the 1 roots in the day 0 but not day 20 plants, due to differential growth over the acclimation period. ^{13}C labelling data will be presented in the oral presentation.

References

- Irving et al. (2019) *Journal of Plant Physiology* 234-235: 54-59
- Irving and Mori (2021) *Plants* 10(9): 1783