

Photosynthesis and biomass allocation in parasitized clover plants

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Introduction

Parasitic plants are estimated to cause approximately US\$10 billion of damage to agriculture globally. There are about 4000 species of parasitic plants, split into hemiparasites which steal nutrients and water, and holoparasites which also steal carbon from their host plant. *Orobanche minor* and *Phtheirospermum japonicum* are holoparasitic and hemiparasitic plants found in Japan. While the effects of *O. minor* on host plants have previously been established, the effects of *P. japonicum* are poorly understood. It has been suggested that nitrogen (N) nutrition is an important determinant of the host-parasite relationship.

Purpose of the Study

To determine how the parasitic plants *P. japonicum* and *O. minor* affect biomass allocation and photosynthesis of host clover plants in different N conditions.

Methodology

Host clover seeds were planted with *P. japonicum*, and *O. minor* parasite seeds. Clover and *P. japonicum* were also planted on their own as control plants. Seeds were given an N-free nutrient solution during the germination period, which was swapped to treatment solutions containing 1 mM N, 5 mM N, and 25 mM N after two weeks. Plants were grown for a further 6 weeks before photosynthesis and biomass measurements were recorded.

Measurement and data collection

A LICOR 6400XT Portable Photosynthesis System was used to measure the photosynthesis of host plant leaves. The leaves were scanned, and ImageJ was used to measure and account for the varying leaf sizes and obtain the correct photosynthesis measurement values.

Root and shoot fresh weights of all plants were recorded. The roots and shoots were then dried to obtain dry biomass.

Results

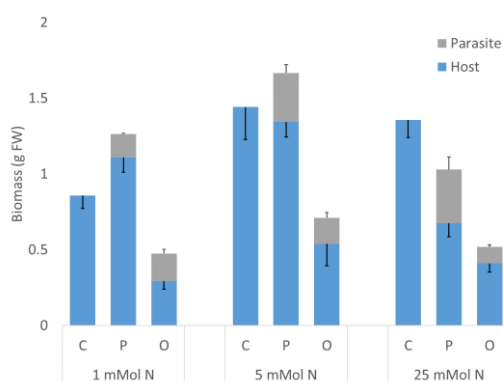


Fig. 1. Plant fresh weight after 6 weeks of different nitrogen level treatments. C is control host plants, P is host + *P. japonicum*, O is host + *O. minor*.

Control plants were bigger than those parasitized by *O. minor* at all N levels, with the proportionate difference in biomass between control and parasitized plants unaffected by N supply. N level did not have a significant effect on the total biomass of the host and *O. minor* system.

P. japonicum infection caused significant decrease in host biomass at 25 mM N but not at lower N levels. *P. japonicum* did not have an effect on host plant biomass at 1 and 5 mM N. The mass of parasitic *P. japonicum* plants tended to increase with N supply, while no effect of N was noted on the mass of *O. minor*.

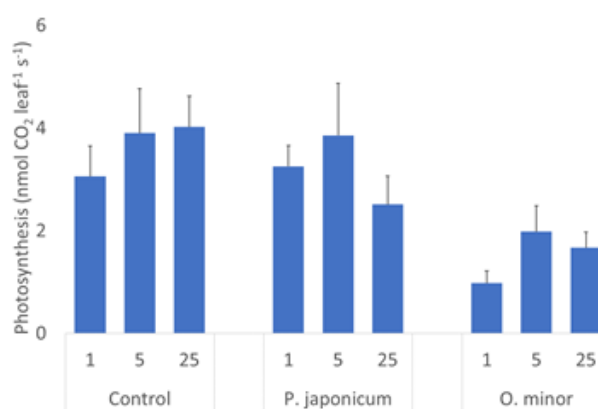


Fig. 2. Photosynthesis of host plant leaves after 6 weeks of growing with parasitic plants at different nitrogen levels.

Host plants parasitized with *O. minor* showed a decrease in photosynthetic rate on a *per leaf* basis at all N levels. *P. japonicum* did not have an effect on the photosynthesis performed by leaves of host plants at 1 or 5 mM N, but may have caused a slight decrease at 25 mM N. Decreases in host leaf size was an important factor in photosynthetic declines.

Conclusion

Orobanche minor infection caused a decrease in both biomass and photosynthesis of host clover plants regardless of N supply. In the case of clover plants infected by *Phtheirospermum japonicum*, no significant effects were detected in the plants supplied with low N levels. However, plants grown with a *P. japonicum* at 25 mM N exhibited a significant decrease in biomass, suggesting that *P. japonicum* affects host plant growth more at higher N levels.

Preliminary experiments have previously shown that *P. japonicum* can cause an increase in photosynthesis of host clover leaves. While this was not found in this experiment, it is possible that this only holds true for young plants. We plan to explore the effects of *P. japonicum* parasitism on host photosynthesis in subsequent experiments.