

SEMESTER/EXPLORATORY GRANT APPLICATION
Cover Sheet

Amount Requested: \$ 685.00

Project Information

<u>Eiting, Jake</u>	
Student Participant (Last, First)	
<u>Solanum lycopersicum L. Response to Herbivory Under Three Different Mycorrhizal Associations</u>	
Project Title (10 words or less)	
<u>Hilbig, Bridget</u>	
Faculty Mentor Name (last, first)	Mail Code
<u>College of Science</u>	<u>Botany</u>
College (Weber State is the University, NOT college)	Department
This project <input type="checkbox"/> DOES/ <input checked="" type="checkbox"/> DOES NOT require review by the WSU Institutional Review Board for Human Subjects or the WSU Animal Care and Use Committee.	

Jake Eiting
Student Signature

Date 24 oct 2018

Bridget Hilbig 10/25/18
Project Mentor Signature

Date Received by Mentor.
Must be 10 business days
before final deadline.

2504
Campus Mail

6176
Phone Ext.

Tracy Covey
Undergraduate Research Committee Representative

11-1-18
Date Received by URC Rep.
Must be 5 business days
before final deadline.

[Signature]
Faculty Mentor Department Chair

Date 11/1/2018

Please check if attended Research Proposal Workshop:



Date Workshop attended Oct. 24th 2018
(Please fill in the date of attendance)

Also attended in spring 2018.

SEMESTER/EXPLORATORY GRANT APPLICATION Budget Worksheet

BUDGET ITEM	Department or College Funds	Outside Agency Funds	Personal Funds	Undergrad. Research Funds	GRAND TOTAL
Materials <u>Botany Department</u> Miracle-gro potting mix (25 quarts) x4 Calcofluor White AmScope Microscope Slides (x144) with cover slips (x200) <u>OUR</u> MF-Millipore Membranes (.45µm pore size) Commercial Inoculant (Premier- Tech AGTIV) Caterpillars (<i>Helicoverpa</i> <i>armigera</i>)	\$36.94 \$56.00 \$10.98	Donation		\$225.00 \$460.00	
Equipment Growth Chamber Confocal Microscope	Already owned by college of science				
Mileage to gather Data (.38 per mile)					
GRAND TOTAL	\$103.92			\$685.00	\$788.92

SEMESTER/EXPLORATORY GRANT APPLICATION

Body of Proposal

Solanum lycopersicum L. Response to Herbivory Under Three Different Mycorrhizal Associations

Project Description

Plants are continuously interacting with their environment both above and below ground. Interactions between plants and other organisms can both benefit and harm plants (Bennett and Bever 2007). Interactions with herbivores harm plants and can decrease total photosynthetic area, alter resource allocation patterns, and could ultimately result in the death of the plant (Bennett and Bever 2007). Plant interactions with below ground fungal networks, specifically with AMF (arbuscular mycorrhizal fungi), can, conversely, promote plant growth and help plants to deal with abiotic and biotic stressors (Jung et al. 2012). This project aims to learn if fungal association with mycorrhizal fungi can improve plant defenses against leaf chewing herbivores. To do this I will examine the response of Tomato plants (*Solanum lycopersicum L.*) to herbivory while under three different fungal associations. Tomato has been shown to form mycorrhizal associations and is therefore a suitable species for this experiment (Hart et al. 2015).

This project will satisfy my honors thesis requirement through the botany department and it will also contribute to the ongoing research of my thesis mentor, Dr. Hilbig. Dr. Hilbig will be assisting me in isolating fungal spores from local soil samples, determining the percentage of root colonization using confocal microscopy techniques, and with any other methods in which I may require assistance (see Methods).

I have learned laboratory techniques, gained hours of practical experience, and am prepared to undertake this thesis project having taken the following courses:

- Soils

- Plant Form and Function
- Principle of Chemistry I & II
- Cytogenetics
- Ethnobotany
- Anatomy of Vascular Plants
- Plant Soil Feedback
- Taxonomy of Vascular Plants
- Plant Ecology
- Intermountain Flora

At the completion of this thesis project I will publish my results in ERGO in place of presenting at the Weber State undergraduate research symposium. This experiment will be conducted during the spring 2019 semester and will therefore not be completed in time to present at the 2019 OUR symposium. However, I will be attending an undergraduate research symposium/conference and presenting the results of my thesis project as required by the Botany department honors thesis contract. This conference will either be the 2019 National Conference on Undergraduate Research (NCUR) or the 2019 Botanical Society of America conference.

Methods

Tomato plants will be grown in sterile soil (control), soil inoculated with a commercial fungal inoculant (premier tech AGTIV), and soil inoculated with local mycorrhizal species that will be obtained from the foot hills to the east of Weber State University campus. After the local soil samples are collected they will be passed through .45 μm gridded filter membranes to isolate fungal spores. The spores will then be counted and introduced to sterile soil in an amount proportional to that of the commercial inoculant. This will ensure equal colonization pressures on the tomato plants. It is important

to note that all soils will be heated in a soil oven prior to inoculation and planting in order to achieve complete sterilization and avoid mycorrhizae contamination.

Once the plants are established and healthy, a caterpillar (*Helicoverpa armigera*) will then be introduced to half of the plants from each soil type (see timeline). After one week of exposure to the herbivore a random subset of each plant group will be selected. Plants from these subsets will be measured for water content and relative mycorrhizal dependency using the methods described in Baslam et al 2011, root and shoot dry weights using the methods described in Latef 2011, the amount of physical damage to leaves, and lastly, percent root colonization using calcofluor white stain and confocal microscopy techniques if time permits.

Timeline

This project will be conducted during the spring 2019 semester while I am enrolled in Thesis Research (BTNY 4850). See the table below for a weekly breakdown of the timeline.

Week	1-3	4-9	10	11-15
Objective/Activity	<ul style="list-style-type: none"> • Soil collection • Soil conditioning • Tomato seed germination 	<ul style="list-style-type: none"> • Tomato plants will grow in the growth chamber • Caterpillar larva begin to grow 	<ul style="list-style-type: none"> • Caterpillar introduced to healthy tomato plants 	<ul style="list-style-type: none"> • Data collection • Microscope analysis

Budget Explanation

The items listed under department/college funds will either be provided by the Botany department or are already owned by the department/college. The items listed under undergraduate research funds are items that the department does not have readily and/or cannot provide funds in order to procure them. The membrane filters and the commercial inoculant listed under the undergraduate research funds are materials that are vital to the success of this thesis project. The prices of both the commercial inoculant and the membrane filters were known by Dr. Hilbig as she has used them during past research projects. Under the advice of Dr. Schramm, I will spend the time between now and the beginning of the spring semester to contact a research lab that is willing to donate caterpillar larva for this project.

Works Cited

- Marouane Baslam, Idoia Garmendia, and Nieves Goicoechea. Arbuscular Mycorrhizal Fungi (AMF) Improved Growth and Nutritional Quality of Greenhouse-Grown Lettuce. *Journal of Agricultural and Food Chemistry*, 2011, 59, (10), pp 5504-5515.
- Bennett, A. E. and Bever, J. D. Mycorrhizal Species Differentially Alter Plant Growth and Response to Herbivory. *Ecology*, 2007, 88: 210-218.
- Hart, M., Ehret, D.L., Krumbein, A. et al. Inoculation with arbuscular mycorrhizal fungi improves the nutritional value of tomatoes. *Mycorrhiza*, (2015) 25: 359.
- Jung, S.C., Martinez-Medina, A., Lopez-Raez, J.A. et al. *Journal of Chemical Ecology*, (2012) 38: 651.
- Abdel Latef, A.A.H. Influence of arbuscular mycorrhizal fungi and copper on growth, accumulation of osmolyte, mineral nutrition and antioxidant enzyme activity of pepper (*Capsicum annuum L.*). *Mycorrhiza*, 2011 21: 495.

SEMESTER/EXPLORATORY GRANT APPLICATION

Additional Questions

1. What funding have you received from OUR in the past, Where has your previous project been disseminated.

I have not received prior funding from OUR.

2. Is this project part of a required course? If so, please indicate the support (monetary and in-kind) provided for this project by the academic department.

This project will fulfill the requirements for a botany department honors thesis. During the course of this project I will take three botany courses, Thesis Readings (BTNY 4840), Thesis Research (BTNY 4850), and Botany Thesis (BTNY 4970). None of these three courses have a formal lecture/meeting time. Neither departmental honors nor a three semester thesis option are required for completion of a botany degree.

3. What additional sources of funding have been solicited? Is your department willing/able to fund any equipment they will be retaining?

The botany department is providing funding/materials for some of the required materials (see budget).

4. Where do you plan to disseminate the results of this project

As this project will be completed after the annual symposium I will instead submit my results to ERGO and well as NCUR (National Conference of Undergraduate Research) and/or BSA (Botanical Society of America).

5. If you are requesting a stipend, please list all significant time commitments (5+ hours per week) that you expect to maintain over the duration of your project including, for example, class and work schedules.

I am not requesting a stipend at this time.

SEMESTER/EXPLORATORY GRANT APPLICATION Faculty Recommendation Form

Student Name (last, first): Jake Eiting

Project Title: *Solanum lycopersicum L. Response to Herbivory Under Three Different Mycorrhizal Associations*

Mentor Directions: After carefully reviewing the proposal and assessing both the viability of this project and the qualifications of the student requesting funding, answer the questions found below. Please expand the sections as necessary (**do not attach separate letter**). If the project involves the use of human subjects or protected animals, be sure the student secures IRB or ACUC approval. If the project receives funding, it is your responsibility to work closely with the student, monitor the ongoing progress of the project and budget, and evaluate the project's results. Failure to do so will jeopardize funding for this project and any future projects.

1. How long and in what capacity have you known this student?

I have known Jake since Fall of 2017. Jake is currently enrolled in Thesis Readings and Anatomy of Vascular Plants with me. Prior to this semester, he took Plant-Soil Feedback and Food and Water for A Hungry World from me.

2. Briefly describe the proposed project. Is this part of a larger research project? Is this part of a course? If so, how is the project apart from the nature and scope of activities normally taken for the course (Please attach a copy of your course syllabus)?

Jake is examining the interaction between plants, arbuscular mycorrhizal fungi, and herbivores as part of his honor thesis. More specifically, he will examine if mycorrhizal tomatoes have increased growth and less herbivore damage relative to non-mycorrhizal tomatoes under herbivory from caterpillars. Jake will look at all of the plant growth response variables and fungal infection of plant roots, but there is the potential to collaborate with another student on the chemistry of the defense compounds produced by tomatoes. A second student could analyze the plant tissue from Jake's project for concentrations of secondary defense compounds in mycorrhizal versus non-mycorrhizal individuals. That would be well beyond the scope of an honors thesis for a single student, and, so Dr. Schramm and I are looking to see if another student would like to take on the chemical analyses. Together these projects have the potential to make for a very strong paper.

3. Give an assessment of the project's significance to the student's discipline and of the project's educational and/or professional benefit to the student.

Jake is a Botany major in Track B. From this and his selected coursework, it's clear that he has focused his education in the field botany and ecology discipline. Additionally, he has taken my sustainable agriculture course (Food and Water for A Hungry World) and has done some work with James Loomis at Green Team Farms in Salt Lake City. This project is examining ecological interactions in an agricultural setting, and as such combines some of his interests in the field. Jake has had the chance to be involved in research experiences already here at WSU, but the chance to do thesis research, write the results up for publication, and present that research will open many doors for him. It's an experience that could allow him to go straight into a Ph.D. program if he wants, or one that would make him more competitive for permanent positions with the USDA, BLM, NPS, etc. Additionally, Jake would like to be a part of an REU program this summer. This research experience will make him more competitive for the limited spaces available in REU programs. Some programs where this research will help his application include: 1) REU Site: Botany and Conservation Biology Research at the Missouri Botanical Garden or 2) REU Site: Assessment and Sustainable Management of Ecosystem Services at the Nexus of Food, Energy, and Water.

4. Comment on the qualifications of the student to successfully complete this project, both in terms of the project's scope and its time frame.

The experimental design that Jake has come up with is a good size project for a thesis project. Once the soils are conditioned appropriately, the plants and herbivores can be maintained in our new growth chambers. The above ground plant biomass variables will be easy and quick to collect. The variable that will take the most time is the percent of

arbuscular mycorrhizal fungi in plant roots, but he has established a good protocol for sub sampling. Additionally, Jake has a good timeline of methodologies and analyses outlined. He has thought about potential pitfalls of the experiment and has plans in place to prevent this (e.g. additional plants than the determined sample size in case there are mortalities related to transplanting or environmental conditions not under investigation).

Jake has complete Plant Form and Function, Soils, Plant Soil Feedback, Food and Water for A Hungry World, and is currently enrolled in Anatomy of Vascular Plants and Plant Ecology. Together, with other Botany courses, Jake has the necessary training to complete this research project. In Anatomy of Vascular Plants he has learned how to prepare samples for microscopic analysis and to use the Olympus Confocal Fluorescent Microscope. In Plant Soil Feedback he completed reviews of primary literature and led discussions on the topic of Plant soil interactions. In Plant Ecology, he is learning about plant ecological interactions and completing an in-class research project. Similarly, he completed an in-class research project while enrolled in Soils. Lastly, he is currently enrolled in Thesis Readings with me and has been reading some of the more recent literature in the field to help refine his hypothesis and methodology. To this end, Jake is very prepared to successfully complete the proposed research.

5. Comment on the justification and appropriateness of the project budget, including the necessity of a stipend (if requesting one).

Jake has asked for some funds to purchase commercial arbuscular mycorrhizal fungi, specific small pored filter paper for the extraction of arbuscular mycorrhizal fungi from soils, herbivores, and consumables such as slides. The department, and my lab specifically, has the equipment necessary to complete the project. Furthermore, the Department is willing to contribute funds for other consumables, attendance at a conference, and/or publication fees.

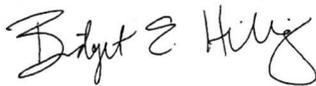
6. Describe your role in the project.

As a Thesis mentor to Jake, I have been working with him on developing the hypothesis and the experimental design. In the spring semester, I will be available to help Jake with any aspects of the experiment that he needs help with. I will be as hands-on or hands-off as he wishes or needs. There are some protocols that he has not had exposure to yet in which I may be more helpful with. For example, I will need to help Jake with the procedures for extracting fungal spores from soils, staining plant roots for arbuscular mycorrhizal colonization, and may be more hands on is in helping to analyze and interpret the data, and how to best sell his story to reviewers of his conference abstract and paper.

7. Include anything else that you think will be helpful to the committee in evaluating this application.

It is my pleasure to recommend Jake for funding for this semester research grant. Jake is incredibly hard working, driven, and bright. He is an honors student maintaining a very high GPA, working as a tutor, and is an active and engaged member of the Botany Club. He exemplifies a student that has that has the potential to become a leader in botany. As his thesis mentor, I want him to have every opportunity here at WSU to set him for success in graduate school and his career. I think he is very deserving of an opportunity like this, and that this research opportunity will help him be successful in finding a place in an REU program this summer.

This project ___ DOES _X_ DOES NOT require review by the WSU Institutional Review Board for Human Subjects or the WSU Animal Care and Use Committee.



Project Mentor Signature

Date 10/29/18

2504
Campus Mail Code

6176
Phone Extension