

**The Friends of Nachusa Grasslands
2023 Scientific Research Project Grant Report
Due June 30, 2024**

Please answer the following questions with clearly written summaries to give Nachusa Friends' science committee members, officers, and board members a good idea of what you accomplished using your grant money. Unless you object to the Friends doing so, your report will be uploaded into the science section of the Friends' website: nachusagrasslands.org.

1. Please save this form to your desktop with a unique file name that includes "Friends 2022 Science Grant Report" and your last name.
2. Complete the form using the headings in bold as your guide.
3. Save the file as a Word document or a PDF.
4. Attach the file to an e-mail, and send it to: nachusafriendsscience@gmail.com no later than June 30, 2024.
5. The subject of the e-mail should be "2023 Scientific Research Grant Report" and your last name.
6. If you have not completed your work, please submit this form anyway by the June 30 deadline and plan to contact Friends after your project is complete so that we may learn from and publicize the outcomes as appropriate.

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2023 grant amount: \$14,525

Research Project Topic: Testing the effect of native arbuscular mycorrhizal fungi on prairie restoration success at Nachusa Grasslands

Research Project Purpose: This grant was sought to support a 3-year study analyzing the effect of inoculating plants with native arbuscular mycorrhizal (AM) fungi from prairie remnant soils on restoration success. We hoped to successfully establish plant species of interest that have historically been rare in restorations and improve the native plant biodiversity in prairie restorations at Nachusa Grasslands.

Research Project Outcomes to date:

Greenhouse experiment

Using the soil cultures created in 2021, we inoculated 12 plant species (*Asclepias syriaca*, *A. tuberosa*, *Baptisia alba*, *Chamaecrista fasciculata*, *Coreopsis lanceolata*, *Coreopsis tripteris*, *Dalea candida*, *Desmanthus illinoensis*, *Echinacea pallida*, *Eupatorium altissimum*, *Liatris pycnostachya*, and *Rudbeckia hirta*) with either sterile soil

or soil cultured from a post-agricultural site or one of the four prairie remnants (six total treatments) in 2022. Half of these plant species were weedy/early successional, and half were conservative/late successional.

We collected aboveground and belowground plant biomass as well as percent root colonization by AM fungi. Conservative plant species grew larger with inoculation of AM fungi in general than more weedy species, and almost all species grew largest when grown with native AM fungi cultured from a remnant prairie.

Field experiment

In 2022, we established experimental plots in both the Senger planting and MRCP hill site, established in 2015 and 2021, respectively. Both sites contain 12 plots of each treatment (sterile, post-agricultural, and remnant soil inoculation) for a total of 36 plots at each site. Inocula containing AM fungi was introduced via “nurse plants” grown with the cultured soil in a greenhouse at the University of Kansas. At the Senger site, we planted *Asclepias tuberosa* (butterfly milkweed) and *Coreopsis lanceolata* (lanceleaf coreopsis); at the MRCP hill site, we planted *A. tuberosa*, *C. lanceolata*, *Echinacea pallida* (pale purple coneflower), and *Dalea candida* (white prairie clover).

At both sites, we monitored the survival and growth (via height and leaf number) in July of both years. First year data in 2022 showed a treatment effect on survival in the established Senger planting ($p < 0.001$), where there was higher mortality overall than in the MRCP hill site likely due to increased competition, particularly belowground, from established plants. In both sites, we saw species-specific height responses to inoculation ($p < 0.001$), where some species grew larger with inoculation of post-agricultural or remnant-cultured soil than others. Second year data in 2023 largely showed these same patterns. Only survival was impacted in the Senger planting with inoculated plants generally surviving at higher rates (**Fig. 1**). The lack of treatment differences in terms of growth may reflect the higher mortality of smaller plants in the Senger planting as opposed to the MRCP hill site. At the MRCP hill site, we again saw species-specific effects of treatment on plant height ($p < 0.05$; **Fig. 2**). Specifically, we found that both *A. tuberosa* and *D. candida* grown with remnant-cultured AM fungi grew significantly larger than those that were uninoculated ($p < 0.05$). These data are consistent with studies that highlight the species-specific nature of mycorrhizal response, especially to different AM fungal species. This is especially true of late successional plants, which tend to respond more positively to native AM fungi.

We also monitored the plant communities at both sites at the end of July. At the Senger site, we observed the species composition. While we did not find differences between treatments, there was an astounding amount of native plant diversity and conservative species already established. At the MRCP hill site, we measured the percent cover of all plant species in the plots. In the first growing season, we already detected a difference in plant diversity due to inoculation ($p < 0.05$), with lower diversity seen in plots with post-agricultural inoculum. In 2023, we did not observe any consistent plant community differences due to treatment. As plant competition increases in the third year, we may see community differences appear more in following growing seasons. For this reason, we will monitor plant community changes in the following year.

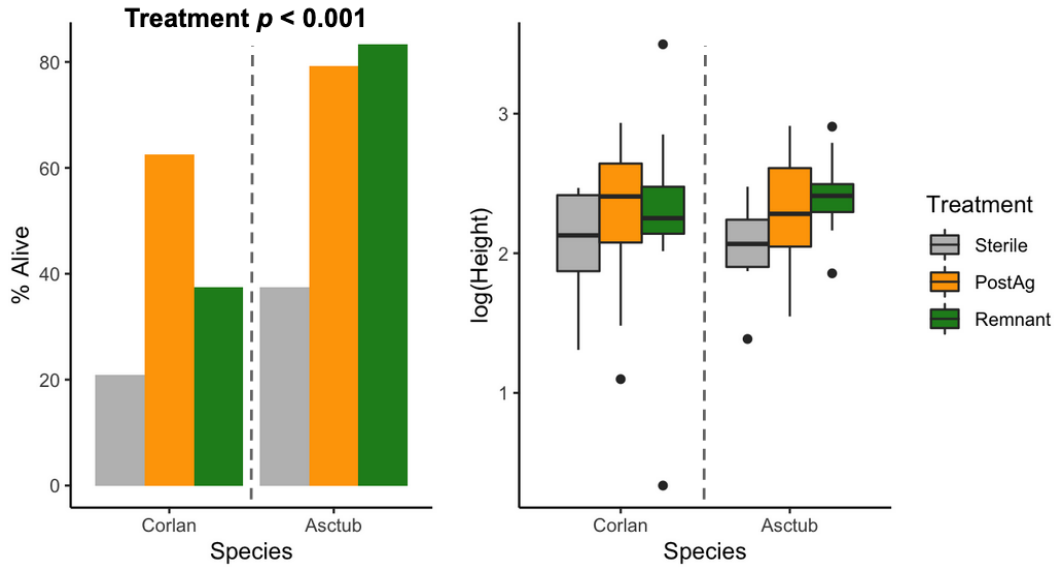


Figure 1. Plant survival and height in the Senger planting in 2023. The colors refer to the source of inocula where gray, orange, and green refer to uninoculated, post-agricultural, and remnant prairie soil, respectively.

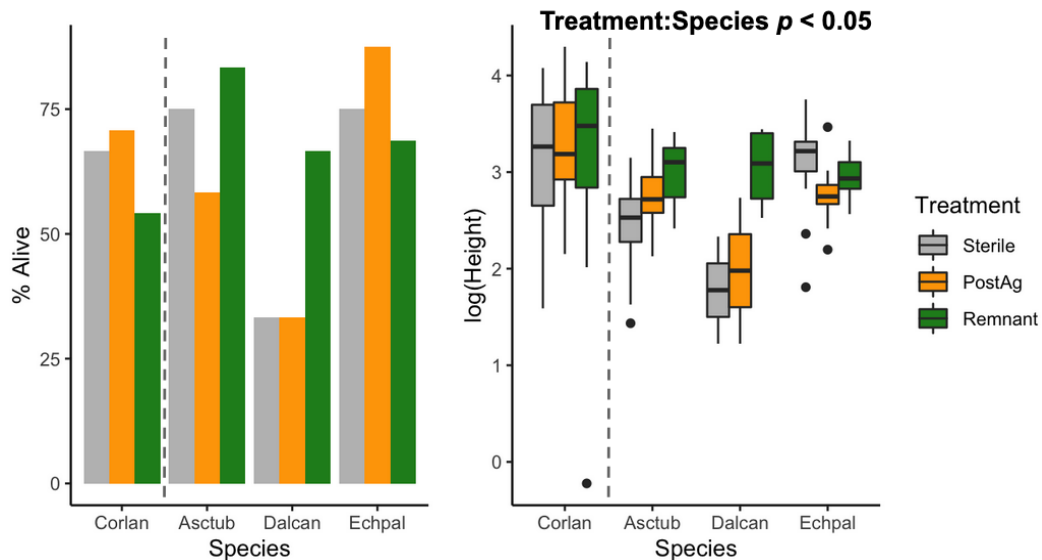


Figure 2. Plant survival and height in the MRCP hill site in 2023. The colors refer to the source of inocula where gray, orange, and green refer to uninoculated, post-agricultural, and remnant prairie soil, respectively.

Describe how the grant funds you have received from the Friends of Nachusa Grasslands have been used in regard to the above topic, purpose, and/or outcomes: The grant funds were used for research materials (e.g. flags, plant containers, etc.), travel to Nachusa Grasslands from the University of Kansas (e.g. mileage and per diem expenses), and undergraduate student salary for work at Nachusa Grasslands and in the greenhouse experiment at the University of Kansas.

Describe how your project has benefited the work and goals of Nachusa Grasslands: We have introduced native AM fungi from remnant prairies to two restorations along with over 200 seedlings of native prairie plants. With this, we have cultivated trap cultures of AM fungi that we are able to share with interested scientists at Nachusa Grasslands. Additionally, the data we collected documents the diversity of the restorations that may be useful for monitoring efforts. Importantly, we have also demonstrated how inoculating soils with native AM fungi can benefit the establishment of target plant species in restorations at Nachusa Grasslands.

Describe how your findings can be applied to challenges in management practices for restoration effectiveness and species of concern: Many restorations struggle to restore late successional prairie plant species such as many legumes (e.g. leadplant, white and purple prairie clover, etc.) and other species of interest (e.g. pale purple coneflower, stiff aster, etc.). This can lead to a less productive and overall less functional and resilient prairie restoration. Our findings both in the field and greenhouse study highlight the role native AM fungi can play in helping these late successional plants establish at higher rates and grow larger. These impacts have been explored in both a new and older restoration and can help guide stewardship decisions.

Please list presentations/posters you have given on your research:

2023 Bryant, R.L. & J.D. Bever. "Differential impact of local native and non-native sources of arbuscular mycorrhizal fungi on plant individuals and community at Nachusa Grasslands." Ecological Society of America. (Talk)

2023 Bryant, R.L. & J.D. Bever. "Making the right connections: Source matters when using arbuscular mycorrhizal fungi in prairie restoration." Nachusa Grasslands Science Symposium. (Talk)

2022 Bryant, R.L. & J.D. Bever. Nachusa Grasslands Science Symposium. (Poster)

Have you submitted manuscripts to scientific journals? If so, which ones? If not, do you anticipate doing so? (Please send digital copies of published articles to the Friends so that we can learn from your work.)

We haven't submitted any journal articles yet as we will collect and analyze data this summer to have three years of field data to work with. We believe this will be important to look at as competition in the new restoration is expected to increase in this year. With this work, we plan to submit to a journal like *Restoration Ecology*, *Ecological Applications*, or a similar publication by the end of 2024.

What follow-up research work related to this project do you anticipate (if any)?

We will return this growing season (expected July 2024) to repeat the data collection from previous years. Additionally, we will be sequencing the DNA of the different microbial communities of the AM fungal trap cultures used in the experiment.

Optional: Suggestions for improving the application and award process for future Friends of Nachusa Grasslands Scientific Research Grants: N/A. This process has

been very straightforward, and communication has been excellent both from the Friends and staff at Nachusa Grasslands.