# Environment and Natural Resources Trust Fund

2022 Request for Proposal

## General Information

**Proposal ID:** 2022-179

**Proposal Title:** Employing the plant microbiome to protect Minnesota plants

## Project Manager Information

**Name:** Jannell Bazurto

**Organization:** U of MN - College of Biological Sciences

**Office Telephone:** (954) 980-6236

**Email:** jbazurto@umn.edu

## Project Basic Information

**Project Summary:** We will isolate beneficial plant microbes, characterize their ability to protect plants from temperature stress, and employ them to protect various plant hosts from extreme temperatures associated with climate change.

**Funds Requested:** $162,000

**Proposed Project Completion:** August 31 2024

**LCCMR Funding Category:** Small Projects (H)

**Secondary Category:** Air Quality, Climate Change, and Renewable Energy (E)

## Project Location

**What is the best scale for describing where your work will take place?**

Region(s): Metro

**What is the best scale to describe the area impacted by your work?**

Statewide

**When will the work impact occur?**

In the Future

## Narrative

**Describe the opportunity or problem your proposal seeks to address. Include any relevant background information.**

Climate change has impacted weather patterns across the world. In Minnesota, climate change has manifested itself through steadily rising average temperatures, an increase in temperature extremes, more frequent temperature fluctuations, and increased precipitation. Extreme temperatures alone can damage and kill valuable crops and native plant species; however, even relatively small changes in temperature can also make plants much more vulnerable to pathogens. Thus, climate change can negatively impact plants on multiple fronts and it will increasingly jeopardize the health of Minnesota's plants, the central component of Minnesota's ecosystem. Protecting Minnesotan plants, including its most valuable crops, will require eco-friendly approaches that will fortify our plants without harming the environment through chemical treatment. Microbes are native residents of plants and have the potential to tolerate climate extremes as well as confer stress tolerance to their plant hosts; thus, they are promising targets for use as plant-enhancing treatments. Although climate change has already begun to take a toll on Minnesota-based agriculture and native ecosystems, we can use naturally occurring environmental microbes to strengthen our plants, preventing further damage and enhancing the resiliency of our ecosystem, especially in periods of rapid temperature shifts.

**What is your proposed solution to the problem or opportunity discussed above? i.e. What are you seeking funding to do? You will be asked to expand on this in Activities and Milestones.**

Plant-associated microbes profoundly impact plant health. While some microbes can lead to disease, the microbes naturally associated with plants (microbiome) are beneficial. Beneficial plant microbes can promote plant health by producing growth-stimulating molecules and essential nutrients. Additionally, beneficial plant microbes can confer plant tolerance to environmental stressors and biological stressors such as pathogens. Methylobacterium is a predominant group of pink-pigmented microbes that are known to possess numerous plant-growth-promoting properties. Individual strains of Methylobacterium have been shown to produce plant growth hormones, fix atmospheric nitrogen, provide protection against bacterial and fungal pathogens, and enhance plant tolerance to high salinity. By isolating beneficial plant microbes such as Methylobacterium from native Minnesota plants during periods of climate extremes, we will be able to select particularly resilient microbes that can withstand temperature stress. Our project seeks to exploit the protective effects of these hardy microbes and apply them to plants to increase plant hardiness. We will directly use them to enhance the tolerance of native Minnesota plants to temperature stress, including rapid temperature fluctuations and temperature extremes. The use of native microbes will provide an environmentally friendly way to increase plant resilience and safeguard Minnesota's ecosystem as the climate continues to change.

**What are the specific project outcomes as they relate to the public purpose of protection, conservation, preservation, and enhancement of the state's natural resources?**

The goal of this project is to develop new applications for promoting plant health in spite of the extreme and fluctuating temperatures imposed upon weather patterns by climate change. This approach will leverage Minnesota's natural microbial resources which intrinsically have a role in promoting plant stress tolerance. By taking such an approach, we will decrease the use of chemical treatments and pesticides required to support plant health and preserve Minnesota's invaluable ecosystem.

## Activities and Milestones

### Activity 1: Isolate plant-growth-promoting microbes from leaves of native Minnesota plant species

**Activity Budget:** $48,200

**Activity Description:**
To identify microbial candidates for increasing climate tolerance of plants, we will isolate and enrich Methylobacterium from Minnesota to find isolates with the greatest impact on plant temperature stress tolerance. Because Methylobacterium have a unique metabolism, they can be readily isolated from host plants by simply pressing leaves onto solid growth substrate. This effort will build upon our current studies in establishing the various benefits that Methylobacterium can confer on its plant hosts. Our isolations will take place primarily at Cedar Creek Nature Reserve in the Metro area and Itasca Biological Field Station in Northern Minnesota. These efforts will include outreach with local secondary school teachers and communities through events such as Science in Nature which includes presentations with hands-on activities. Additionally, we will engage secondary students across the state by crowd-sourcing isolations to increase the sampling range. These activities will promote scientific literacy in local schools and communities and ensure that Minnesotans are informed about and invested in the well-being of the state's environment.

**Activity Milestones:**

| Description | Completion Date |
|---|---|
| Field collection of cold-tolerant plant-associated microbes during the winter and spring seasons | May 31 2023 |
| Field collection of heat-tolerant plant-associated microbes during the summer season | August 31 2023 |

### Activity 2: Identify climate-resistant microbial isolates

**Activity Budget:** $32,500

**Activity Description:**
In the laboratory, we will use high-throughput growth assays and grow our microbial isolates with a variety of environmental stressors. Specifically, we will grow them in high, low, and fluctuating temperatures. The goal of this activity is to determine their overall stress-resistance patterns and to identify the most resilient isolates (i.e., the most promising candidates for protecting plants). Our efforts will focus specifically on temperature stress: we will test the temperature limits that the microbes survive and even grow in upon exposure. In addition to single isolates of the collection, we will also generate combinations of our most promising candidates to assess the potential impacts of small microbial communities as well. Through this process, we will develop a microbial collection that can be stored long-term and easily accessed to rapidly screen for a variety of additional useful traits.

**Activity Milestones:**

| Description | Completion Date |
|---|---|
| Determine stress resistance profiles of Winter 2022 isolates | May 31 2023 |
| Determine stress resistance profiles of Summer 2023 isolates | December 31 2023 |
| Assembly of stress resistant microbial communities | January 31 2024 |

### Activity 3: Measure the impact of microbial isolates and communities on plant climate tolerance

**Activity Budget:** $81,300

**Activity Description:**
To determine the impact of our isolated microbes on temperature tolerance of plants, we will screen the protective effect of our isolates on several plant species. The first set of screens will involve the use of the model system

Arabidopsis thaliana, where seeds will be individually inoculated with individual microbial strains or a mixed microbial community. The resulting seeds will be used to grow plants at high, low, and fluctuating temperatures. The goal of this activity is to identify and characterize the microbes that are most successful at mitigating the effects of the imposed temperature stress on the plant host. From this screen, we will select our top-performing microbes and use this subset of strains (or communities) to perform additional temperature stress tests with high-priority Minnesota plants. Examples of high-priority plants are endangered native species and agriculturally important crops. This effort will provide proof of principle for the employment of Minnesota's native microbes to protect Minnesota's plants against heightened climate stress.

**Activity Milestones:**

| Description | Completion Date |
|---|---|
| Perform cold stress experiments on A. thaliana with winter isolates | November 30 2023 |
| Perform heat stress experiments on A. thaliana with summer isolates | August 31 2024 |
| Perform climate stress tests on native Minnesota plants | August 31 2024 |

## Long-Term Implementation and Funding

**Describe how the results will be implemented and how any ongoing effort will be funded. If not already addressed as part of the project, how will findings, results, and products developed be implemented after project completion? If additional work is needed, how will this be funded?**

We expect this to be a long-term project. The goals of the project are to identify eco-friendly methods to support plant health in the face of the changing climate. We believe that the best way to achieve this is to harness the microbes that naturally protect their plant hosts against extreme weather stress. While these microbes are already associated with plants across the state, by isolating them we can amplify their naturally protective effects by manipulating their temporal abundance on their plant hosts. Through this work, we will develop a plant growth-supporting treatment that can be applied to agriculturally relevant crops and endangered plant species, to maintain plant fitness during temperature stress. Our research will also contribute to related future directions that will use plant-growth-promoting microbes as more sustainable alternatives to current agricultural practices that are harmful to Minnesota's precious ecosystems.

## Project Manager and Organization Qualifications

**Project Manager Name:** Jannell Bazurto

**Job Title:** Assistant Professor

**Provide description of the project manager's qualifications to manage the proposed project.**

Professor Jannell Bazurto from the Department of Plant and Microbial Biology, the BioTechnology Institute, and the Microbial and Plant Genomics Institute will lead the project. The Bazurto lab is an interdisciplinary lab with expertise in microbial physiology and plant biology. Professor Bazurto is an expert in Methylobacterium stress resistance and has extensive experience in isolating plant-associated microbes. The Bazurto lab also works within a collaborative department with research labs that study a variety of different plant species, ensuring access to various host plants and associated resources.

**Organization:** U of MN - College of Biological Sciences

**Organization Description:**

The mission of the College of Biological Sciences is to deliver cutting-edge, internationally recognized research and teaching at all levels of biological organization from molecules to ecosystems. While preparing today's students to create the biology of tomorrow, CBS promotes collaborative research within and beyond the University to advance knowledge and find solutions that improve human health and the environment locally, nationally and globally.

## Budget Summary

| Category / Name | Subcategory or Type | Description | Purpose | Gen. Ineligible | % Benefits | # FTE | Classified Staff? | $ Amount |
|---|---|---|---|---|---|---|---|---|
| **Personnel** | | | | | | | | |
| Graduate student | | Perform field isolations and lab-based stress tests | | | 72.4% | 1 | | $108,000 |
| Undergraduate researcher | | Assist with isolations and stress tests | | | 0% | 1.2 | | $30,000 |
| | | | | | | | **Sub Total** | **$138,000** |
| **Contracts and Services** | | | | | | | | |
| | | | | | | | **Sub Total** | **-** |
| **Equipment, Tools, and Supplies** | | | | | | | | |
| | Tools and Supplies | media, chemicals, consumables (i.e. pipet tips, petri dishes, centrifuge tubes, 96-well plates) | field work, microbial/plant growth experiments | | | | | $22,000 |
| | | | | | | | **Sub Total** | **$22,000** |
| **Capital Expenditures** | | | | | | | | |
| | | | | | | | **Sub Total** | **-** |
| **Acquisitions and Stewardship** | | | | | | | | |
| | | | | | | | **Sub Total** | **-** |
| **Travel In Minnesota** | | | | | | | | |
| | Miles/ Meals/ Lodging | Travel to Cedar Creek Ecosystem Science Reserve. (27 miles) and Itasca Biological Field Station (221 miles). There will be ~5 trips to each site per season (1-2 people). Current travel rate: 57.5 cents/mile. | Travel to field sampling sites | | | | | $2,000 |
| | | | | | | | **Sub Total** | **$2,000** |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Travel Outside Minnesota** | | | | | | | | |
| | | | | | | | **Sub Total** | **-** |
| **Printing and Publication** | | | | | | | | |
| | | | | | | | **Sub Total** | **-** |
| **Other Expenses** | | | | | | | | |
| | | | | | | | **Sub Total** | **-** |
| | | | | | | | **Grand Total** | **$162,000** |

## Classified Staff or Generally Ineligible Expenses

| Category/Name | Subcategory or Type | Description | Justification Ineligible Expense or Classified Staff Request |
|---|---|---|---|

## Non ENRTF Funds

| Category | Specific Source | Use | Status | Amount |
|---|---|---|---|---|
| **State** | | | | |
| | | | **State Sub Total** | **-** |
| **Non-State** | | | | |
| In-Kind | Indirect costs associated with this proposal at 35% MTDC. | Indirect costs cover both facilities costs and administrative costs that are incurred by the University of Minnesota when conducting sponsored research, instruction, and public service projects. | Secured | $70,957 |
| | | | **Non State Sub Total** | **$70,957** |
| | | | **Funds Total** | **$70,957** |

# Attachments

## Required Attachments

### *Visual Component*

File: 2d2ac4ab-06d.pdf

### *Alternate Text for Visual Component*

"Employing the plant microbiome to protect Minnesota plants". The left panel depicts a thriving woodland in the summer while the right panel depicts the woodland in the winter. The extreme temperatures associated with each season due to climate change are indicated by thermometers in each panel. In the center, a group of plants are shielded from these temperature extremes by Methylobacterium, a group of beneficial plant microbes. Activities associated with this proposal are indicated: 1.Isola...

## Optional Attachments

### *Support Letter or Other*

| Title | File |
|---|---|
| Authorization to Submit | 9663a2c4-ee6.pdf |

## Administrative Use

**Does your project include restoration or acquisition of land rights?**

No

**Does your project have potential for royalties, copyrights, patents, or sale of products and assets?**

No

**Do you understand and acknowledge IP and revenue-return and sharing requirements in 116P.10?**

N/A

**Do you wish to request reinvestment of any revenues into your project instead of returning revenue to the ENRTF?**

N/A

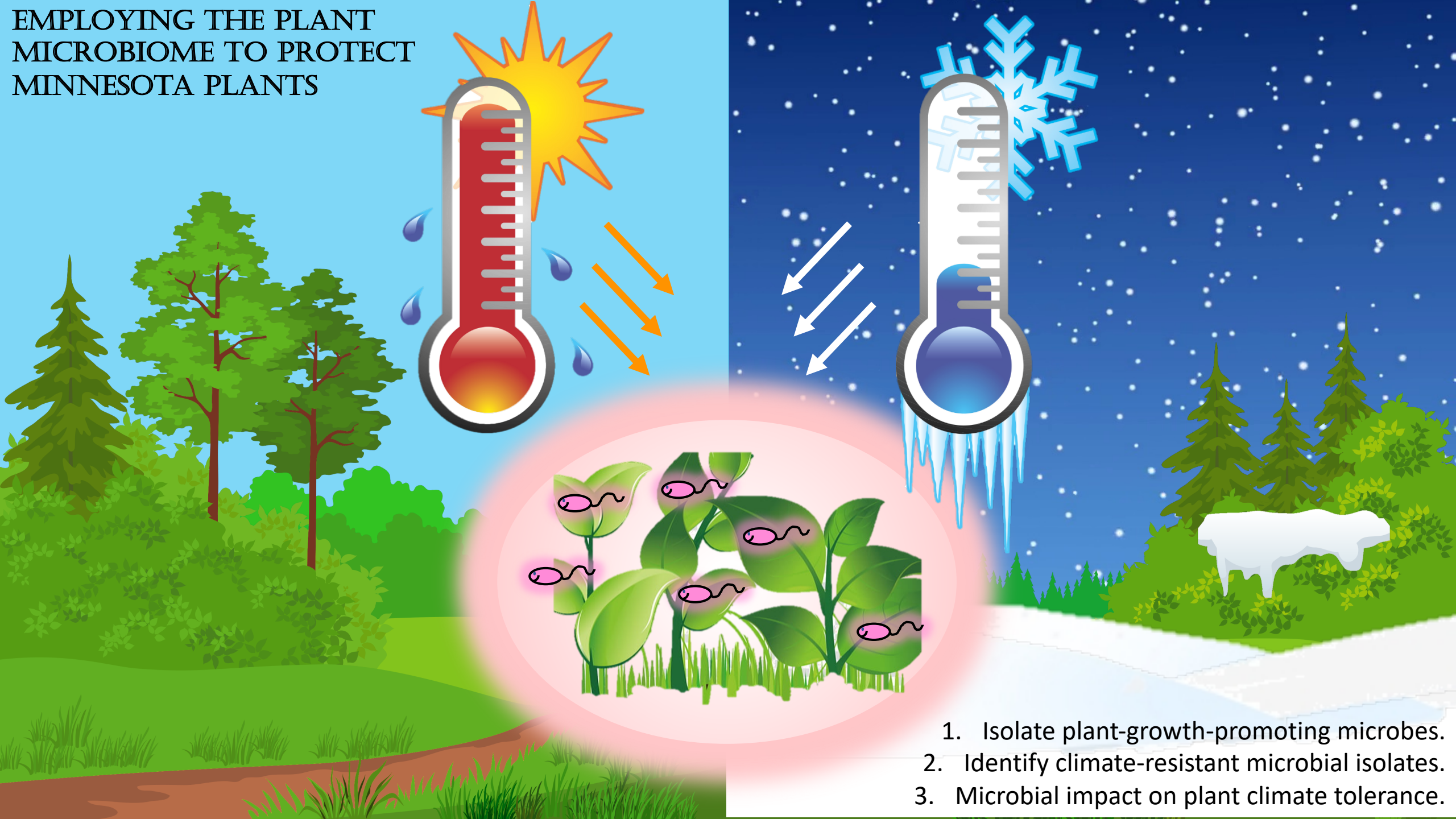
**Does your project include original, hypothesis-driven research?**

Yes

**Does the organization have a fiscal agent for this project?**

Yes, Sponsored Projects Administration

# EMPLOYING THE PLANT MICROBIOME TO PROTECT MINNESOTA PLANTS



1. Isolate plant-growth-promoting microbes.
2. Identify climate-resistant microbial isolates.
3. Microbial impact on plant climate tolerance.