The effects of simulated herbivory on the growth of a common greenhouse weed

Sarah Bolen, Julina Almonte, Sydney Bialek, C. Eric Hellquist
Department of Biological Sciences, State University of New York Oswego, Oswego, NY 13126

ABSTRACT

Herbivory plays an important role in the growth and reproduction of plants. We studied the impacts of herbivory on *Pseuderanthemum variabile* by measuring height, biomass, and photosynthesis. Preliminary observations indicate that increased levels of simulated herbivory were detrimental to the photosynthetic efficiency and overall health of the plants.

INTRODUCTION

Impacts of Herbivory

- Plants are constantly attacked by many different organisms. Herbivory can have harmful effects on plants such as increasing their susceptibility to disease, reduced seed production, and delay rates of shoot and root growth (Maron & Crone 2006).
- Plants have different defence mechanisms to complex responses to herbivory. For example, once attacked various signal cascade are activated and this results in defense responses such as the release of defense hormones, specialized metabolites, volatile organic compounds and more (Waterman et al. 2019).
- Simulated herbivory offers advantages when conducting experiments such as precision and being able to standardise damage without confounding effects of different types of herbivory (Baldwin 1990).

Figure 1: Plant desiccation and decay caused by simulated herbivory

Pseuderanthemum variabile (Acanthaceae)

- *Pseuderanthemum* is a genus with ~60 species and is known as a pantropical species (Butaud et al. 2019)
- *Pseuderanthemum variabile* is a ground growing perennial plant that grows up to about 12 inches tall and is typically native to Australia (Howes 2023)
- Leaf color ranges typically from dark to light green and sometimes from grey to red or purple.Flowers come in an assortment of a lilac, blue, and white (Howes 2023).

Figure 2: *Pseuderanthemum variabile.*

Objective:
Determine how different levels of simulated herbivory would affect the growth and overall photosynthetic levels of the *Pseuderanthemum variabile.*

Hypothesis: As levels of simulated herbivory increase from low to high, the percentage of photosynthesis will decrease in the *Pseuderanthemum variabile*.

METHODS

Experimental Design

Treatments & Replicates
- 3 treatments; low, medium and high, as well as a control.
- Each treatment had 8 replicates n=32

Data Parameters Collected:
- Quantum yield
- Number of dead leaves

Instrumentation Used:
- FluorPen FP110

Figure 3: Levels of herbivory being performed on *Pseuderanthemum variabile*

Simulated Herbivory Performed on *Pseuderanthemum variabile*

- Two pots containing eight different plant replicates chosen and labeled
- Photosynthetic measurements were measured with the FluorPen FP110 and recorded before and after treatment was applied

Treatment: Levels of simulated herbivory for levels of Control, Low, Medium, and High
- Hole puncher (5mm) was used to apply treatment, four leaves from each plant had the treatment applied, one treatment per leaf
- Starting from the top of the plant and working down going left to right doing the first four leaves for each level.
  - Control, no punches
  - Low, one hole punch
  - Medium, three hole punches
  - High, six hole punches
- Photosynthetic data was taken using the FluroPen FP110 every 2-3 days for 6 different collection days. Plants were then depotted, and dried for analysis.

RESULTS and DISCUSSION

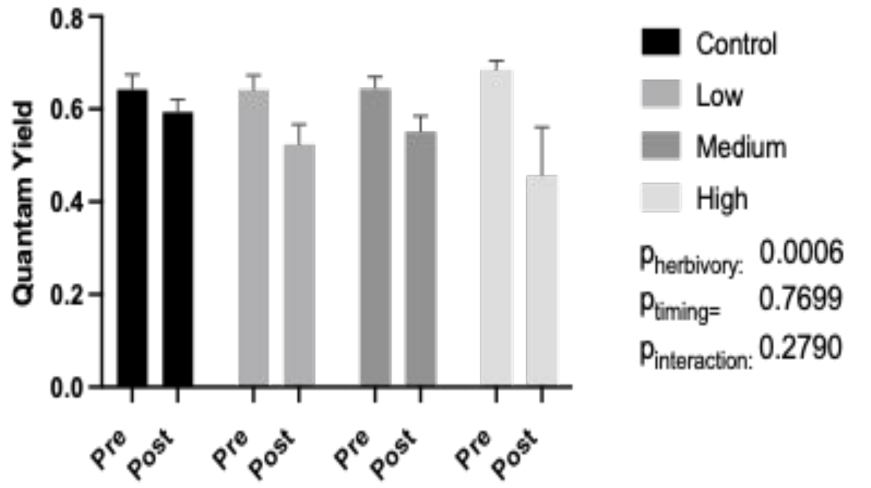

Figure 4. Quantam yield of different levels of herbivory for *Pseuderanthemum variable.* P-values derived from a two-way ANOVA. Error bars are from standard error of mean.

Quantum Yield

- Comparing all herbivory intensities, before and after treatment we see decreases in photosynthesis. Looking at the high intensity we see a 0.23% decrease in photosynthesis, (ANOVA; p=0.0006, Figure 4.)
- The intensity of herbivory was not significant (p=0.77). It's important to note that this might be due to the sample size of our experiment.
- Herbivory has many different harmful effects on plants, such as increasing their susceptibility to disease and reduced seed production to name a couple (Maron & Crone 2006).
- One study concluded that there was no change in the rate of photosynthesis when under different treatments (Escudero et al. 2008).

RESULTS and CONCLUSION CONTINUED

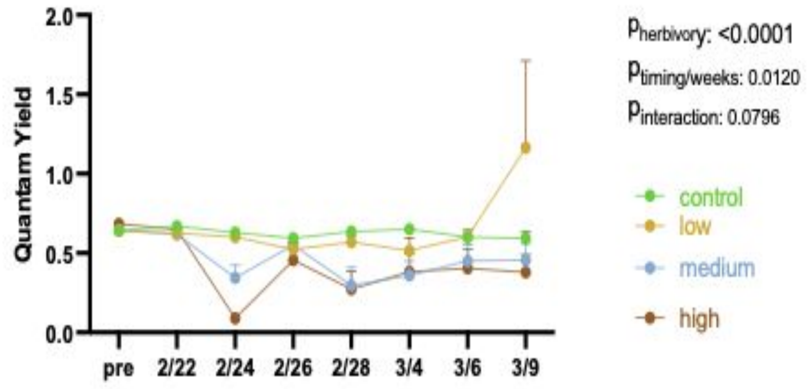

Figure 5. Quantam yield of different levels of herbivory over time for Pseuderantemum variabile. P-values derived from a two-way ANOVA . Error bars are for standard error of mean.

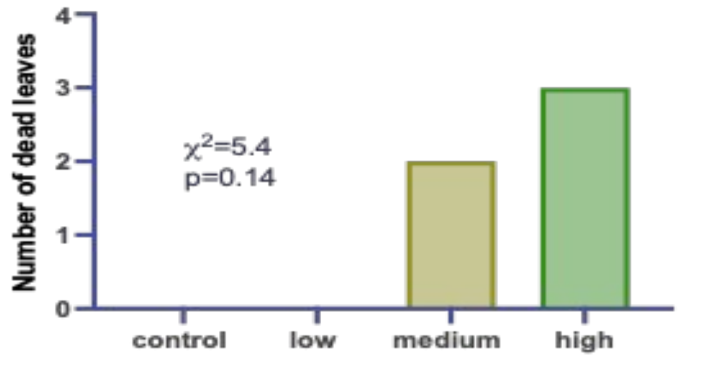

Figure 6: Number of dead leaves for different levels of herbivory for Pseuderantemum variabile. P value and χ^2 derived from a χ^2 test.

Quantum Yield over Time:

- There was a decrease in quantum yield at all levels of herbivory intensity. Our high treatment had a 0.31% decrease compared to the quantum yield pre herbivory and quantum yield on March 9th (ANOVA; p=0.012, Figure 5).
- Time since herbivory treatment also had a 1.2% effect on quantum yield.
- Herbivory leads to a direct reduction of photosynthetic capacity caused by the removal of tissue (Nabity et al. 2009).
- When performing simulated herbivory it is often difficult to produce plant responses that properly illustrate complex interactions between biodata, which may not yield accurate ecological responses in a lab setting (Baldwin 1990).

Decayed or Dessicated Leaves:

- There was no significant correlation between the number of dead leaves and the herbivory treatment applied. (p=0.14).
- Herbivory is known to cause unequal mortality rates or lost tissue (Huntly 1991).
- Herbivores are able to impact the effects along the trophic chains of ecosystems (Schmitz 2008).

CONCLUSION:

Quantum Yield
- Tested for both the significance of Herbivory and the Intensity of Herbivory, which yielded that these ecological processes have significant impacts
- Showed that the interaction and intensity of herbivory were not significant
- The timing of when the herbivory occurred did yield a significant result

Decayed or Dessicated Leaves
- After 6 days of treatment application there was visible desiccation in some replicates
- Almost 3 weeks after the treatment was applied there was a large amount of desiccation visible in all replicates.

LITERATURE CITED

Baldwin I.T. 1990. Trends in Ecology & Evolution 5: 91-93.
Butaud J.F. et al. 2019. Phytokeys 128: 73-84.
Delucia E. H. 2009. Annals of Botany 103: 655-663.
Escudero A. et al. 2008. Trees 22: 785–793.
Howes J. 2023. . Australian Plants Society NSW.
Huntly N. 1991 Annual Review of Ecology and Systematics 22: 477–503.
Peeters P. J. et al. 2007. Functional Ecology 21: 246-255.
Maron J.L. & Crone E. 2006. Proceedings of the Royal Society B: Biological Sciences 273: 2575-2584.
Schmitz O. J. 2008. Annual Review of Ecology, Evolution, and Systematics 39: 133–152.
Waterman J.M. et al. 2019. Trends in Ecology and Evolution 34: 447-458.