UVU COLLEGE OF SCIENCE

Scholarly Activities Committee (SAC)

STUDENT PROPOSAL FOR FACULTY MENTORED RESEARCH

Students working with a faculty or staff mentor may submit this proposal to obtain funds for research supplies or travel to conduct research. The completed form will be submitted electronically as a Word document to the Department Chair or Department SAC representative of the faculty/staff mentor's department. Upon review and approval, the signed form should be emailed by the Chair or Department SAC representative to the COS Associated Dean SAC representative for final approval.

Criteria for submission:

The proposal and budget must be written and developed by the student(s), with guidance from the mentor. Students must be directly involved in the research in a significant way and demonstrate a thorough knowledge of the research project and budget. See last page for Guidelines and Limitations.*

1) **Title of project**: Exploring the relationship between arthropod and plant endophyte microbiota.

2) **Lead student information**:

   i) Name: Lauren Groathouse

   ii) Email: 10765555@uvu.edu

   iii) UVID: 10765555

   iv) # of UVU credit hours earned: 144.5

   v) Anticipated date of graduation: Spring 2023

   vi) Major: Biology

   vii) Phone #: (801)638-5037

3) **Faculty/staff mentor**:

Dr. Geoffrey Zahn

4) **Start/Stop dates of project (a project summary will be due by the stop date of the project.)**:

Start on 23rd Aug 2022, End on 16th Dec 2022

5) Name, UVID, and email address of other students to be involved in the project (if any). Also include # of UVU credit hours earned and anticipated date of graduation for each student:

Joshua Jumper 10832426, 102 credits, Graduate Spring 2023
Brooke Miller 10909910, 79 credits, Graduate Spring 2024

6) Have any students involved in this project received funding prior SAC funding for this or any other project? If so, list name(s) of students, titles of previously funded project(s), date(s) of funding, and amount(s) of funding received for each student.

No

7) If this is a continuation of a project that was previously funded by SAC, please describe what work related to the project has been completed and what are the results of that work. *(Please attach any papers, abstracts, etc.)*

No

8) List any other UVU or off-campus funding sources you have applied to for this project (e.g., OEL, Department funds, NSF, NIH, etc.):

None

9) List other sources of funding, including amount, already received for this project, if any *(Please note that priority is given to projects that seek funding from sources other than SAC).*

None

10) Do you require funding from both SAC and other source(s) in order for your proposed project to proceed? Yes or No

No

11) Is any part of this proposal redundant with the proposal submitted to any other funding source (e.g., are you seeking funds for the same supplies from both SAC and the other source)? Yes or No

No

(If yes, and if you are successful in obtaining funds from the other source, the SAC award may be reduced.)

12) Description of the proposed work/project (1-2 pages). Read evaluation criteria listed in the proposal writing guidelines at the end of this form for guidance.

Introduction

Farmers often use pesticides to kill insects that are harmful to crops. Pesticides are necessary to increase yield production by preventing insects from destroying their crops. However, this also has unintended adverse effects. By killing the insects, they also prevent them from transferring fungal endophytes to the plants. The endophytes are a vital part of the plant's microbiome and are essential for the plant's health (St Leger & Screen, 2001). For instance, endophytes are crucial for protecting plants from pathogens. By protecting the crops from insect attacks, they increase their likelihood of disease. Decreasing the diversity of the fungal microbiome can even promote insect attacks in some cases. The plant microbiome can include entomopathogenic fungi that help protect them from herbivory insects (Boucias et al., 2018)

Our project aims to study how arthropods help establish plant microbiomes, specifically endophytic fungi. This knowledge will help us understand how the insecticides used in

agriculture prevent the maximum crop yield they could obtain. By understanding the extent of the arthropodic contribution to a plant's biochemical composition, agronomists and farmers can promote crop health and increase yield by adding fungal endophytes at various points of the growth cycle.

Methods

This project will include growing cabbage to determine the microbiome that results from arthropod interactions. To resolve this, we will be using four different test groups. These groups will consist of two control groups and two different experimental groups. The experimental groups will be allowed to receive endophytes from various sources while being prevented from specific interactions that will help assemble their microbiomes. We will then compare the diversity of the resulting microbiomes to that of the control groups.
We will start by sterilizing the cabbage seeds of all groups using bleach. We will then plant the seeds in pots, each of which will have identical soil that we will sterilize in an autoclave. We will add a centimeter of sterile sand on top of the soil, which will keep spores from reaching the soil to keep it pure as the seeds grow. This process will be kept identical for each test group. After the cabbage grows for a while and obtains its microbiome, we will take samples from the leaves and culture the endophytes located in the leaves. We will sterilize the external surface of the leaves using bleach to ensure we only culture the endophytes found inside the cabbage.

Our environmental control group will also be grown in Grit Garden; however, they will be in a mesh net. This will allow the plants to receive endophytes from spores but prevent any arthropod interactions. We will use this to determine the environmental fungi so that we can determine which fungal species was the result of arthropod interactions in our experimental groups.

Our first experimental group, Group E1, will be grown openly in the UVU Grit Garden, allowing them to receive endophytes from spores and arthropods in the garden. Our intention is for this group to receive endophytes under normal agricultural conditions. We can then compare the endophytes of this group against our control to determine which fungal species were provided by the arthropods.

Our second experimental group, Group E2, will be grown in a sealed box and inside an incubation chamber within the lab so that it does not receive endophytes from spores. However, we will introduce arthropods to E2's container. We will use this group to determine the diversity of the endophyte microbiome when the plant receives endophytes from only arthropods.

To help ensure the arthropods are as similar to our control group as possible, we will collect the arthropods from the Grit Garden. We will use one species to minimize the possibility for error and to produce more finite data. The exact species will be determined later by observing the garden's environment. Additionally, identical arthropods will be placed on Petri dishes and allowed to walk around so we can determine their microbiome. This will enable us to determine the microbiome of the insects to compare to the cabbage.

We will also have a sterile control group. This group will be cabbage grown in a box inside the growth chamber. This group will not receive endophytes from spores or arthropods. This will allow us to determine the effectiveness of our sterilization process. Any fungal species found in this group and the other groups will not be included in our analysis.

We will water all groups using water we sterilized with an autoclave. The sterilized water will prevent fungal contamination.

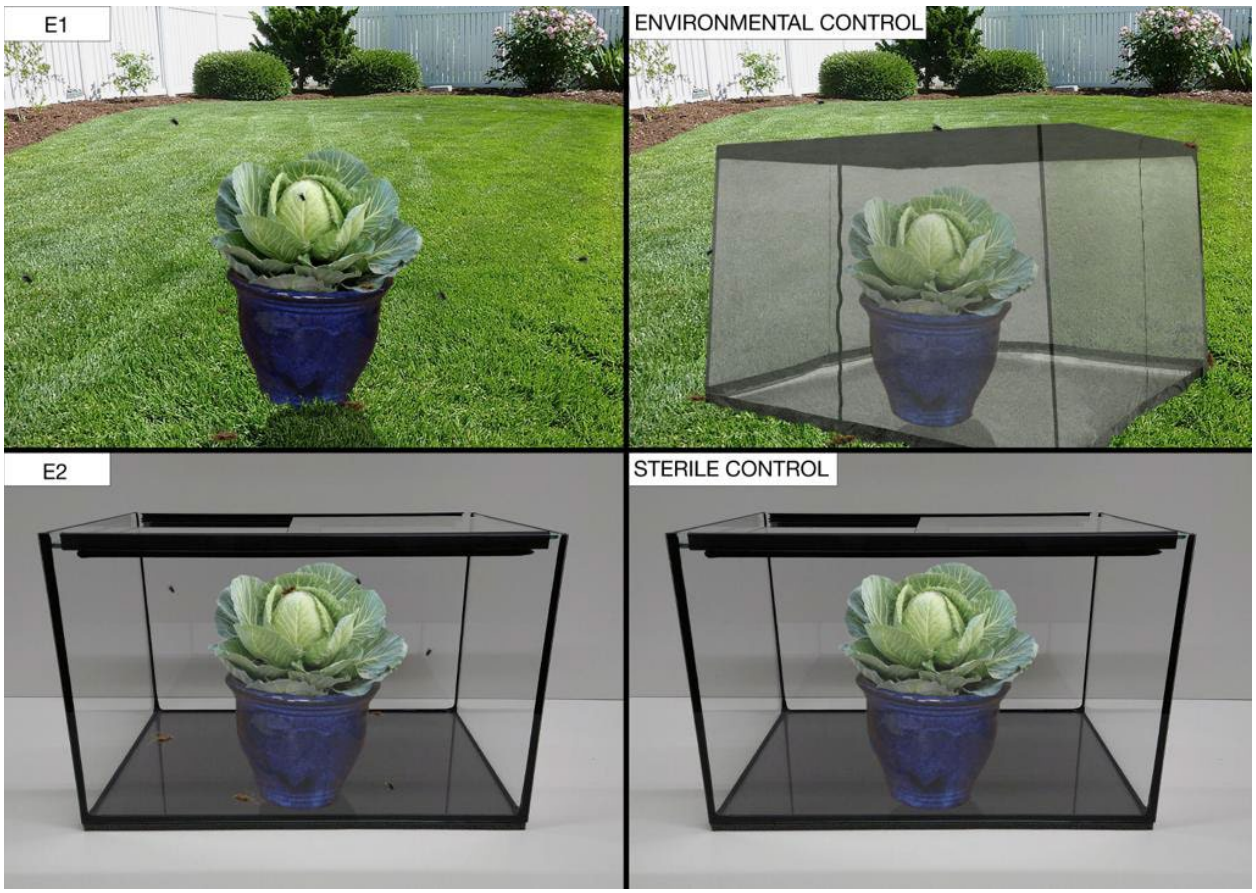
Once the plants are grown, we will collect samples using a hole punch from the cabbage leaves. The fungal microbiome from these samples will be cultured on separate Petri dishes. We will separate the individual fungal species into different Petri dishes so the endophytes can be isolated. We will view these species under a microscope to determine if we have successfully separated the species. We will then test each fungal species using DNA sequencing to compare the species found in each group.

Additionally, we will dry the cabbage from each group and determine the biomass. This process will allow us to determine how the endophytes' diversity affects the cabbage's growth.

We hypothesize that the arthropods will directly contribute to the majority of the diversity of the endophytic microbiomes of the cabbage. As a result, the experimental groups will have significantly more fungal microbiome diversity than the control groups. Specifically, our diversity order will be E1>E2>Environmental Control>Sterile Control.

We expect E1 to have the most diverse microbiome because it receives its microbiome from arthropods and spores. Group E2 will have the second most varied microbiome because arthropods will contribute to the development of the microbiome. The third most diverse microbiome will be the environmental control group because it only receives endophytes from spores, not arthropods. Finally, the least varied microbiome will be from Group E3 because neither spores nor arthropods will help develop its microbiome. We also expect each group's biomass to be in the same order.

After we finish collecting data, we will use a permanova analysis and display the results using an ordination plot with the help of the UVU statistics department. This will allow us to determine the statistical significance of our data.



13) Describe planned outcomes, including dissemination of this work. Outcomes might include presentations by students at professional meetings or department seminars, senior theses, papers for peer-reviewed journals, other types of papers, etc. Please provide approximate dates of planned outcomes. Note: Travel funds to conferences for dissemination are available through separate URSCA dissemination and SAC dissemination applications.

After completing our research, we plan to compile the data onto a presentation poster and present our findings in the Marc and Debbie Bingham Atrium in the Science Building of Utah Valley University. We plan to provide information that will allow viewers to better understand the importance of fungal microbiomes in agriculture and how arthropods play a vital role in their development. We hope our research will spark the viewers' interest to continue the investigation of this topic in the future.

Student's purpose: Throughout our time in college, we have all developed a love for research and the potential to find more efficient ways to solve problems. Although our majors and plans after graduation vary, each originated from a desire to help people. We hope that one day our research will be able to improve crop yield and reduce the use of ecotoxic insecticides and fertilizers, enabling farmers to lower their costs as well. Not only will this help farmers, but it may also help to decrease the price of food, thereby increasing its availability to those in need.

Additionally, this will provide a great experience in research that will enhance our ability to play an active role within the scientific community. We are working in partnership with the UVU statistics department to analyze our data, giving us a unique opportunity for interdepartmental collaboration.

Joshua Jumper: Medical school followed by physician residency
Lauren Groathouse: Grad school for PhD in Paleontology
Brooke Hart: Pharmacy school for PharmD

14) Budget:

a) Budget Table (If the project spans fiscal years, indicate the proposed expenditures in each fiscal year. Use a table for each fiscal year. See SAC Guidelines below for more information.)

Materials/Supplies (add additional rows as needed)[1]	**Cost**
*Bacto Agar (Will be shared with the other groups)	$285.22
*Nitrile Gloves (Large) (Will be shared with the other groups)	$48.54
*Nitrile Gloves (Medium)	$0.00

Seeds (Cabbage)	$5.00
*Microscope Slides (Will be shared with the other groups)	$55.99
Potting Mix	$40.00
Bug Collection Gear (Net and containers)	$127.48
*Cover Slips (Will be shared with the other groups)	$39.50
*Petri Dish (regular)	$0.00
*Petri Dish (Small)	$0.00
*Malt Extract	$0.00
*Ethanol (Denatured)	$0.00
*Micropipette Tips (1000µL)	$0.00
*Micropipette Tips (200µL)	$0.00
*Micropipette Tips (10µL)	$0.00
*Parafilm	$0.00
*Water (molecular grade)	$0.00
*Sequencing	$0.00
**Plant Pots	$0.00
**Sand	$0.00
**Mesh Net	$0.00

**Bleach	$0.00
Shipping costs:	$0.00
Material/Supplies /Shipping Total:	$601.73

Research-Related Travel Expenses	**Cost**
[2]Transportation	$0.00
[3]Lodging fees	$0.00
Other[4]	$0.00
Travel Total:	$0.00

Total requested budget (material/supply + research travel):	$601.73

*Budget note: Our research will be conducted alongside other groups. Supplies will be shared between the groups.

**Some supplies are owned by the lab and will be used or borrowed for the semester.

[1]Material/Supplies must be purchased by June 1 of the current fiscal year.

[2]Transportation: If you are requesting funds for transportation (airfare or UVU Fleet Operations), please provide destination, dates of travel, representative airfare estimates and number of people flying **or** UVU Fleet Operations Vehicle estimate cost . (https://www.uvu.edu/fleetops/). Students will not be reimbursed for private vehicle use.

NA

[3]Lodging fees: If you are requesting funds for lodging, please provide the dates, city/cities, names and cost per night for required rooms in for modestly-priced hotels in appropriate areas.

No lodging is needed for this project

[4]Other: If per diem is requested, there is a $30/day limit to align with the Office of Engaged Learning. Departments may supplement per diem. Work with department chair.

No per diem is needed for this project.

b) Budget Narrative: Briefly describe how the requested Materials/Supplies will be used in the research.

We will use bleach to sterilize the seeds before growth and to sterilize the external surface of the leaves before testing for endophytes. The plant pots and the potting soil will be used to grow the plants. The purpose of the sand is to cover the potting soil to keep it sterile while the plants grow and also to improve water availability to each plant's tray by capitalizing on sands wicking properties. We will use the bug collection gear to capture bugs so their fungal microbiome can be analyzed and they can be added to plant groups with bugs. The mesh net will be used to keep out arthropods for our control group that will be grown in the Grit Garden so that it can get endophytes from spores, but not arthropods. The Petri dishes, bacto agar, malt extract, and nitrile gloves will be used for culturing the endophyte samples. Parafilm will be used to seal the Petri dishes during incubation. The micropipette tips, molecular grade water, and sequencing will be used to extract the DNA and determine the species of fungi, while the microscope slides and coverslip are for viewing the samples visually. Throughout the testing process, the denatured ethanol will be used for sterilization to prevent contamination of the samples.

c) Travel Narrative: Briefly describe the travel needed to complete field work or travel to research sites. Travel is subject to UVU travel restrictions and policies.

Because each part of this project can be conducted at UVU, no travel is required.

Students must be transported in UVU Fleet vehicles or vehicles approved through a UVU vendor). If the project spans fiscal years (July 1 – June 30), travel dates must be specified by fiscal year.

Travel proposals for student dissemination are submitted separately (see SAC Guidelines).

Signature Page

Typed signatures are acceptable

1) Title of project: Exploring the relationship between arthropod and plant endophyte microbiota.

2) Lead Student Name and UVID: 10765555

3) Faculty/Staff Mentor: Dr. Geoffrey Zhan

4) Start/stop dates of project: August 22 ,2022 to December 13, 2022

5) Names and UVIDs of other students involved in the project (if any):

Joshua Jumper, 10832426

Brooke Miller, 10909910

By signing this form, we agree that:

1. This proposal was written by the student(s), with guidance from the faculty mentor.
2. A summary of the results of the project will be submitted to the faculty mentor and then COS Associate Dean SAC representative by the date indicated in the award notification. Failure to provide a summary may result in suspension of further funding for the student(s) and faculty mentor.
3. If awarded, all stipulations in the award notification will be followed.
4. The SAC Guidelines** applicable for student participation in a faculty mentored research have been read and understood.

Lauren Groathouse 09/07/2022

_____ _____

Lead Student Applicant Date

Geoffrey Zahn 09/15/2022

_____ _____

Faculty Mentor Date

Chair or Department SAC representative:

Please meet with the student(s) on the proposal to review and discuss the application thoroughly. Ensure they understand the project and that the request makes appropriate use of existing department/college resources and funds.

I have met with the students. I have reviewed and support the proposal. The proposed research makes appropriate use of existing department and/or college resources and is appropriate in scope.

Michael C. Rotter _____9.15.2022

Department Chair/Dept. SAC Representative Date

This signed form should be forwarded via email from the Department Chair or Department SAC Representative to the Associate Dean SAC Representative.

***Proposal Writing Guidelines and Limitations:**

Each proposal submitted will be evaluated according to the following criteria. Keep in mind that the proposal should be understandable by people who are scientifically literate, though not necessarily experts in your field.

Evaluation criteria

1) Is the proposed research of sufficient quality and significance?
2) How will the proposed work benefit the student(s)/faculty/UVU?
3) Is the proposal written by the student, demonstrating a clear understanding of the purpose and scope of the project? (Note: The proposal should not be written at the level of a faculty member who is an expert in the field.)
4) Has the proposal taken in account existing department resources that may be used for the project?
5) How complete is the budget narrative?

SAC **may** provide funds for:

· Supplies, small equipment, and travel to research sites

SAC **will not** provide funds for:

· Major equipment, student wages, faculty per diem

****The following is an excerpt from the SAC Guidelines, Part 1.b.:**

Students who desire to participate in faculty-mentored research projects may apply at any time for an award to purchase supplies, small equipment, and travel to conduct research.

i. Individual students are limited to an award total of $3,000 toward research projects in their UVU career ($1,500 max per request).***

ii. Teams of students may submit one proposal, but the award will be limited to $1,500 per student with a maximum award of $5,000 per proposal. An equally divided award amount will be credited toward each student's career maximum.

iii. Student(s) must write the proposal and develop the budget, with guidance from their mentor. Student(s) must be directly involved in the research in a significant way and demonstrate a thorough knowledge of the research project and budget. Mentors should not be the primary authors of student submitted proposals.

iv. Student proposals may be submitted via email at any time to the Department Chair and/or Department SAC representative (check with Department for submission guidelines).

v. Proposals that span fiscal years need to specify what portion of the proposal will be used by June 1 of the current fiscal year and what portion will be used after July 1 of the next fiscal year. (Purchases must be made by June 1 to allow for shipping/receiving. Research related travel can be completed in June, but all documentation and submission of travel expenses

must be completed before June 30.) The award may be split between the fiscal years.

vi. Department Chair and/or Department SAC representative will meet with the students(s) and faculty mentor to and review the proposal to:

1. Ensure the request is completed by student(s) and they understand the nature and scope of the project (Department may choose to meet only with lead student and faculty mentor.)

2. Ensure the request is for necessary supplies that makes appropriate use of SAC funds and existing department resources.

3. Meets department guidelines for faculty-mentored research

vii. The Department Chair and/or Department SAC representative will review, sign, and forward the proposal via email to the Associate Dean SAC representative

Bibliography

Boucias, Drion G., et al. "Microbiota in Insect Fungal Pathology." Applied Microbiology and Biotechnology, vol. 102, no. 14, 2018, pp. 5873–88, https://doi.org/10.1007/s00253-018-9089-z.

St Leger, R., and S. Screen. "Prospects for Strain Improvement of Fungal Pathogens of Insects and Weeds." Fungi as Biocontrol Agents: Progress, Problems and Potential, edited by T. M. Butt et al., 1st ed., CABI Publishing, 2001, pp. 219–37, https://doi.org/10.1079/9780851993560.0219.