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:

Efficacy and Specificity of Commercial Mycorrhizal Powders on Fruit-Bearing Annual Garden Plants

2) Lead Student Information:

(1)Name: **Thiago Vecchi**

(2)Email: **tvecchi94@gmail.com**

(3)UVID: **10649934**

(4)# of UVU credit hours received: **99**

(5)Anticipated date of graduation: **08/12/22**

(6)Major: **Biology**

(7)Phone #: **(801)404-8107**

3) Faculty/Staff Mentor:

a) Dr. Geoffrey Zahn

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

i)Start: 1/25/2022 **ii)End: 05/05/2022**

5) Name, UVID, and email address of other students to be involved in the project (if any):

-Hunter Houtz (10777988) - hunter.houtz11@icloud.com
-Alex Little (10772843) - alexlittle11695@gmail.com
-Sterling Brinkerhoff (10842362) - sterling.brinkerhoff@gmail.com

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.

-None of the students involved have received prior SAC funding.

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.)*

-N/A

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.):

-N/A

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).*

-N/A

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

-No

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:

Today's market is flooded with commercial mycorrhizal powders that advertise miraculous growth of plants when mixed into their soil. Put simply, mycorrhizal powders are colonies of fungi that

form a symbiotic relationship with the plant roots. New data supports the idea that these mycorrhizal powders work, but when accounting for different types of plants, effectiveness varies.

Many researchers have provided statistical data that show potential benefits of plants that have been subjected to commercial mycorrhizal growth powder. An example of this is the effectiveness of mycorrhizal fungi on the yield of growing soybeans (Johnson et al., 1992). N.S. Bolan discovered that mycorrhizal fungal powders have massive positive effects on plant growth especially in the uptake of natural nutrients that are present in soil such as phosphorus (Bolan, 1991). Although there is research that indicates the benefit of commercial mycorrhizal powders, there is still data that shows the potential limitations to their use. Researcher Hamel shares potential limitations and a lack of a full spectrum of knowledge in the symbiosis of mycorrhizal powders. This indicates that there is a need for more research to establish a more full knowledge of their potential influence on plant growth (Hamel, 1996).

Our research intends to demonstrate the effectiveness of using commercial mycorrhizal inoculum on sweet corn (Zea mays var. Earlivee or Zea mays var. Silver N Gold) and tomatoes (Solanum lycopersicum var. 4th of July). We will grow several of these plants with different brands of inoculum, as well as plants containing no additives to record how their growth is affected. ***Benefits:***

Impact on UVU→

The students at UVU reflect UVU as an institution. As we better ourselves through our research and the experience that research brings, the better the school looks. We are the fruits of the school and productive research reflects well on the school.

Impact on Students→

This research has a large sway on the future of our educational careers. Medical and Dental school's both weigh research experience heavily in their application processes. Having funded research will exponentially help our applications compared to unfunded research. Sterling has been growing plants on his family's farm his whole life and this project has a direct impact on the effectiveness of his farming and production for local farmers markets.

-Thiago Vecchi: Medical School
-Alex Little: Dental School
-Hunter Houtz: Dental School
-Sterling Brinkerhoff: Bioengineering PhD (Focus in Plant Science)

Impact on Faculty→

Relevant research reflects positively on the faculty in the Biology, Botany, Chemistry, and Zoology departments. Our research will hopefully show the effectiveness and quality of education that we are receiving as students from the faculty at UVU.

Impact on Program→

Having students in the Biology department that have had positive experiences in research will lead to the recruitment of future Biology undergraduate students. Research is the most exciting part of school, and we hope to share and influence incoming students to experience what we experience.

Impact on Community→

There are hundreds of thousands of farms in America, and even more individuals that garden as a hobby. Understanding the effectiveness and specificity of different mycorrhizal powders could

have a direct impact on large farms and recreational gardeners. Anything that could potentially increase plant growth and yield should be looked into to help growers feed the world in an era of decreasing farmland. Some growers feel that use of these powders and more sustainable growing practices could potentially help reduce worldwide hunger.

Methods:

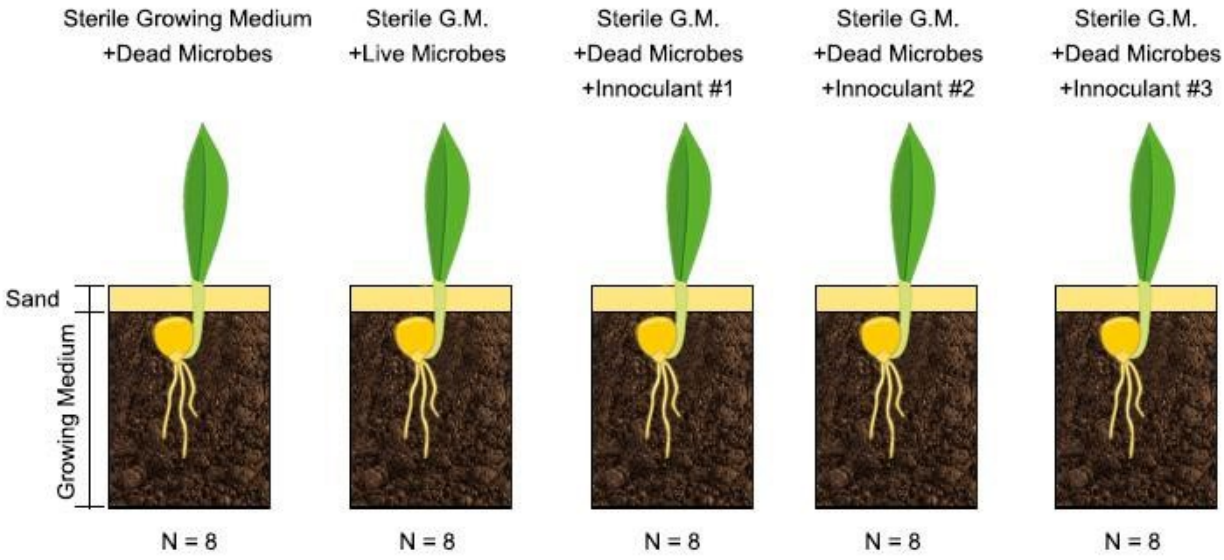
To begin, we will first obtain permission from Boston Swan (the current greenhouse manager at UVU) for materials and an area to execute the experiment. As soon as we gain approval we will order three commercial mycorrhizal inoculants from three different companies. All products to be used were selected on two major criteria. First, they are made with just arbuscular mycorrhizae and an inert carrier. Comparable products have other beneficial microbes and additional fertilizers added. To prevent these potential confounding variables these products were omitted. Another reason these were selected is because they are all from different parent companies. Many of the inoculants on the market were manufactured by a parent company and distributed to subsidiaries to be altered slightly and packaged with a different label. By testing from a wider pool of products we can reduce the risk of having all three of our products made from the same blend of mycorrhizae that was developed by the same company.

Next, our growing medium composition will loosely follow a procedure presented in the Journal of Environmental Horticulture (Corkidi, et al., 2004). It will consist of standard nursery mix (Sungro Sunshine Mix #1 or Lambert LM-3 All Purpose Mix) and sand at a 4:1 ratio by volume. This blend will be amended with Osmocote Controlled Release Fertilizer 18-6-12 at a rate of 16.799 g per cubic foot of soil (1 lb/cu yd) after the soil media is autoclaved. By applying the fertilizer after we will reduce the risk of volatilizing the fertilizer, avoid a potential explosion, and the loss of a known variable.

The seeds for the experiment will be representative of two of the major plant families that mycorrhizae companies claim that their products will improve the quality of: poaceae and solanaceae. The first family focuses on a monocrop crop that holds major commercial value, while the second one is a dicot crop that would be more predominantly grown by home gardeners. The purpose for using two types of fruiting annual plants will be determining the specificity of the different mycorrhizal powders. The variety in plant seeds will lead to data on which mycorrhizal powders are most effective with which plant species.

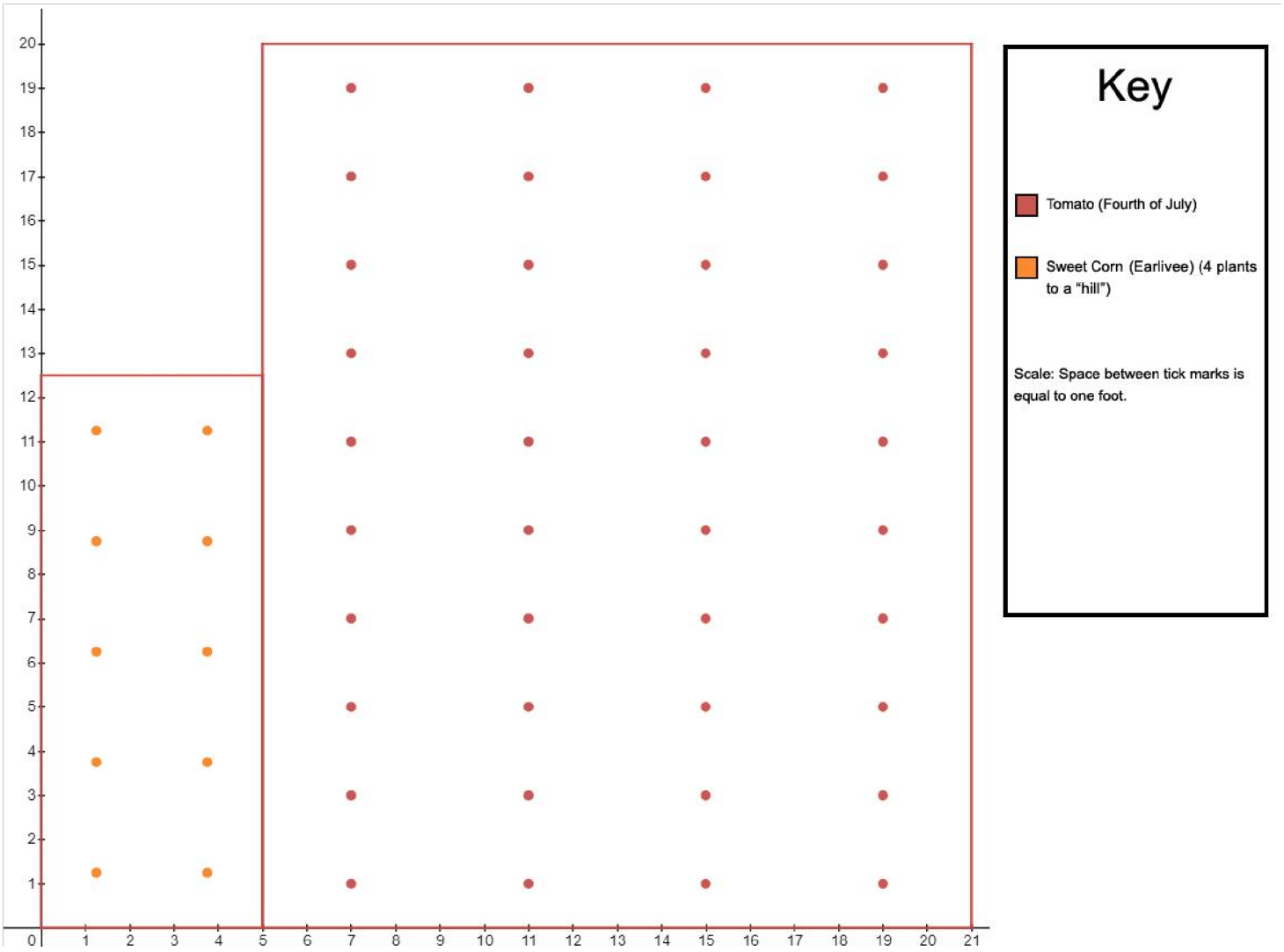
Before planting the seeds, all of them will be sterilized using the methods described below. The tomato seeds will be surface sterilized with a bleach solution (30% commercial bleach + 0.02% Triton X-100) for 15 min, and washed 3 times with sterile water under a laminar flow hood (University of Michigan). Corn seeds are sterilized using the same process using the solution at half strength (15% commercial bleach + 0.01% Triton X-100). It should be noted that the epichloë fungus naturally found in all monocots will not be removed as it is essential for the plant's success. To sterilize the pots, they are washed in a dish detergent and water solution. Then the pots are soaked in a solution containing one part commercial bleach to 9 parts water for a minimum of 10 minutes. Then rinsed using sterile water. After this, they are dried in a laminar flow hood. (Rindels, 1994) Three groups of each species of the sterilized seeds will then be inoculated using the mycorrhizal powders according to the package directions. There will be two remaining groups that will be used as controls. The first will be grown in only the sterile growing medium. The second is the same but has live microbes added. These were collected from a corn field that has held the same crop for over 15 years. To separate the microbes from the rest of the soil a process of progressively smaller

filters will exclude anything larger than a microbe. After the microbes have been separated, the water used to wash them from the soil will be combined and autoclaved. Once cooled to room temperature the liquid will be distributed evenly among the treatments, and live microbes will be added back to the treatment so that it simulates a wild colony of microbes. Below is a picture depicting what the experiment for the corn would look like.



Seeds will be planted two to a pot in the following way. All will be labeled according to treatment and species. Corn will be sown in 40 one gallon deep pots 1.75 inches deep in the medium and covered with a quarter inch of sterile sand. Tomatoes will be placed directly on top of the growing medium in 40 five gallon pots and covered with a quarter inch of sterile sand. Once the seeds emerge from the soil the weaker of the two plants is culled if two emerge. Watering with sterile water will occur when the potting medium is dry according to a soil hygrometer sensor. The probe will be sanitized when transferred between treatments.

The pots containing the seeds will be randomly arranged on the table with no regard to treatment. As the experiment progresses they will be rotated around the growing area bi-weekly. As the plants mature the pots will be spread out if possible. If this is not possible they will be analyzed as they outgrow their space. As the plants mature, the tomatoes will be supported via the Florida weave trellising method, and the corn will remain unsupported due to the lack of harsh winds in the greenhouse. The picture below shows what the ideal spacing of these plants is.



Any fruit that is produced will be harvested as it is ripe and will be included on the wet fruit and gross wet biomass for the plant. Fruits will then be dried and added to the dry ripe fruit and gross dry biomass after their wet weight is taken. Additional information such as brix reading and fruit number will be collected if any fruit is produced. Any unripe fruit on the plant at the time the plant is analyzed will be weighed separately from the ripe fruit and included on the wet unripe fruit and gross wet biomass. Fruits will then be dried and added to the dry unripe fruit and gross dry biomass after their wet weight is taken.

As the plants are harvested the plants are carefully removed from the pots and washed to remove any soil from the roots. After this, a picture of the plant is taken against a measuring stick the roots are cut from the shoots and weighed. The plants are then dried in an oven and another weight is taken. Calculations will be made to determine water content of the plant matter. Data will be analyzed using ANOVA to determine significance. The N value for the experiment is 80 plants.

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.

Outcome:

This research has the possibility to produce an immense amount of meaningful outcomes that are applicable to multiple fields of research and industrial practices, here we will focus solely on the outcomes that are most motivating to our research team. Our research with these fungi will empower farmers, gardeners, and home planters worldwide. Growers around the world will have increased clarity when purchasing from vendors who may be over-advertising their products. We will shed light on the true potential of mycorrhizal powders for a group that has not been properly informed, the consumers.

We will be able to present our research to peers, professors, and researchers at UVU. We will also have the opportunity to promote our work at UCUR and NCUR conferences. These outcomes will propel our education and research experience to a new level. This will initiate a tremendous effect on our efforts to become PhDs, DMDs, and MDs. Funding for our research is a crucial step on our journeys.

14) Budget:

Budget Table:

Materials/Supplies	Cost
Sand (11x 0.5 cu ft bags)	$55.00
Sungro Sunshine #3 Potting Soil / Lambert LM-3 All Purpose Mix (6x 3.8 cu ft. bales)	$240.00
5 Gallon Pots (4x 10 packs)	$99.60
1 Gallon Deep Pots (40x single pots)	$62.78
Support Posts (40)	$0.00
Commercial Bleach (1 Gallon)	$12.00
Triton X-100 (100 g)	TBD
MycoApply Mycorrhizal Inoculant (1 lb)	$29.00
Xtreme Gardening Mykos (2.2 lbs)	$29.00
BioOrganic Micronized Endomycorrhizal Inoculant (0.5 lbs)	$20.00
Southern Ag Long Lasting Controlled Release Fertilizer 18-6-12 (5 lbs)	$30.00
Fourth of July Tomato Seeds (50 Seeds)	$6.00

Earlivee / Silver N Gold Sweet Corn Seeds (150 Seeds)	$9.00
Pyrex Glass Media Bottle (5 L)	$156.00
Soil Hygrometer Sensor	$13.00
5 Micrometers Filters	$127.50
2 Micrometer Filters	$0
Shipping costs:	$0
Material/Supplies/Shipping Total:	$888.88
Research-Related Travel Expenses	**Cost**
Transportation	$0
Lodging fees	$0
Other	$0
Travel Total:	$0
Total requested budget (material/supply + research travel):	$888.88

Budget Justification:

***Sand→** *The sand will consist of 20% of the growth medium, and will provide needed weight to the pots to help prevent them from becoming top heavy and tipping over.*

***Sungro Sunshine #3 Potting Soil / Lambert LM-3 All Purpose Mix→** *The potting soil will consist of the other 80% of the growth medium. These brands were selected because they provide an adequate environment for the seedlings to live in without needing to be transplanted.*

Pots →The pots needed for this experiment will be bought through online sources and after the conclusion of the experiment be donated to UVU's greenhouse. These pots will hold soil for the plants that are being trialed.*

Support Posts →The posts that are needed for this experiment will be borrowed from UVU's greenhouse. These posts will support the tomatoes as they mature.*

***Southern Ag Long Lasting Controlled Release Fertilizer→** *It is claimed that Mycorrhizal fungi aid in the absorption of nutrients from the soil to the plants. The fertilizer will serve as the nutrients in the soil. A controlled release fertilizer was selected to eliminate the need of weekly fertilization, and to prevent burning from over fertilization.*

Mycorrhizal Inoculants →These inoculums were chosen from a large selection of products that claim to help with plant growth. These in particular were chosen because they are composed of only arbuscular mycorrhizae and an inert carrier. Comparable products have other beneficial microbes and additional fertilizers added. To prevent these potential confounding variables these products were omitted. Another reason these were selected was because they were all from different parent companies. Many of the inoculants on the market are essentially the same product that has been altered slightly and packaged with a different label.*

Xtreme Gardening Mykos→*This product was selected because it is comprised of a single strain endomycorrhizal fungi (Glomus intraradices). The company (Xtreme Gardening owned by Reforestation Technologies International) claims that eliminating any type of root competition will enhance plant performance. This product claims the highest propagule count of our three inoculants at 300 per gram.*

BioOrganics Micronized EndoMycorrhizal Inoculants→*This product was selected because it consists of 9 distinct species of endo-mycorrhizal fungi (Glomus aggregatum, G. etunicatum, G. clarum, G. deserticola, G. intraradices, G. monosporus, G. mosseae, Gigaspora margarita, and Paraglomus brasilianum). The company (BioOrganics LLC) claims that this blend of fungi will be more effective than any single species because they can work together to become more adaptable to a wider range of conditions. This product claims the lowest propagule count of our three inoculants at a minimum of 50 per gram.*

MycoApply Mycorrhizal Inoculant→*This product was selected because it contains 4 species of endomycorrhizal fungi (Glomus intraradices, G. mosseae, G. aggregatum, G. etunicatum) and 7 species of ectomycorrhizal (Rhizopogon villosulus, R. luteolus, R. amylopogon, R. fulvigleba, Pisolithus tinctorius, Scleroderma cepa, Scleroderma citrinum). This is the only one of our three products that contains ectomycorrhizal fungi. The inclusion of this type of fungus isn't as common on the market, because it is known to be much more of a specialist, while the endomycorrhizae is more generalist. Out of our three products, this one has the second highest endomycorrhizal propagule count at 132 per gram and the highest ectomycorrhizal count at 240,500 propagules per gram. It should be noted that the ecto- propagules are significantly smaller than the endo- ones which accounts for the disparity in propagule counts.*

Seeds→The seeds for the experiment will be representative of two of the major plant families that mycorrhizae companies claim that their products will improve the quality of: poaceae and solanaceae. The first family focuses on a monocrop crop that holds major commercial value, while the second one is a dicot crop that would be more predominantly grown by home gardeners. The purpose for using two types of fruiting annual plants will be determining the specificity of the different mycorrhizal powders. The variety in plant seeds will lead to data on which mycorrhizal powders are most effective with which plant species.*

Earlivee / Silver N Gold sweet corn→*For poaceae we have Earlivee or Silver N Gold sweet corn. Poaceae is arguably one of the most important plant families in the world. From corn to rice to wheat, these species provide more than half of all calories consumed by humans. Saying that it is a major crop worldwide is an understatement. These corn varieties are some of the earliest maturing varieties of sweet corn on the market and depending on seed availability one will be the monocot representative in our trial.*

4th of July Tomato→ *For solanaceae we have the 4th of July tomato. On the farm owned by one of this trial's researchers, they specialize in growing heirloom and artisan varieties of tomatoes and peppers. Research into this family will help their farm to be more productive. This particular variety is known to be one of the first tomatoes in the garden to fruit, frequently reaching maturity just 49 days after transplant (75 days after seeding) and can reach yields of 40 lbs per plant. This variety will be the dicot representative.*

Filters→Both 5 and 2 micrometer filtration sizes will be used in filtering out bacterias and microbes from garden soil. We will use them to create our negative control to test how wild microbes react in this trial under greenhouse conditions. This will help us obtain a baseline to determine the effects of our treatments.*

5 Micrometer Filters→*At this size of filter most of the microbes that we are searching for will be let through. Fine clay particles will mostly be separated.*

2 Micrometer Filters→*At this size of filter most of the microbes that we are searching for will not be let through. The remaining liquid that passes through will contain soluble nutrients that will be sterilized and applied equally to the other treatments.*

Pyrex Glass Media Bottles→The glass media bottles will be bought by another group in our lab. We will be using these for the purpose of water storage. This will aid in the speed of and efficiency of the watering process.*

Water→The water for the experiment will be provided by UVU and will be sterilized in their autoclaves.*

****Soil Hygrometer Sensor→****Due to the fact that the soil shouldn't be disturbed for the duration of the experiment the common method of determining soil moisture by sticking a finger in the soil can't be used. This sensor can be probed into each pot to determine moisture content without excess agitation. The probe will be sanitized when transferred between treatments.*

Measuring Stick→At the time of harvesting, the height of the plants will be recorded.*

Scale→At the time of harvesting, the weight of the plants will be recorded. Another measurement will be taken after the plant matter is dried. The scale used will be borrowed from UVU.*

Travel Narrative:

-*No travel will be required for this project.*

Signature Page

Typed signatures are acceptable

1) Title of project:

Efficacy and Specificity of Commercial Mycorrhizal Powders on Fruit-Bearing Annual Garden Plants

2) Lead Student Name and UVID:

Thiago Vecchi (10649934)

3) Faculty/Staff Mentor:

Dr. Geoffrey Zahn

4) Start/stop dates of project:

Start: 01/25/2022

End: 05/05/2022

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

-Hunter Houtz (10777988) - hunter.houtz11@icloud.com
-Alex Little (10772843) - alexlittle11695@gmail.com
-Sterling Brinkerhoff (10842362) - sterling.brinkerhoff@gmail.com

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.

Thiago Vecchi *February 4, 2022*

_____ _____

Lead Student Applicant Date

Feb 4, 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___ __2.8.2022__

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.