Effects of Herbivory and Gibberellic Acid on Resource Allocation in Native Radish

W. K . Kellogg Biological Station
MICHIGAN STATE UNIVERSITY

Marissa Nufer, Ava Garrison, Dr. Jeffrey Conner

Background

- All organisms make tradeoffs in allocating limited resources.
- Gibberellic acid (GA) is a vital hormone in plants that regulates growth, photosynthesis, and flowering.
- Herbivory on plants induces the production of jasmonates—defense regulating hormones—inhibiting gibberellin signaling and thus inhibiting plant growth, known as the growth defense tradeoff.
- *Raphanus raphanistrum,* commonly referred to as wild radish, are self-incompatible annuals and thus rely on floral traits to attract pollinators to increase fitness.

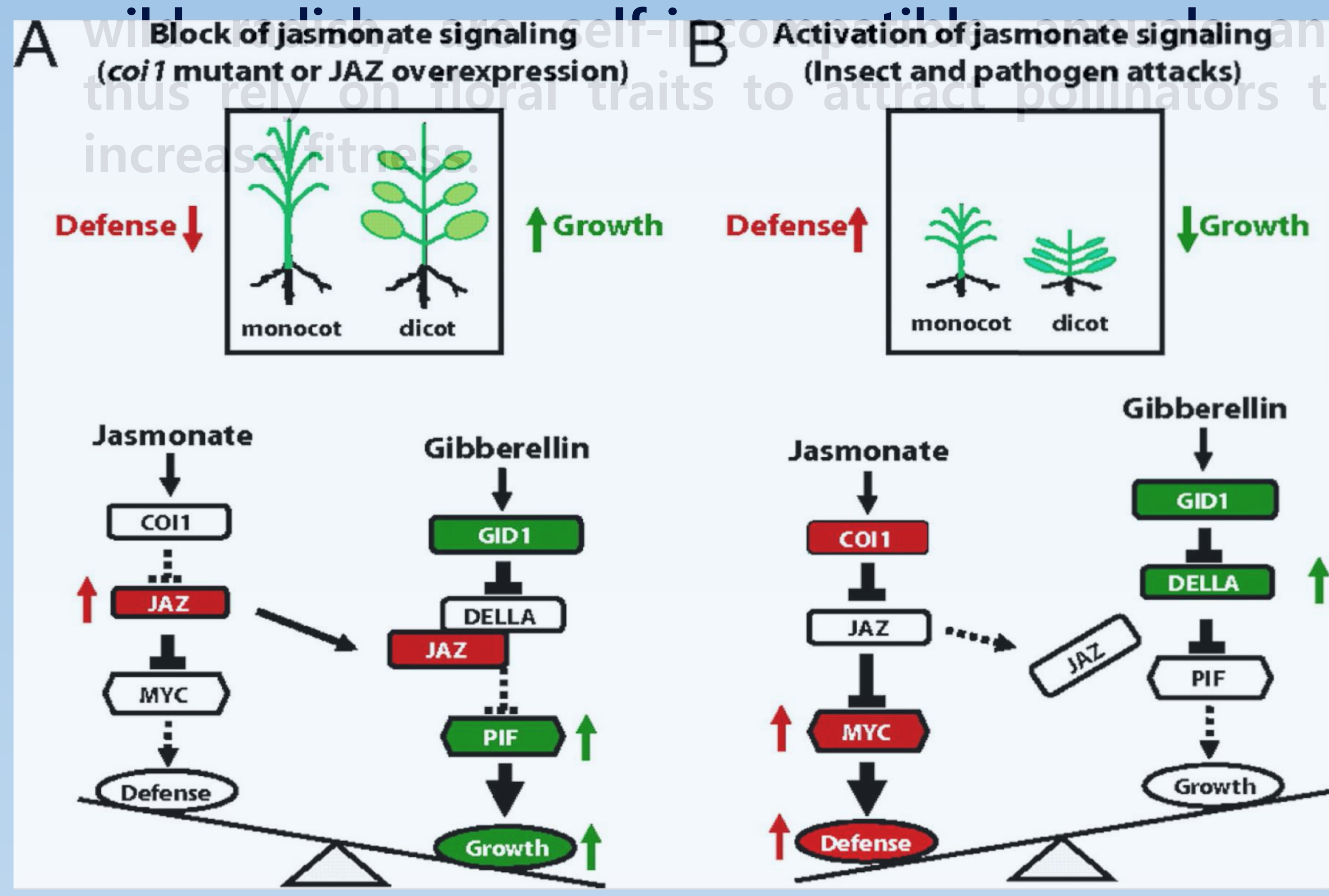
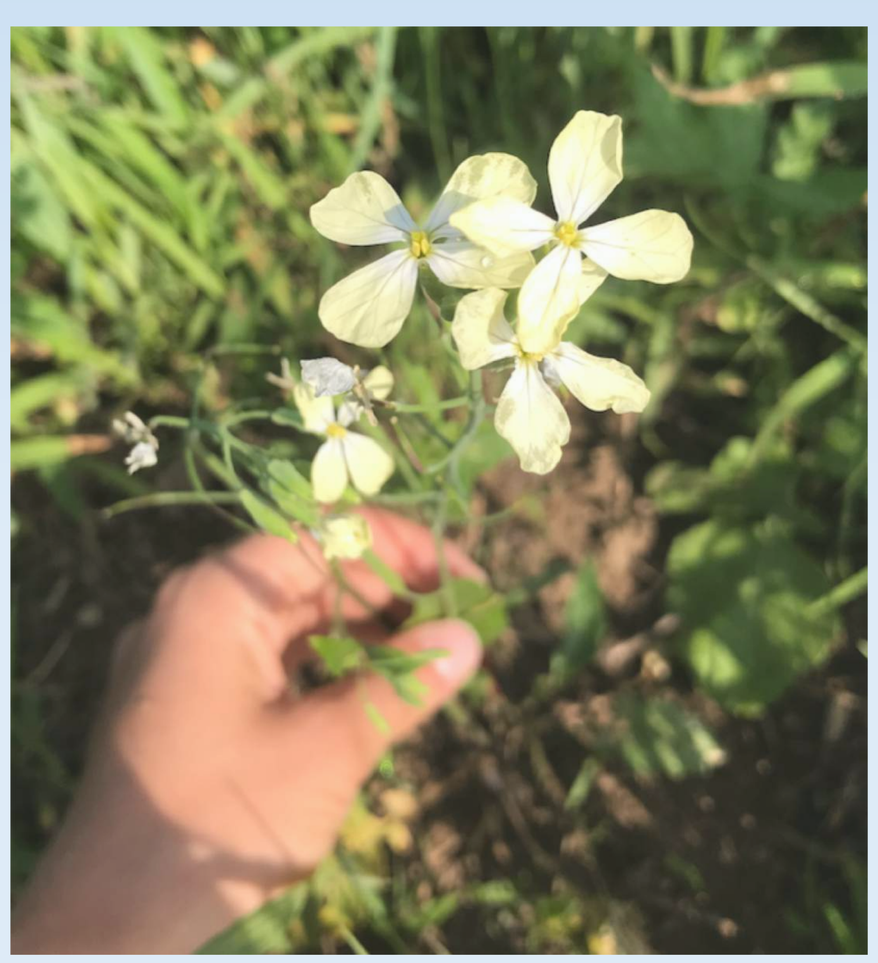


Fig. 1 (From Yang et al.) *A*: Jasmonic acid (JA) signaling is down regulated, thus JAZ repressors accumulate, taking away DELLA's ability to regularly inhibit PIFs, which then activates growth promoting genes to enhance growth. *B:* JAZ repressors typically inhibit MYC but degrade upon insect attack, causing defense uptake. JAZ usually inhibits DELLA's ability to inhibit PIF, DELLA is no longer inhibited and blocks PIF transcription factors, thus slowing growth.

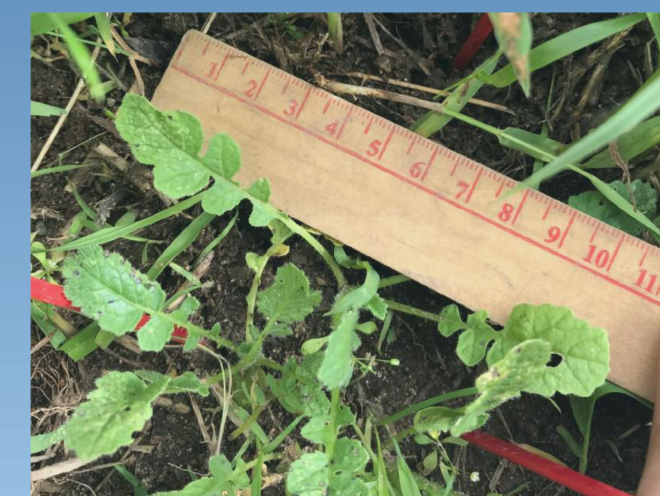
Objectives



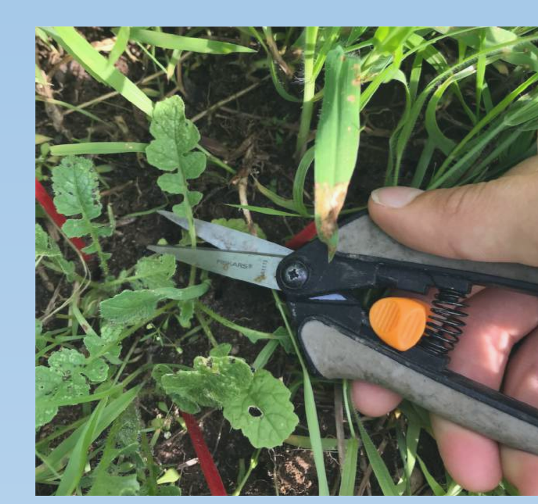
The goal of my experiment is to see what effects gibberellic acid and herbivory have on allocation of resources to flowering.

(Left) Mature *R. raphanistrum* flowers, from a separate experiment.

Methods



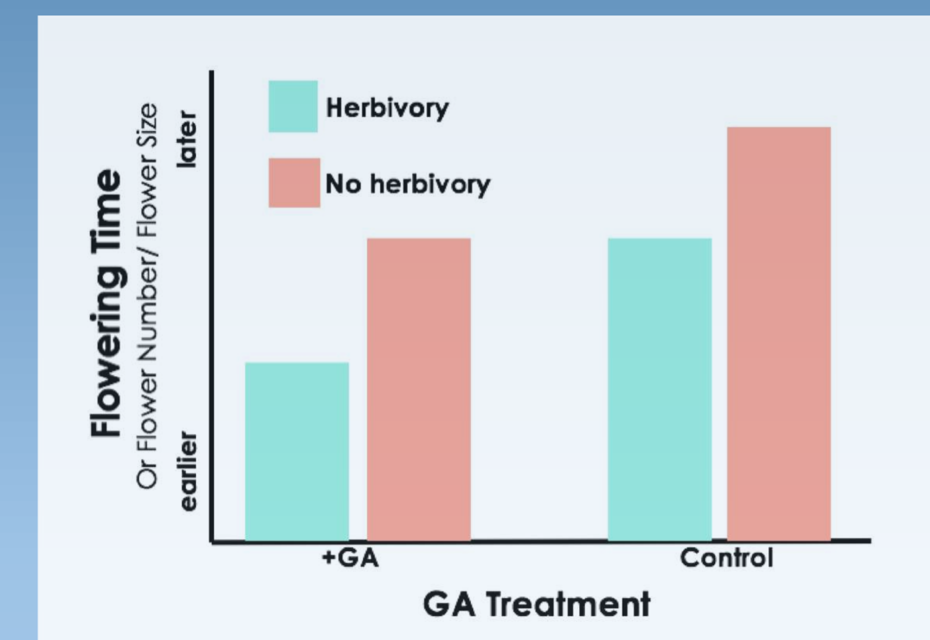


(Upper left) Spraying radish with control substance (deionized water). (Upper center) Measuring radish at 10cm to clip. (Upper right) Spraying radish with GA treatment. (Middle) Field set up. (Lower left) Planting radish seeds. (Lower right) Clipping radish leaves as "herbivory treatment".

- Planted 160 radish plants in a randomized order at Ft. Schemske, using 80 from each of two native populations
- Four treatment groups were used: herbivory with GA, herbivory with control (deionized water), no herbivory with control, no herbivory with GA.
- Apply herbivory treatment by clipping half the leaves once plants reach 10cm diameter.
- Spray with control/GA treatment every other day when the plant gains its first true leaves.
- Record flower size, flower number, and first flower date.

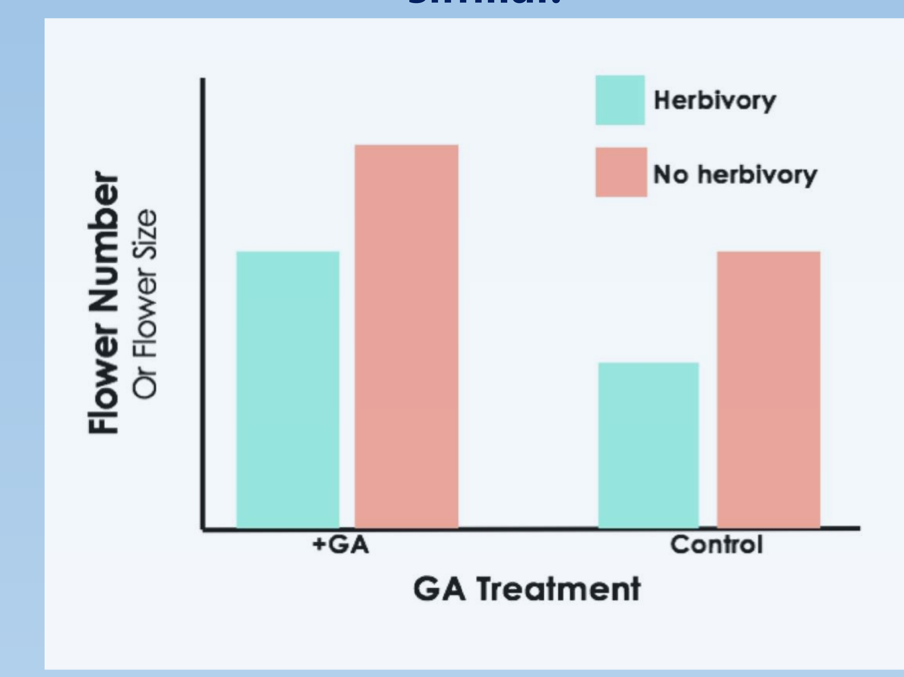
Fig 2. The experimental set up of native radish plots at Ft. Schemske field site.

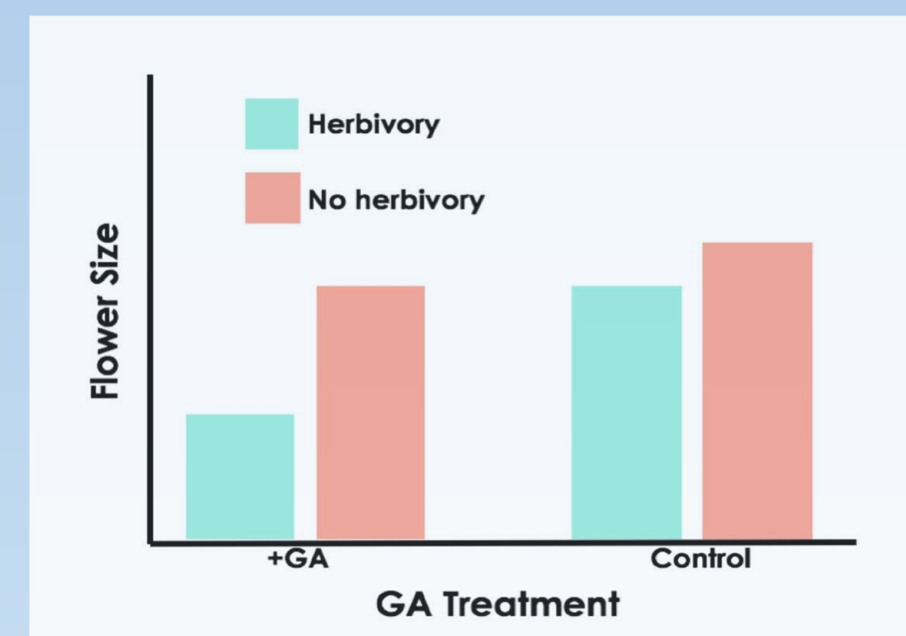
Predicted Results



Scenario 1
(Left) Fig. 3.
GA and stress from herbivory each induce earlier flowering. Thus, plants exposed to both will flower earliest. In this scenario, the flower size and number results would look similar.

Scenario 2a
(Right) Fig. 4.
In this scenario, plants with GA and herbivory would have similar flower number and size to plants with neither treatment. By flowering earlier, added GA would cause plants to allocate more resources towards flowering.





Scenario 2b
(Left) Fig. 5.
Under scenario 2, plants that produce the most flowers under a given treatment will then have less resources to allocate towards flower size, causing them to produce smaller flowers.

Future Steps

Given past data sets and information, my radish will most likely flower around September. When they flower I will measure the floral traits listed previously and analyze the data.

References & Acknowledgments

Thank you to the Conner lab for hosting and helping with my experiment, and to BEACON, KBS Werner Scholarship for Ecological field studies and KBS Noall Scholarship for Biological and Environmental Science.

Charbonneau et al. (2018). Weed evolution: genetic differentiation among wild, weedy, and crop radish. *Evolutionary Applications,* 11:1964-1974.

Cipollini (1997). Gibberellic acid treatment reduces the tolerance of field-grown common bean to leaf removal. *Journal of Plant Growth Regulation,* 16:123-127.

Machado et al. (2017). Herbivory-induced jasmonates constrain plant sugar accumulation and growth by antagonizing gibberellin signaling and not by promoting secondary metabolite production. *New Phytologist*, 215:803-812

Yang et al. (2012). Plant hormone jasmonate prioritizes defense over growth by interfering with gibberellin signaling cascade. *Proceedings of the National Academy of Sciences of the United States of America,* 109 (19) 7152-7153.