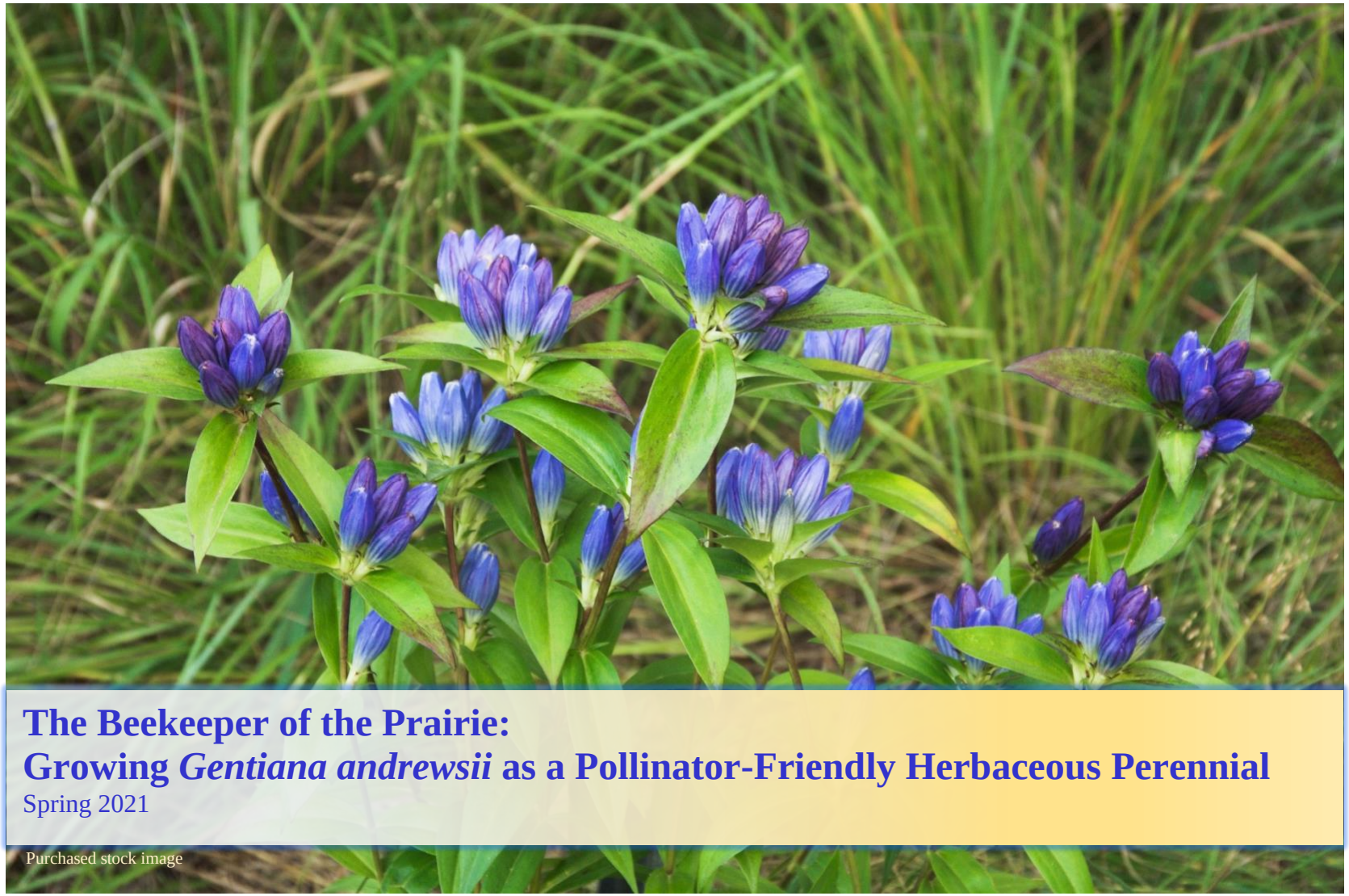

The Beekeeper of the Prairie:
Growing *Gentiana andrewsii* as a Pollinator-Friendly Herbaceous Perennial

Spring 2021

Purchased stock image

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WORK LOCATION:
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Saint Paul, MN 55018

PROJECT CATEGORY INFORMATION:
Floriculture and herbaceous perennial

START DATE: September 1, 2021
END DATE: August 31, 2022

REQUESTED AMOUNT OF FUNDING:
$9,816.28

PROJECT SUMMARY

SUMMARY

Growing native forbs has ecological and economic benefits. Native plants provide food and habitat to pollinators, which in turn supports local farmers and agriculture that benefit from natural pollinators. *Gentiana andrewsii*, commonly known as the closed bottle Gentian, is an herbaceous perennial native to the prairies of northcentral and northeastern North America. It has been identified as a unique pollinator food source for bees because they are the only insects strong enough to enter the unusual, closed corolla of *G. andrewsii*. With the clearing of prairie lands for agriculture, *G. andrewsii* has lost significant natural habitat and is considered a threatened species in several states (USDA, NRCS 2011). As a native pollinator-friendly herbaceous perennial, *G. andrewsii* has the potential to be a valuable floriculture crop for the pollinator habitat movement; however, there is little published research available for the commercial production of this species.

Additional research is needed to investigate preferred growing methods for *G. andrewsii*. The limited available research indicates that germination poses a key challenge to the production of *G. andrewsii*. This project proposes to research the germination characteristics of *G. andrewsii* using Gibberellic acid (GA_3) with cold stratification treatments and its results will contribute to the information available on *G. andrewsii* for commercial growers as well as educators and researchers in the horticulture academic community. The results of this study will be used to host a virtual roundtable with these groups. An article will also be written for publication in horticulture trade magazines and university extension publications. The outcomes of this project will raise awareness of *G. andrewsii* and inform growers, educators and researchers on how to grow *G. andrewsii* and its potential as a marketable crop. The desired long-

term outcome is for commercial growers to produce *G. andrewsii* as a pollinator-friendly crop, which could help reestablish the species, support pollinators with habitat and support the local agriculture and farmers that benefit from natural pollinators. Evaluation of these outcomes will be conducted with pre- and post-discussion surveys of the virtual roundtable participants from the commercial growing and horticulture academic community, and with a review of the online statistics available for published articles of the study results in horticulture trade magazines and university extension publications.

DESCRIPTION

This is a study of the germination characteristics of *G. andrewsii* using Gibberellic acid (GA_3) with cold stratification treatments for the greenhouse production of *G. andrewsii* as a pollinator-friendly herbaceous perennial crop.

OUTCOMES

The short-term learning outcomes of this study will include increased knowledge of the germination characteristics of *G. andrewsii*, greater awareness of the species, and increased interest in *G. andrewsii* as a pollinator-friendly herbaceous perennial amongst stakeholders in the commercial growing and horticulture academic community. The objective of this project is to use the study results to engage with these stakeholders to bring attention to this species and to generate interest in its production as a pollinator-friendly crop. Mid-to-long-term action outcomes include more growers and educators seeking information about *G. andrewsii* and using the results of this study for further research, education and collaboration. The long-term outcome may result in more growers

incorporating *G. andrewsii* into commercial production as a pollinator-friendly crop and increasing the commercial availability of plant material.

PROGRAM LOGIC MODEL

The program logic model (Figure 1) outlines an overview for this study and the anticipated outcomes resulting from this research. This model is provided as a general protocol for the study. Further detail for each section is provided in this proposal.

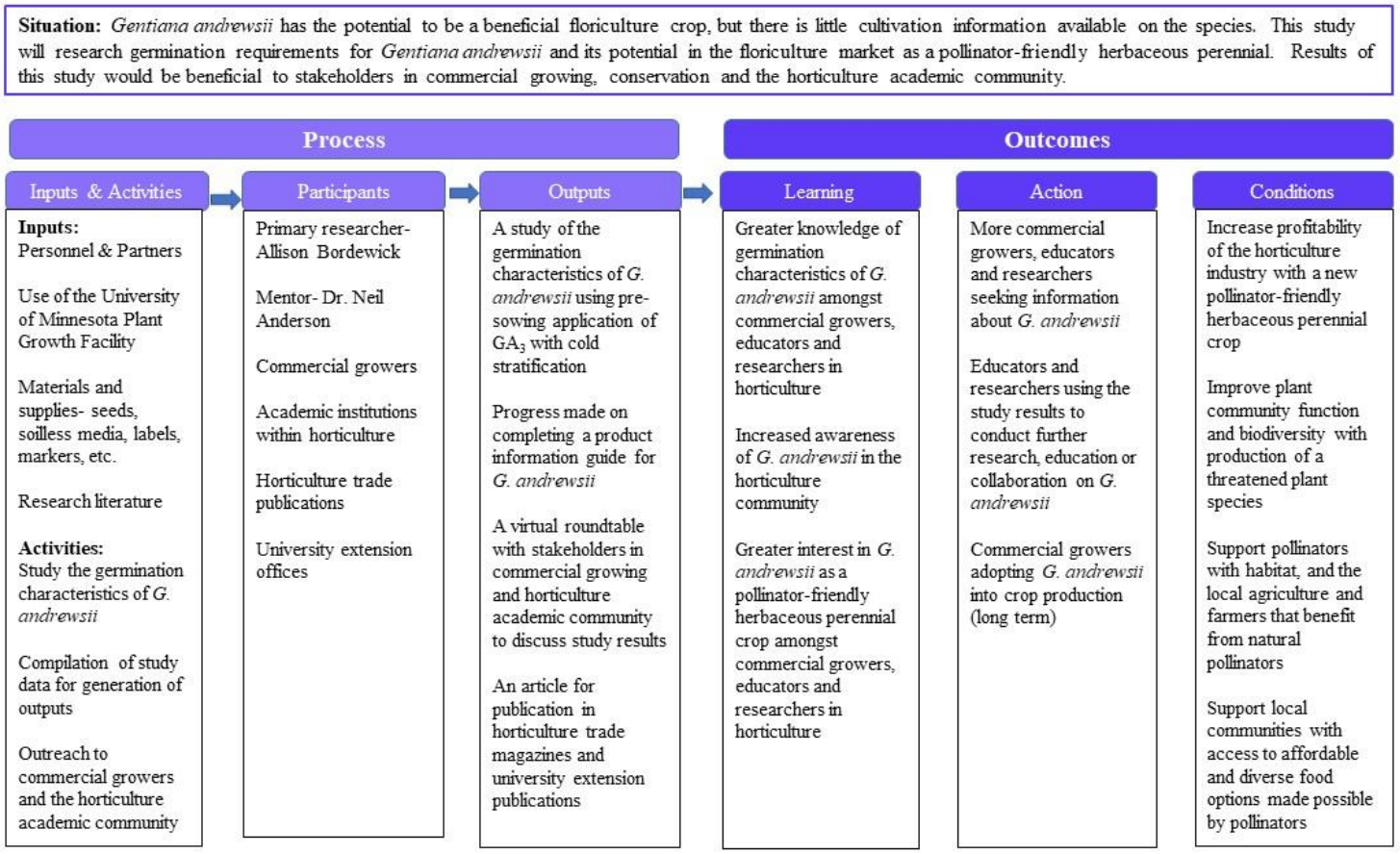

Figure 1. Program logic model illustrating the study overview and anticipated outcomes.

PROPOSAL NARRATIVE

PROPOSAL NARRATIVE

Statement of Problem, Background, Justification

Background

This proposal serves as a guide to understanding the species *Gentiana andrewsii* with the objective of introducing it to the floriculture market as a pollinator-friendly herbaceous perennial. *Gentiana andrewsii* plays an important ecological role as a pollinator food source; however, its native prairie habitat has largely been lost to agriculture. Limited information and research are available for *G. andrewsii* and its position in the floriculture market. Therefore, it is important to understand the environmental conditions in which *G. andrewsii* grows and if it has the potential to be a viable commercial crop. The following presents important background information for *G. andrewsii* relating to its taxonomic classification, geography, habitat, ecology, crop history and use in the horticulture industry. Figure 2 shows the closed corolla of *G. andrewsii.*

Figure 2. Terminal corolla of *Gentiana andrewsii* (USDA, NRCS 2021).

Taxonomic Classification

Gentiana andrewsii is taxonomically listed as:

Family: Gentianaceae- Gentian family
Genus: *Gentiana L.*
Species: *Gentiana andrewsii* Griseb.

Gentiana is in the Gentianaceae (Gentian) family- a widely distributed plant family native to all continents except Antarctica. Comprising approximately 100 genera and 1,800 species, many species in this family grow in mesic habitats and are characterized as herbaceous herbs or subshrubs having persistent tap roots and bisexual, hypogynous flowers that produce small, winged seeds for wind dispersal (Pringle 2014) (Figure 3).

Figure 3. Winged seeds of *Gentiana andrewsii* (Hampton 2011).

Gentiana L., the largest genus of the Gentianaceae family, is known for its flowers, which are commonly trumpet-shaped and blue. The genus is comprised of about 400 species that are found worldwide, excluding low-altitude tropical regions, most of Africa and western Australia (Pringle 2014).

Figure 5. *Gentiana andrewsii* botanical illustration showing above-ground morphology (Mason 1959).

Commonly called the closed bottle Gentian, *G. andrewsii* is an herbaceous perennial with a striking purple-blue bottle-shaped corolla that remains closed (Figure 4). *Gentiana andrewsii* has a stout taproot and an erect stem that grows 30 - 60 cm high with opposite leaves terminating in a whorl (Figure 5). It is a late-blooming species (August-October) with sessile flowers in the upper 1-6 axils. The cylindrical corolla is 3-4.5 cm long and has pleated, fringed petals. Its hypogenous flower is insect-pollinator-dependent and self-compatible when hand-pollinated (Costelloe 1983) (Figure 6). *Gentiana andrewsii* produces small, winged seeds that require cold stratification for germination (Mason 1959).

Figure 4. The unique corolla of *Gentiana andrewsii* remains closed at anthesis (Hampton 2011).

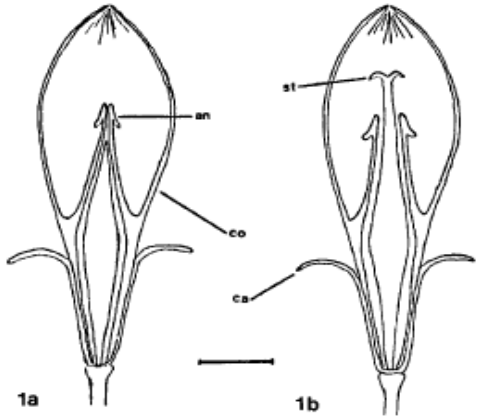

Figure 6. *Gentiana andrewsii* botanical illustration of hypogenous flower; 1a, anthers mature; 1b, stigma mature, bar represents 1 cm (Costelloe 1988).

Geographic Distribution, Native Habitat & Ecology

Gentiana andrewsii is generally found between latitudes of 37◦ N – 60◦ N and is native to northcentral and northeastern North America (Figure 7). It is primarily a prairie species which grows in undisturbed wet-mesic to mesic prairies and savannahs. These regions generally have humid continental climates, characterized by four distinct seasons with large temperature differentials and annual precipitation of 50-125 cm.

Figure 7. Native distribution of *Gentiana andrewsii* (USDA, NRCS 2021).

Gentiana andrewsii plays an important ecological role as a pollinator food source. Its deep, closed corolla is uniquely suited to bees, the only insect strong enough and with the learning capacity to enter the corolla. The purple-blue flower is a color shown to be easily "fixed" and remembered by bumblebees (Costelloe 1988). Native habitats to *G. andrewsii* are some of the most endangered ecosystems, as the fertile soils of prairies and savannas have largely been cultivated for agriculture (Gardner 2011). *Gentiana andrewsii* is considered a threatened species in several states (USDA, NRCS 2011).

Tendency to Naturalize or Become Invasive

There is little evidence to suggest *G. andrewsii* would become an invasive crop. It also is unlikely to naturalize outside of its native habitat due to its slow growth and temperamental response to moisture (Mason 1959).

Crop Species History and Cultivation

Some *Gentiana* species have been used internationally in indoor and outdoor cultivation and are important ornamental plants for Japan's floriculture industry. However, there is little research that defines the commercial viability of *G. andrewsii* in the floriculture market. A limited number of native plant vendors sell seeds, but *G. andrewsii* is not widely available. While it has been used for tonics, *G. andrewsii* is not commonly used for medicinal purposes, and due to its bitter taste, it is not likely used as an edible plant.

Little research exists on the breeding and domestication of *G. andrewsii* except for a study conducted by Tamagake et al. (2014) which reported an effective interspecific hybrid of *G. trifloral* and *G. andrewsii* produced by ovule culture. The limited research available for cultivation of *G. andrewsii* suggests that it is propagated by seed, needs 1-2 months of cold stratification, has poor germination rates (24% - 45%) and is slow growing (1-3 years to maturity) (Mason 1959; Nuzzo 1976; Gardner 2011). Figure 8

highlights these and other challenges found in the production of Japanese Gentians. However, a breakthrough study found the pre-sowing application of Gibberellic acid (GA_3) used with cold stratification increased germination percent of *Gentiana lutea* (González-López, Casquero 2014). With further research, the findings may also have applications for *G. andrewsii*.

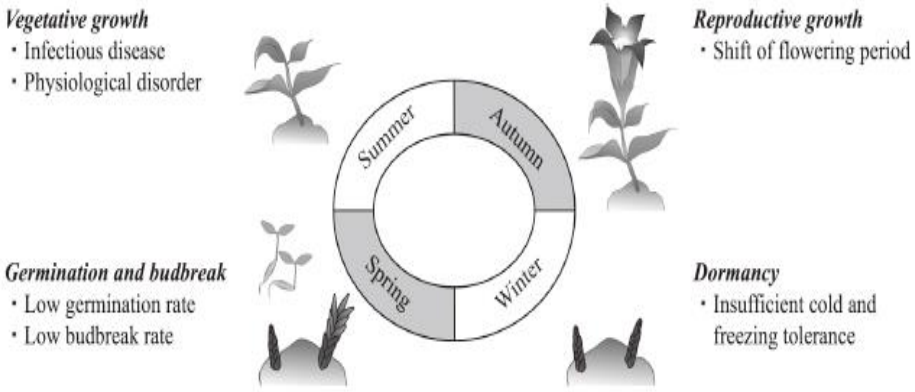

Figure 8. Challenges encountered with the production of Japanese Gentians by season (Nishihara et al. 2018).

Potential Uses

As a species uniquely suited for bees, *G. andrewsii* has potential in the floriculture market as a new pollinator-friendly herbaceous perennial. Although it is slow growing, it is a long-lived herbaceous perennial that is cold hardy in zones 7a-2b, making it an ideal crop for outdoor gardening in the North Central region. Its bitter taste also provides natural deer and rabbit resistance.

Potential Production Environment

There is currently little information available on the preferred production environment for *G. andrewsii*, however, information on its native habitat may be used to suggest preferred growing conditions. *Gentiana andrewsii* grows in mesic prairie soils, with a pH of 4.9-7.5 and 37%-106% water retaining capacity (Chapman 1984). Average summer temperatures range 21◦-28◦C and *G. andrewsii* grows in full to part sun, or facultative long-day production. Seed germination is shown to have obligate light requirements and seeds should be surface sown and left uncovered after a cold stratification period of 1-2 months (Mason 1959). A 288-size plug is ideal and the finishing container size may be as large as 1 gallon. *Gentiana andrewsii* is slow growing, but if necessary, a spray application of daminozide (2500-500 ppm) may be used to control plant height.

Impact on sustainability in the North Central Region

Economic Impact

This project has potential to improve the profitability of the horticultural industry by introducing *G. andrewsii* as a new herbaceous perennial for the pollinator habitat movement. Research shows consumers are interested in attracting pollinators, and habitat restoration has become a big business in the private and public sectors (Molano-Flores 2004). Supporting pollinators also helps the economy as pollinators contribute approximately 24 billion dollars to the U.S. economy (Fact Sheet 2014).

Environmental Impact

Native forbs, like *G. andrewsii*, are essential to plant communities and provide food and cover for wildlife (Mikkelson, Lym 2013). Much of the prairie habitat native to *G. andrewsii* has been lost to agriculture and the species is considered threatened in some states. The production of *G. andrewsii* as a pollinator-friendly crop may help reestablish the species and support pollinators and the local agriculture and farmers that benefit from natural pollinators.

Social Impact

Pollinators play a critical role in our food systems and contribute to food security for our communities. The health of pollinators and the availability of pollinator habitat are linked to the health of our society (Potts et al. 2016). Including pollinator-friendly crops such as *G. andrewsii* in horticultural production can help support communities by providing access to affordable and diverse food options that are made possible by pollinators.

Approach and Methods

Inputs

The following inputs are required for the execution of this study (Table 1).

Input	Resource
PERSONNEL	Allison Bordewick- Pursuing a Master of Professional Studies in Horticulture Plant Growth Facility Lab staff
MENTORS/ PARTNERSHIPS	Dr. Neil Anderson, B.S. in Ornamental Horticulture, M.S. in Horticulture, Ph.D. in Horticulture Members of commercial horticulture and academic community
PHYSICAL LOCATION	**Work Location:** The University of Minnesota Plant Growth Facility Lab St. Paul Campus
MATERIALS AND SUPPLIES	Research literature and supporting documents Supplies: • *Gentiana andrewsii* seeds • Plastic bags • Paper towels • Gibberellic acid (GA_3) • Distilled water • Soilless media • Plug trays and growing containers • Plant labels • Sharpie markers

Table 1. Inputs for research and experimental design

Activities

This section describes the research activities and experimental design for this study.

Location

This study will be conducted at the Plant Growth Facility on the University of Minnesota St. Paul campus. A dark cooler and two greenhouses will be utilized. The growing conditions of each are outlined in Table 2.

Facility	Conditions
Dark Cooler (Used for cold stratification)	• Temp: 3-5◦C • Light: none
Mist House (Used for seed germination)	• Day/night temps: 21.1◦C/ 21.1◦C • Light: 16 hours at 150 µmol m-2 s-1, (0600-2200 HR) • Moisture: Mist every 10 minutes for 7 seconds • Nutrients: none • DIF: none
Production House 2 (#369 C-7) (After seed germination)	• Day/night temps: 21.1◦C/18.3◦C, early morning dip at sunrise to 10◦C • Light (LD bench): 16 hours at 500 µmol m-2 s-1, (0600-2200 HR) • Nutrients: 125 ppm N CLF 15-5-15 Cal-Mag (CLF) • Monthly fungicide drenches on flowering crops only • DIF: +2.8

Table 2. Facilities and conditions at the University of Minnesota Plant Growth Facility

Experimental Design

Seed propagation poses a key challenge to the production of *G. andrewsii*, as it requires 1-2 months of cold stratification and has low germination rates (24%-54%) (Mason 1959; Gardner 2011). This study is based upon the research of González-López & Casquero (2014), which found the pre-sowing application of Gibberellic acid (GA_3) used with cold stratification was successful in increasing the germination rate of *Gentiana lutea*. In some cases, GA_3 produced off-type seedlings, thus seedling growth habit was also studied to determine the optimal concentration of GA_3 for increased germination rates and good seedling morphology.

The research methods of this study are designed to determine if the pre-sowing application of GA_3 used with cold stratification can increase germination rates of *G. andrewsii* and produce good seedling morphology. This study will be conducted over a 12-month period. The desired outcome is to inform stakeholders in commercial horticulture and the academic community on best practices for seed germination of *G. andrewsii* for greenhouse production.

Four concentrations of GA_3 will be used with two cold stratification treatments to test germination rates of *G. andrewsii* (Table 3). Seeds will be placed in ragdolls for cold stratification periods of 30 or 60 days in a dark cooler at 3-5◦ C. After cold stratification, seeds will be soaked for 24 hours in a GA_3 water solution, then cleaned with distilled water to remove GA_3 residues before they are surface sown into 288 plug trays with germination mix. All plug trays will be started in the mist house and moved into the greenhouse after germination occurs.

Crop #	Ragdoll Cold Stratification Period	GA_3 Application (ppm) 24 hours	# of Seeds
Control	0 days	No application	50
1	30 days	No application	50
2	30 days	50	50
3	30 days	100	50
4	30 days	500	50
5	30 days	1000	50
6	60 days	No application	50
7	60 days	50	50
8	60 days	100	50
9	60 days	500	50
10	60 days	1000	50

Table 3. Experimental design for seed germination of *Gentiana andrewsii*

Crops will be consistently monitored, and data will be recorded at five stages:

- Stage 1: The radicle extends 1mm beyond the seed coat.
- Stage 2: The radicle penetrates the soil (hypocotyl is present).
- Stage 3: True leaves begin to develop. (Seedlings will be moved to greenhouse 369 C-7.)
- Stage 4: Seedlings are ready for transplant into 4-inch pots with growing mix.
- Stage 5: 180 days after sowing.

Due to lack of research and information, it is difficult to anticipate how long stages 1-4 will take. All crops will be evaluated based upon germination rate, time to reach each stage of growth and the seedling morphology at Stage 5. Table 4 illustrates the data that will be collected at each stage for all crops.

Crop	Stage 1	Stage 2	Stage 3	Stage 4	Stage 5
Crop #	• Average number of days to germinate • Total germination percent	• Average number of days to hypocotyl emergence	• Average number of days for true leaf development • Average length of stem (from soil surface to apex of primary stem) (10 random samplings from each crop)	• Average number of days to reach Stage 4 (ready for transplant) • Yield potential • Average length of stem from soil surface to apex of primary stem (10 random samplings from each crop)	• Average length of stem from soil surface to apex of primary stem (10 random samplings from each crop) • Average length of most developed leaf in third set of leaves from the base (10 random samplings from each crop) • Observations on seedling morphology

Table 4. Example of data collection for evaluation of germination study

Timeline

The following outlines the timeline, by month, for this study and outreach (Table 5).

Task Description	Sep-21	Oct-21	Nov-21	Dec-21	Jan-22	Feb-22	Mar-22	Apr-22	May-22	Jun-22	Jul-22	Aug-22
Project initiation: finalize plans, contact partners, gather supplies, prepare space, prepare data collection records, begin 60-day cold stratification												
Begin 30-day cold stratification												
Apply GA_3 treatments to 30 and 60-day cold stratification crops and sow all crops, monitor all crops for germination, if seedlings are ready-transplant into 4-inch pots												
Continue monitoring seedlings and transplants												
Start preparing materials for virtual roundtable and article for publication												
Host virtual roundtable												
Prepare final report, annual report and submit article for publication												
Conduct project evaluation												

Table 5. Timeline and task descriptions for this project

Outputs

1. A study of the germination characteristics of *G. andrewsii* by seed using pre-sowing application of GA_3 with cold stratification.
2. Progress made on completing a product information guide using information gathered from experiment results and a review of literature. This guide is intended to provide plug and finished container sizes and cultural recommendations for germination, plug production and growing from transplant to finish, including relevant information on the use of plant growth regulators, fertilizer and common pest or disease issues. It will also include information on colors, plant size, plant characteristics and the potential market use of *G. andrewsii*.
3. A virtual roundtable discussion with stakeholders in commercial horticulture and the academic community to present the experiment results and answer questions.
4. An article for horticulture trade magazines.
5. An article for university extension publication.

Outreach

The results of this study will identify best practices for optimal germination of *G. andrewsii* to inform stakeholders in commercial horticulture and the academic community. A virtual roundtable will be hosted for commercial growers and those in the horticulture academic community. This will be an opportunity to present results of the experiment, answer questions, and share in a discussion on

production methods for *G. andrewsii*. Additionally, an article will be written for publication in horticulture trade magazines and in university extension publications. This outreach will benefit anyone interested in working with *G. andrewsii*, including seed vendors, commercial growers, wholesale and retail plant vendors, landscape designers and managers, conservationists, plant breeders and extension educators.

Potential Partners:

Commercial Growers:

- Gertens
- Bachman's
- Wagners

Academic Institutions within Horticulture:

- University of Minnesota
- Purdue University
- Iowa State University
- Cornell University

Horticulture Trade Publications:

- *Greenhouse Grower* Magazine
- *Horticulture* Magazine
- *Greenhouse Management* Magazine
- *GrowerTalks* Magazine

University Extension Offices:

- University of Minnesota Extension
- Purdue University Horticulture Extension
- Iowa State University Extension
- University of Illinois Extension
- Cornell Extension

Project Evaluation

The evaluation of this project will measure the responses of key stakeholders in the commercial horticulture industry and academic community resulting from the outreach activities of this project.

Learning Outcomes

Learning outcomes address changes in awareness, attitudes, knowledge and skills. Anticipated learning outcomes from sharing the results of this study include increased knowledge of the germination characteristics of *G. andrewsii*, greater awareness of a species for which there is currently little research or information available, and greater interest in *G. andrewsii* as a pollinator-friendly crop for commercial production amongst stakeholders in the commercial grower and horticulture academic community.

Action Outcomes

Action outcomes address changes in behavior and practice. Anticipated action outcomes include more commercial growers, educators and researchers seeking information about *G. andrewsii* and using the results of the study for further research, education, or collaboration. The long-term potential outcome is that this study will provide information that leads commercial growers to incorporate *G. andrewsii* into production as a pollinator-friendly crop.

These anticipated outcomes will be evaluated with pre- and post-discussion surveys of virtual roundtable participants to measure their knowledge, awareness, and interest in *G. andrewsii*, and their use of the study results for further education, research, or collaboration. One month after publication of the study results in horticulture trade magazines and university extension publications, reader responses and online views and downloads analytics will be collected to measure the audience's behavior in seeking out information

on *G. andrewsii*.

Experience and Roles

Project Mentor

- Dr. Neil Anderson, B.S. in Ornamental Horticulture, M.S. in Horticulture, Ph.D. in Horticulture

The mentor will assist the primary researcher with research questions, experiment design and will supervise the primary researcher on any necessary components of this project.

Primary Researcher

- Allison Bordewick, B.A. in Journalism and Professional Strategic Communication. Currently pursuing a Master of Professional Studies in Horticulture.

Allison Bordewick has completed several foundational horticulture classes in her MPS in Horticulture curriculum. Her experience includes plant propagation by seed and vegetative cuttings, crop scheduling, greenhouse production, plant identification and taxonomic classification. She is also a research assistant to Dr. Neil Anderson and responsible for execution of a research project which will study the use of biorefined effluent in hydroponic cultivation of vegetables and herbs.

The primary researcher will execute the experimental design, compile study data for the generation of outputs, and execute outreach activities and the evaluation plan. The primary researcher has access to all necessary facilities, equipment and materials required to execute this project.

Plant Growth Facility Lab Personnel

Staff at the Plant Growth Facility Lab will assist with day-to-day operations, including greenhouse watering, applying fertilizer and pesticides and ordering supplies for the greenhouse (soilless media, pots, fertilizer, pesticides, etc.).

Project Partners

The help of partners such as vendors of *G. andrewsii* seeds, the editorial staff of horticulture trade publications, and those in the horticulture academic community will be instrumental to executing the study of *G. andrewsii* germination characteristics and distributing the results of the study.

BUDGET

BUDGET

This proposal requests a fixed budget of $8,475.37. Table 6 outlines the budget required for each category and the total budget. The following narrative breaks down the line-item expenses for each category.

Salaries

The salary for the primary researcher includes all phases of the project, including setup, executing the experimental design, collating data for generation of the outputs, outreach activities and executing the evaluation plan. The salary for the 12-month period will be paid as a monthly stipend of $600.00 for a total of $7,200.00. Salary expenses for greenhouse staff are included in the rental fee for use of the Plant Growth Facility, which is covered in the direct cost category. Greenhouse staff will assist with greenhouse watering, the application of fertilizer and pesticides and ordering greenhouse supplies.

Materials and Supplies

The following is an itemized list of required materials and supplies to complete this study:

- *Gentiana andrewsii* seeds
- Plastic bags
- Paper towels
- Gibberellic acid (GA_3)*

- Distilled water
- Soilless media (germination and growing mix)*
- Plant labels*
- Sharpie markers
- Plug trays*
- Four-inch pots*
- Fertilizer*
- Pesticides*

*These items are included in the rental fee for use of the Plant Growth Facility, which is covered in the direct costs category.

The total cost for supplies not covered by the Plant Growth Facility rental fee is estimated at $16.30.

Travel

Travel to the University's Plant Growth Facility Lab is required to complete the study. The cost to travel to the University over a 12-month period is based upon the cost of a public transit pass totaling $342.00.

Direct Costs

Direct costs include the rental fees for use of the Plant Growth Facility at the University of Minnesota. The rental fee of $0.0308/ ft^2 per day includes the physical space needed to complete the project, supplies (soilless media, pots, labels, fertilizer, pesticides, etc.) and all greenhouse staff time provided by the Plant Growth Facility. A 75 ft^2 bench costs $2.31 per day, thus the cost to rent space in the mist house (for the period November 2021 through January 2022) is $2.31 x 92 days= $212.52. The cost to rent space in the greenhouse (for the period November 2021 through August 2022) is $2.31 x 305 days = $704.55, totaling $917.07 in direct costs.

Category	Cost
Salaries	$ 7,200.00
Fringe benefits	$ -
Non-expendable equipment	$ -
Materials and supplies	$ 16.30
Travel	$ 342.00
Direct costs	$ 917.07
Indirect costs	$ -
Total	**$ 8,475.37**

Table 6. Estimated budget for this project

Expected Outcomes	Inputs and Activities	Outputs	Evaluation/ Monitoring Plan; Measurement Methods
Learning Outcomes: • Increased knowledge of germination characteristics of *G. andrewsii* amongst growers, educators, and researchers • Greater awareness of *G. andrewsii* amongst growers, educators, and researchers • Greater interest in *G. andrewsii* as a pollinator-friendly crop for production amongst commercial growers **Action Outcomes:** • Commercial growers, educators and researchers seeking information about *G. andrewsii* • Educators and researchers using the study results to conduct further research, education or collaboration • Growers adopting *G. andrewsii* into commercial production (long term)	**Inputs:** • Personnel • Mentors • Use of University of Minnesota Plant Growth Facility • Materials and supplies • Research literature **Activities**: • Study the germination characteristics of *G. andrewsii* • Compilation of study data for generation of outputs • Outreach to commercial growers and the horticulture academic community	• A study of the germination characteristics of *G. andrewsii* using pre-sowing application of GA_3 with cold stratification • Progress made on completing a product information guide using information gathered from experiment results and a review of literature • A virtual roundtable with stakeholders in commercial horticulture and the academic community to present results of the study and answer questions • An article for publication in horticulture trade magazines • An article for university extension publication	• Measure of target audiences' interest in the results of the study • Pre- and post-discussion surveys of virtual roundtable participants will measure knowledge of germination characteristics, awareness, and interest in *G. andrewsii* as a pollinator-friendly crop, and the participants' intent to use study results for further education, research or collaboration • Collection of responses from readers of respective publications and any available online analytics relating to views or downloads of the articles published from this study to measure how many people are seeking information on *G. andrewsii*

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