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Summer 2020

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Arianna Perez-Wolf

Laurie Dizney

University of Portland, dizney@up.edu

Jennifer Ng

Ryan Heron

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Citation: Pilot Scholars Version (Modified MLA Style)

Perez-Wolf, Arianna; Dizney, Laurie; Ng, Jennifer; and Heron, Ryan, "The Effects of Roundup and Mycorrhizal Fungi on Narrow leaf Milkweed" (2020). *Biology Undergraduate Publications, Presentations and Projects*. 14.

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The Effects of Roundup and Mycorrhizal Fungi on Narrow-leaf Milkweed

Arianna Perez-Wolfe, Jennifer Ng, Ryan Heron, Laurie Dizney

Introduction

The western monarch butterfly (*Danaus plexippus*) has suffered a >99% decline in population over the past 40 years due to habitat loss¹. Female monarchs lay eggs only on milkweed, and monarch caterpillars feed exclusively on it. The destruction of milkweed habitat, essential for the survival of monarch butterflies, is largely attributed to the use of Roundup, a popular weed management herbicide used everywhere from residential lawns to corporate farms².

The negative effects of Roundup may be ameliorated by arbuscular mycorrhizal fungi, AMF, however these interactions have not been well studied. AMF form a symbiotic relationship with plants, where the plants supply carbon to the fungi and receive soil nutrients in return³. Although mycorrhizal interactions are typically viewed as mutualistic, they have the potential to be parasitic to the plant host⁴. The outcome of the interaction depends on factors such as light, soil nutrients, and genotype of the host plant and fungi⁵. The limited research on AMF and milkweed has shown the effects to differentially affect milkweed growth based on plant species type, with some species showing increased growth and others decreased growth, while still others appear unaffected^{3,6}.

Even fewer studies have been performed on the interaction between Roundup and AMF and have found conflicting results. One study directly applied low concentrations of Roundup to AMF and found no negative effects on fungal growth while very low concentrations actually stimulated fungal growth⁷. Conversely, another study found that root colonization by AMF was reduced when low concentrations of Roundup were applied to the soil⁸.

We investigated the effects of Roundup and AMF on one species of milkweed native to the Pacific Northwest, narrow-leaf milkweed (*Asclepias fascicularis*). **We hypothesized that 1) adding AMF to the soil would increase plant growth whereas Roundup would decrease growth, 2) adding AMF to the soil would increase AMF root colonization whereas Roundup would decrease AMF root colonization, and 3) high levels of AMF root colonization would increase plant growth.**

Methods

- Milkweed plants were grown in a greenhouse under four treatments: Roundup added to the soil, AMF added to the soil, both added, and neither added
- Growth measurements (e.g. height) were taken twice over 10 weeks
- Milkweed was harvested at 10 weeks, then oven-dried and weighed for biomass
- Root tips were taken from samples and stained to determine the percent AMF colonization following the technique of Vierheilig et al.⁹

Results

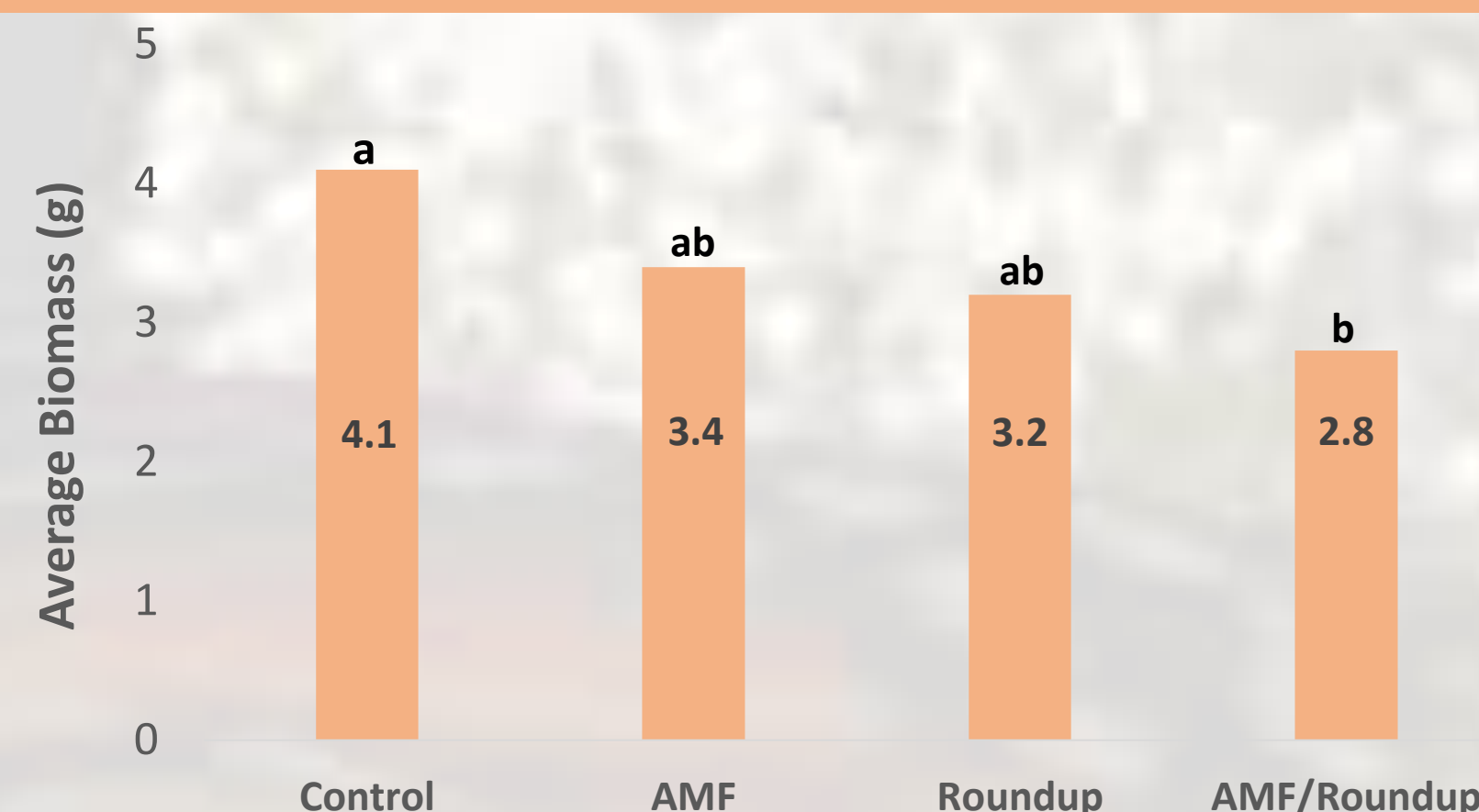


Fig. 1: Average biomass of milkweed when AMF, Roundup, or both were added to soil. Biomass of the AMF/Roundup treatment was smaller than the control (p=.01).

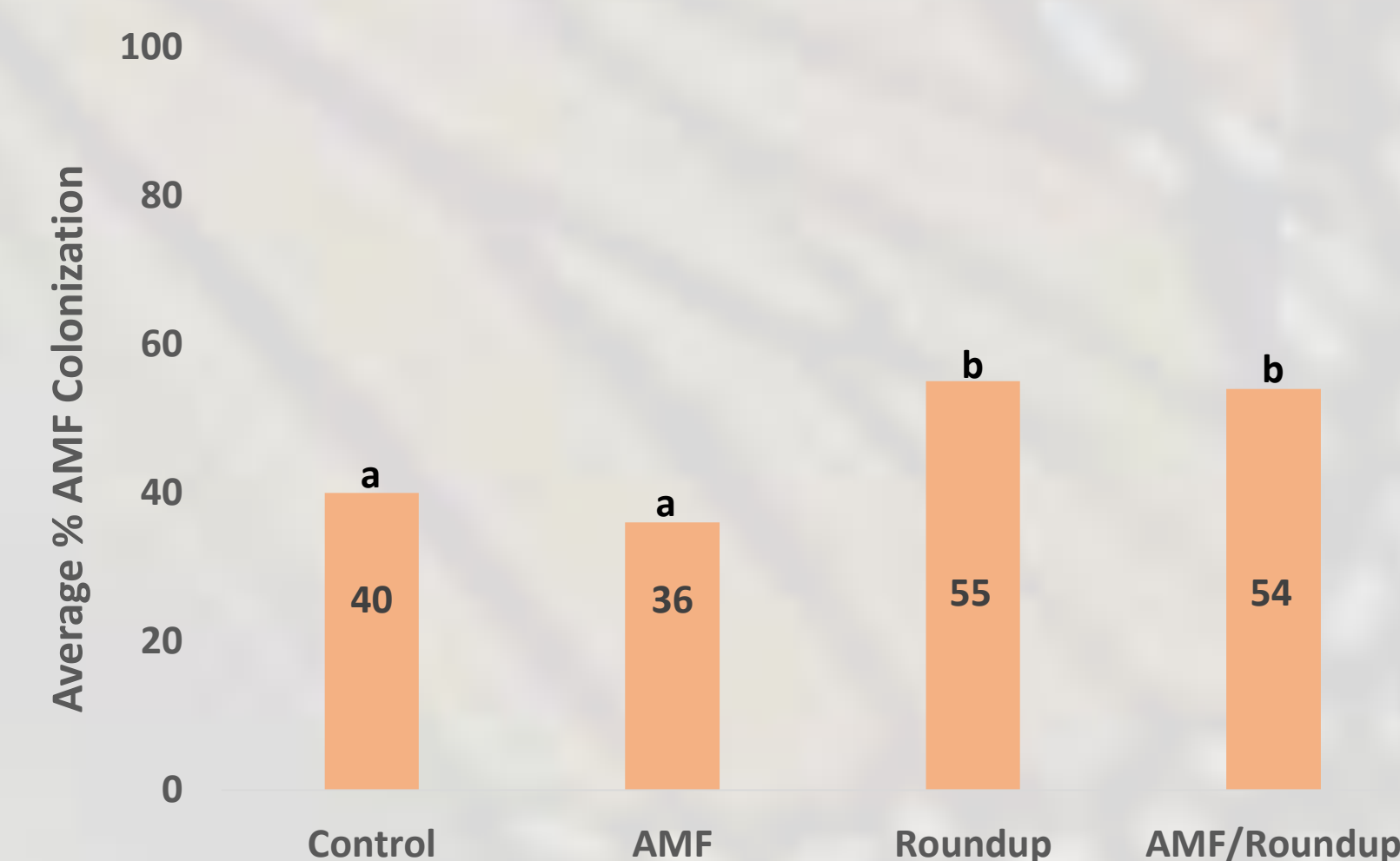


Fig. 2: Average percent AMF root colonization when AMF, Roundup, or both were added to soil. AMF root colonization was greater when Roundup and AMF/Roundup were added to the soil compared to the control (p=.006 and .02 respectively). Surprisingly, there was no increase in AMF colonization in the plants where AMF was added to the soil.

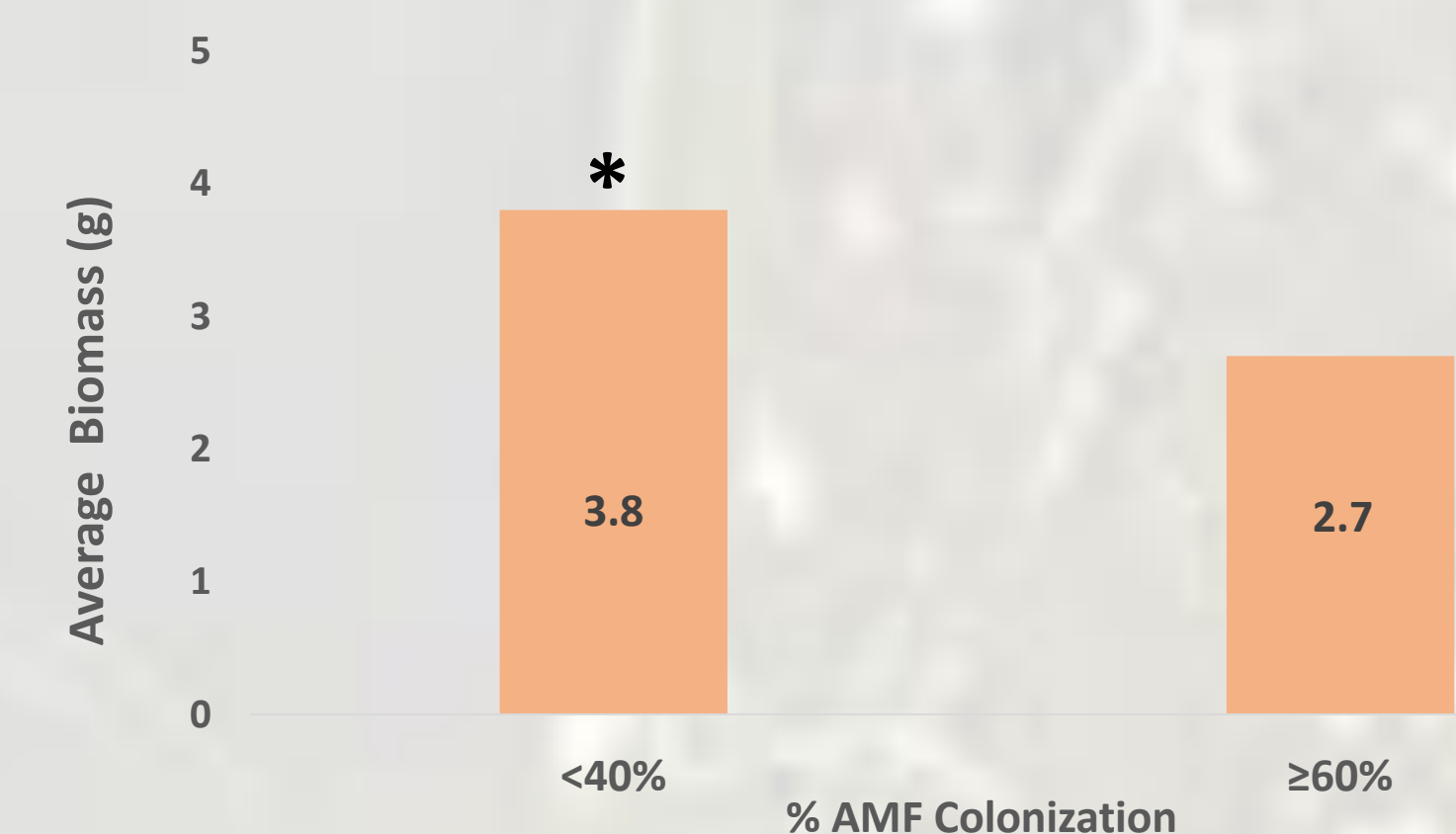


Fig. 3: Average biomass of plants with ≤40% and ≥60% AMF root colonization. Biomass was greater in plants with lower levels of AMF root colonization, regardless of treatment (p=.003).

Conclusions

- Biomass was not affected by Roundup or AMF added to the soil separately, but together they decreased biomass, partially supporting our hypotheses (Fig. 1)
 - Other growth measures such as change in height and number of leaves also decreased
- Adding AMF to soil did not increase AMF root colonization, which does not support our hypothesis (Fig. 2)
 - However, Roundup seems to encourage AMF colonization
- Our hypothesis that increased AMF root colonization would increase growth was not supported
 - In fact, biomass was greater in plants with lower levels of AMF colonization, regardless of treatment (Fig. 3)
 - Our results suggest that at high levels of root colonization, the relationship between AMF and milkweed becomes parasitic
 - Therefore, it is not recommended to add AMF or Roundup to soil when growing narrow-leaf milkweed
 - More research should be done to investigate how Roundup and AMF affect other species of milkweed in their native habitat
- Studies like these are essential in order to protect highly imperiled monarch butterflies and encourage suitable habitat restoration

Acknowledgements

Thank you to the University of Portland College of Arts and Sciences SURE program.

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