Role of Mycorrhizae in Milkweeds: Implications for Monarch Conservation

Bailey Baskin, Eric B. Duell, Dr. Gail Wilson

Department of Natural Resource Ecology and Management

Introduction

As little as 1% of the original expanse of North America's tallgrass prairie remains, and the survival of almost all grassland plants depends on the symbiotic partnership with arbuscular mycorrhizal (AM) fungi. These beneficial soil fungi associate with roots of the host plant and increase uptake of essential nutrients and water, thereby increasing growth, survival, and drought stress. A number of milkweed species, such as common milkweed, butterfly milkweed, and prairie milkweed, are common in the remaining portions of Great Plains grasslands, and are essential to monarch butterfly migration. We know that some milkweed species are highly dependent on arbuscular mycorrhizal (AM) fungi for survival. However, level of dependence on this symbiosis is not known for most milkweed species.

Objectives

1) Determine the relative mycorrhizal dependence, also referred to as responsiveness (rMR), and assess AM fungal root colonization for 21 different milkweed species found in various regions of the Great Plains.
2) Assess latex production in milkweed plants inoculated with AM fungi, and milkweeds plants not inoculated with AM fungi to determine the role of AM fungi in mediating plant defenses.

Hypotheses

1) The milkweed species we selected vary considerably in phenology, site specificity, and morphology, therefore, we expect interspecific variation in rMR
2) Latex production will likely be directly related to plant biomass production and tissue quality, both of which are typically increased with AM fungal associations.



Methods

Experimental Design

- 21 species of milkweed (*Asclepias* spp.)
- 2 inoculation treatments:
  - Mycorrhizal (inoculated with 'live' soil)
  - Non-mycorrhizal (not inoculated with 'love' soil)
- 6 replicates
- Total of 252 pots

Harvest

- Plants harvested at 14 weeks
- Biomass production, rMR= [(Mycorrhizal plant biomass – non-mycorrhizal plant biomass)/ mycorrhizal plant biomass]×100, and latex production quantified for each *Asclepias* plant/ species

Results

Species	+ AMF	- AMF
A. arenaria	**7.595**	**2.911**
A. asperula	1.677	0.630
A. curassavica	**0.445**	**4.698**
A. engelmanniana	**0.006**	**0.278**
A. exaltata	**1.908**	**0.264**
A. hirtella	1.216	2.317
A. incarnata	0.211	0.369
A. latifolia	2.843	2.526
A. oenotheroides	1.409	0.732
A. perennis	0.201	0.239
A. purpurascens	1.951	4.556
A. speciosa	7.200	3.043
A. stenophylla	**2.289**	**0.003**
A. sullivantii	7.615	3.209
A. syriaca	4.803	7.492
A. texana	**0.325**	**0.020**
A. tuberosa	**0.192**	**0.008**
A. verticillata	0.971	0.948
A. viridiflora	3.587	2.842
A. viridis	2.312	0.661
G. fruticosus	**0.093**	**0.482**

Table 1. Latex per g-1 of biomass (dry wt) of each milkweed species. Center columns represent mycorrhizal plants (+AMF) and far right columns represent non-mycorrhizal plants (-AMF). Bolded rows indicate mycorrhizal plants were significantly different from non-mycorrhizal plants ($p<0.05$).

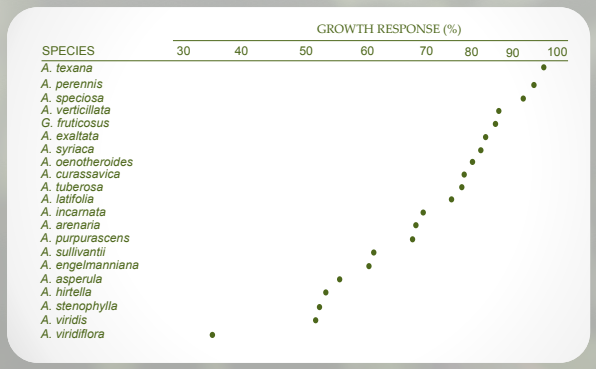

Figure 1. Relative mycorrhizal responsiveness (rMR) values of 21 tested milkweed species.

Conclusion

Responsiveness to AM fungi was highly variable within the genus Asclepias.

Mycorrhizal responsiveness (rMR) did not strongly relate to AM root colonization. More latex was produced by larger (+AM fungi) plants, but not always more per gram of biomass.

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Discussion

Mycorrhizal responsiveness among related species is often similar, but do not appear be the case in diverse genera, such as Asclepias.

It has been previously reported that some AM fungal taxa are more beneficial than others, and some AM taxa produce greater root colonization. Therefore, greater rMR may not be due to increases in AM root colonization, as we observed in our study. It was beyond the scope of our study to assess if different AM fungal taxa were associating with different Asclepias species; this could be the focus of future studies.

We hypothesized latex production would be a function of plant biomass production, and thus, indirectly mediated by AM fungi. However, while larger plants did generally produce greater latex production compared to smaller plants, greater latex production per gram of plant was not always observed.