## Western SARE Funding Application

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### GW16-021 - Identification of peony diseases in the Pacific Northwest and Alaska

**Subject Matter Area: Sustainable Integrated Pest Management**

**Funding Total:**
1st Year: $16,765.00  2nd Year: $8,214.00  3rd Year: $0.00  >>>  Total: $24,979.00

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**Supporting Documents:**
- Graduate Student Vita
- Budget Justification
- Animal Welfare Assurance Statement
- Signed Signature Page
- Major Professor Vita

## Summary:

Little research has been done to diagnose the causal agents of various diseases that affect peony. Modern extension bulletins and growers' guides rely on nearly 100 year-old research to diagnose disease on this high-value cut flower and landscape crop. Through our current efforts focused on identifying species of Botrytis on peony, it has become increasingly clear that the current literature surrounding peony pathogens is inadequate. Our limited sampling of peony pathogens has identified the existence of two pathogens not previously reported in the United States. These and several species of Botrytis are new to peony or newly discovered. While peonies have historically been a small-acreage crop, a surge of growth in production has been observed in the western United States, especially in Alaska where the cut peony flowers are being produced at a time of year when no other country in the world is able to harvest this crop due to differences in environmental conditions. As a result, peonies are becoming a major economic force in the state of Alaska with over 1,000,000 stems projected to sell in 2015. Alaska grown peonies sell for $2 to $6 per stem, making peonies a multi-million dollar industry for Alaska. In 2012, over 100,000 roots were in production in Alaska and those numbers are continually growing. Many Alaskan growers are sourcing this peony rootstock material from farms located in Washington and Oregon, thus, multiple Pacific Northwest farmers are being impacted by Alaska's increasing production. Through our discussions with farmers, it has become clear that both cut flower and rootstock producers are in need of knowledge and education about the pathogens that cause disease on their crops in order to maintain the vitality of this emerging industry. We propose a project to survey for and identify causal agents of various peony diseases throughout the Western region of the United States, as well as in other economically-important and informative peony producing states. A survey of samples, both from our own farm site visits as well as those obtained from peony growers, will elucidate not only the different pathogens infecting peony, but also the frequency at which they occur in each of the peony-producing regions. We propose using the collected information to produce an updated growers' guide in the form of an extension bulletin for easy-access to growers, and to hold hands-on grower education training through many of the pre-established networks we have formed both in Alaska and Washington. Lastly, our project will produce first reports in the journal Plant Disease of these pathogens as they are not only the best way for pathogen existence to become accessible knowledge, but also because first reports on ornamental crops, while seemingly small, have potential for enormous local impact.

## Literature Review:

The most recent research on diseases of peony in the United States is from the early 1900s.1-4 While modern extension bulletins and growers' guides make anecdotal references to a number of peony diseases, most states lack official first reports of peony pathogens, with Alaska having no first reports of this kind.5 It has become clear that there are unreported fungal pathogens infecting peony in the United States. Our limited sampling in an effort to characterize Botrytis species as per another grant has yielded at least two species of fungi never before reported in the United States on peony: Mycocentrospora acerina and Pilidium concavum. M. acerina was only identified as a peony pathogen anywhere in the world this year6 and P. concavum has only been identified from Asia.7 We have multiple other species of fungi isolated from diseased peony foliage that still need to be tested for pathogenicity. Since our small number of samples have led to such diversity of pathogens, we have reason to believe that further investigation will give us more insight into peony pathogens.

The report of local pathogens help horticulture industries mitigate damage due to new emerging pathogens.8 With the movement of planting material and other agricultural products, such as rootstocks and cut flowers, a local pathogen could potentially have much wider ramifications. Accurate identification of pathogens is a critical first step in selection of appropriate management strategies, including selection of fungicides and the use of cultural practices, such as hot water dips.

Diseases of ornamental crops can be detrimental to yields, thus profits. Host-specific pathogens, such as some Botrytis species, have the ability to inflict up to 60% yield losses.9 Cut flowers such as peonies are some of the most profitable crops that can be produced on a per-acre basis. A mature acre of peonies can yield upwards of 50,000 stems. Alaska peony farmers are selling their peonies for $2-6 per stem10 therefore even as small as 10% losses in a mature field due to disease could mean up to 30,000 per acre economic impact. Diseases of geophyte (bulbs, corms, etc.) crops produced for planting stock is also especially damaging as diseases can compromise the health of the underground perennial storage structure.9

The Western SARE program, USDA ARS, and NIFA have already acknowledged that peonies are a priority for Alaskan horticulture by funding projects for Alaskan peonies.

**SARE:** "Using high tunnels to provide peony with a longer growing season to increase productivity in northern latitudes and cold soils" is a farmer/rancher project conducted by an Alaskan peony farm, Polar Peonies, where we have visited and collected Botrytis samples. The farmers in this project used high tunnels to assess them for increasing productivity in their cut flower crop. "Insect IPM Protocols for Fresh Cut Peonies: Protecting a new Alaskan Export Crop" is a newly-funded project working to address peony grower's concerns about lygus bug and thrips.

**USDA-NIFA-CREES:** "Peony Flower Production With Organic Amendments" is a project that is utilizing a planting of peonies at the University of Alaska Fairbanks to test nutrient amendments for organic production of peonies. Projects also taking place at the University of Alaska Fairbanks conducted by a collaborator on our Botrytis project that are funded by a USDA Specialty Crop Block Grant evaluated postharvest quality of peonies ("New Crops for Alaska VIII"), worked to understand peony markets for Alaska growers ("Alaska Natural Resources and Economic Stability"), and assessed peony phenology in the state of Alaska ("Horticultural Crop Production for Alaska"). NIFA is also supporting a grant of which the current PI has received regarding the management of Botrytis in peony.

**NAL:** A search of the National Agricultural Library using the keyword "peony" did not yield search results applicable to the proposed study. Using the term "cut flowers" yielded various relevant and non-relevant results. Those that are relevant discussed the importance of specialty cut flowers to increasing diversity at small farms and the increasing potential for success of domestically-grown specialty cut flowers.
None of the aforementioned projects address concerns with diseases on peony other than the grant investigating Botrytis in peony (a project of which we are a part). For the NIFA grant, we are exclusively focused on Botrytis and discovered the need for the current proposal during our ongoing surveys. A Western SARE grant to support disease research would be building upon the knowledge being produced about peonies to ensure the success of this crop that Steven Seefeldt in his SARE grant summary ("Insect IPM Protocols for Fresh Cut Peonies") calls, Alaska's "most important horticultural export."

**10 Citations:** (1) F. Weiss. Phytopathology. 30:409-417, 1939. (2) H.H. Whetzel. Trans. Mass. Hort. Soc. 1:103-112, 1915. (3) H.H. Whetzel. Laboratory text, Cornell University, Ithaca, NY, 1939. (4) F. Weiss. Fungous diseases and pests of the peony, p. 167-178. In: J. Boyd (ed.) Peonies: The manual of the American Peony Society. American Peony Society, USA, 1928. (5) D.F. Farr and A.Y. Rossman. Fungal Databases, Systematic Mycology and Microbiology Laboratory. ARS, USDA., retrieved from http://nt.ars-grin.gov/fungaldatabases/, Apr 6, 2015. (6) L. Gilchrist et al. Plant Dis. 99:284, 2015. (7) Y.B. Duan et al. Plant Dis. 94:271, 2010. (8) F.M. Dugan et al. Plant Health Prog. doi:10.1094/PHP-2009-0512-01-RV, 2009. (9) J.W. Lorbeer et al. Botrytis species on bulb crops. P. 273-294. In: Y. Elad et al. (eds.) Botrytis: biology, pathology and control, Springer Publishing, Dordrecht, Netherlands, 2007. (10) P.S. Hollway and K. Buchholz. University of Alaska Fairbanks AFES Publication, 2012.

## List of Objectives:

Objective 1. Collect samples. Spring-Summer 2016. The graduate student and PI will conduct surveys to obtain diseased foliage and solicit additional foliage to be collected by peony growers. Collections will focus on at least 30 growers in Alaska, Oregon, and Washington, however will extend to other Western states as identified during the course of the study.

Objective 2. Isolate causal organism(s). Spring-Summer 2016. The graduate student will attempt to isolate causal organism of disease using traditional fungal and bacterial isolation methods. The isolated organisms will be maintained in-vitro in petri plates containing the appropriate growth media.

Objective 3. Identify causal organism(s). Spring-Fall 2016. The graduate student will use a combination of morphological and molecular methods (PCR and sequencing) to positively identify the suspected causal organisms of disease. If suspected pathogen is viral, samples will be submitted to a commercial virus screening laboratory for identification.

Objective 4. Determine pathogenicity of isolated organisms. Fall-Winter 2016. The graduate student will perform Koch's postulates on live plants and detached peony tissues to determine pathogenicity of the organisms.

Objective 5. Disseminate information regarding the peony pathogens. Winter 2017-Spring 2017. The PI and graduate student will prepare all education material. Such material will include an extension bulletin published through Washington State University and/or the University of Alaska Fairbanks, a workshop conducted in Alaska, and first reports published in peer-reviewed journals.

## Materials and Methods:

Collections. The project will utilize preexisting relationships with two Washington peony rootstock producers, one Oregon peony rootstock producer, one Iowa peony rootstock producer, and 26 Alaska peony cut flower farmers to survey private farms for and request samples of diseased foliage from peony. Furthermore, this project will utilize a research planting of peonies at Washington State University Puyallup Research and Extension Center (PREC) at which the PI and graduate student are stationed. The PI and graduate student will make one 10-day trip (9 nights) to Alaska over the summer in 2016 to survey and collect diseased foliage from at least 3 peony fields in each of the four major production regions in Alaska (Homer, Soldotna, Mat-Su, and Fairbanks). The PI and graduate student will make 5 one-day trips during the 2016 growing season to collect diseased foliage sample from a minimum of two farms in Washington and one farm in Oregon each trip , with an emphasis on the popular cut flower cultivar 'Sarah Bernhardt.' The PREC will be surveyed bi-weekly for any disease and collections will be made. Throughout the year, the PI and graduate student will receive overnight FedEx shipments of diseased foliage collected by growers from around the United States, including the areas surveyed by the PI and graduate student. We will be working with the Association for Specialty Cut Flower Growers to obtain diseased samples from small cut flower growers throughout the Western United States.

Isolations. All collected foliage will be brought to laboratories at the PREC where the graduate student and a temporary employee will perform tissue isolations to isolate the causal organism from diseased tissue. Plant tissues will be surface sterilized and portions of diseased tissue will be plated onto appropriate growing media and grown up in vitro in petri plates. In addition to isolates collected during this study, isolates collected over previous years from peony will be sequenced.

Identification. A combination of morphological and molecular techniques will be used to identify the causal organism from successful isolations. Morphological characteristics of suspected pathogens will be observed using light microscopy. PCR to amplify the ITS region for fungi and the 16S ribosomal RNA for bacteria will be conducted and PCR products sequenced to identify pathogens using DNA. For any suspected viral pathogens, the researchers will send peony samples to a virus testing laboratory.

Determining pathogenicity. Organisms new to a location, new to peonies, or new to science (or any combination of these traits) will be tested in the PREC's biocontainment facility on replicated whole plants or detached leaves, stems, or roots to confirm pathogenicity by performing Koch's postulates on plants maintained at the PREC using the appropriate infectious pathogen propagules. Plants used in the studies will be maintained by the graduate student and hourly employee.

## Impacts and Outcomes:

1) Teach peony growers to identify and manage disease. Equip the over 70 peony farmers in Alaska and the Pacific Northwest with knowledge of how to diagnose and treat diseases affecting peonies. Over 120 farmers attended last year's Alaska Peony Grower's Association conference; we can anticipate a similarly wide range of exposure to our findings across Alaska. We can increase the number of farmers who access this information through providing additional support through our multiple farm visits and personal communications with growers as facilitated by this project. There are at least 30 peony rootstock or cut flower growers throughout the Pacific Northwest, and a large, but difficult number to quantify throughout the western states that will benefit from the knowledge generated from this project. We estimate over 200 growers will benefit from the information from this project.

2) Increase yield and profits by up to 60%. Some diseases, such as Botrytis gray mold, can cause up to 60% yield losses. A 10% loss in a mature field in Alaska could mean up to in yield which $30,000 in losses per acre. Our project will help farms produce higher yields and profits.

3) Increase fungicide efficacy. This project will aid in the efficient and sustainable use of fungicides by ensuring that the cause of peony diseases are being accurately identified and managed by selecting fungicides and cultural practices that are effective against the disease-causing organism. Overuse or misuse of fungicides or other controls due to misdiagnosis reduce farm profits and unnecessarily expose the agricultural environment to pesticides.

4) Facilitate success of at least 70 local family farms. 100% of the farms we plan to work with are family owned and operated, therefore, this project will impact small, local, family operations.

5) Empower rural communities. The inclusion of Alaska peony growers in this project is a unique opportunity to include farmers from rural locations. Many farms in Alaska are quite remote and do not have ready access to the extension and outreach as in the lower 48 states. Furthermore, their relatively short history of being a cut flower-producing state means that many of these farmers are first generation and do not

have access to passed-down, local or family information. This project will impact local communities by bolstering their newly-emerging cut flower industry by providing them with information not able to be readily accessed in any other way.

6) Support multiple facets of a US agricultural industry. This project means supporting a greater Western agricultural industry where peony rootstocks are being shipped from the Pacific Northwest into Alaska. This means bolstering complementary domestic agricultural industries (domestic rootstocks provided to domestic cut flower growers) and limiting reliance on foreign supply of agricultural products.

## Educational Outreach Plan:

1) Workshop. The PI and graduate student will hold a workshop in Alaska, possibly in collaboration with the Alaska Peony Grower's Association annual conference, to train growers in diagnosis and treatment of peony diseases. Such a workshop would include the utilization of both live and preserved specimens of diseased peony plants and hands on diagnostic activities. The specimens to be used in the workshop will be collected through survey efforts and preserved or live specimens will be inoculated at the PREC and brought to the workshop by the graduate student and PI. A workshop would also include Power Point slide presentations about basic disease management, including pathogen biology and appropriate and safe use of pesticides. Attendees will be given an initial survey asking them to rate their confidence in their ability to perform accurate and appropriate disease diagnosis and management. Attendees will also be asked to complete an initial quiz on diagnosis of provided diseased specimens. Following the termination of the workshop, attendees will be asked to complete the same survey and quiz and changes in confidence and accurate diagnosis will be evaluated and reported based on percentage of individuals with changes, positive or negative, in response.

2) Facebook page. The graduate student will develop, monitor, and update a Facebook site dedicated to discussion about peony diseases and peony research at the PREC. The graduate student will update the post weekly throughout the peony growing season and periodically during the off-season. Such posts will involve photographs of farm visits, the development of the peony plants and diseases at the PREC peony planting, photographs and updates on peony research being conducted at the PREC including inoculation trials, fungicide trials (supported by a different grant), identification of diseases found throughout the growing season, and discussions on tools the graduate student is using during her research. Through the Facebook page, we will encourage growers to submit photographs of their peonies and peony diseases and questions regarding disease development and management in their fields that the graduate student can respond to. The Facebook page will also be a venue in which the graduate student can request more samples from the Facebook page followers. Our goal would be at least 40 followers on our Facebook page.

## Educational Materials / Scholarly Publications:

1) Extension bulletin/diagnostic guide. An extension bulletin/diagnostic guide describing the diseases identified on peony, their causal organisms, their diagnostic symptoms, and any known disease management strategies will be compiled and published as an extension bulletin through Washington State University and/or the University of Alaska Fairbanks. This information will also be available on the Washington State University website.

2) First reports. The PI and graduate student will prepare first reports of any findings of pathogens new to peony or a state/region in peer-reviewed journals such as *Plant Disease.*

3) Peer-reviewed publication. A peer-reviewed journal article will be prepared to describe the various diseases found on peony in Alaska.

4) Poster at professional meeting. A poster will be presented at the American Phytopathological Society Pacific Division annual meeting to showcase the findings of different peony diseases in Alaska.

5) DNA sequence data. Sequence data obtained will be deposited into GenBank, a free public database for DNA sequence data.

## Producer Adoption:

Producers who attend the workshop are expected to have gained an increase in knowledge about pathogens that infect peony, accurate disease diagnosis, pathogen biology, and proper and safe use of pesticides including information on fungicide resistance. Especially in Alaska, the well-established peony growers are readily willing to help new growers, as evidenced by the many co-ops and peony grower's organizations they have created. Therefore, a survey would not only attempt to capture the confidence that the farmer has to diagnose and manage disease in his/her own field, but how confident the grower is in disseminating the knowledge they have gained and how likely the grower is to share this information to new peony growers or growers in his/her region. Producer gains in knowledge regarding this information and changes in attitude regarding confidence in teaching others will be evaluated using a before-and-after survey similar at the workshop similar to the one described in the educational outreach plan and in Appendix E of the SARE grant website.

Examples of such questions are as follows:

• On a 1-5 scale (1 being the least and 5 being the most), how confident are you in diagnosing diseases of peony?
• On a 1-5 scale (1 being the least and 5 being the most), how confident are you in teaching someone about disease management of peony?
• On a 1-5 scale (1 being not likely at all and 5 being very likely), how likely are you to pass along the information you have gained to another peony producer?
• On a 1-5 scale (1 being very little and 5 being a great deal), how much do you know about the lifecycle of pathogens that infect peony?
• On a 1-5 scale (1 being very little and 5 being a great deal), how much do you know about safely using pesticides?
• On a 1-5 scale (1 being not likely at all and 5 being very likely), how likely are you to utilize the information gained in this workshop in your own farm? Explain.

Follow-up farm visits and continued dialogue with growers will also help the graduate student and PI get a better understanding of the number of producers who have adopted and understood materials presented to them including both the workshop and the growers' guide.

**Project Budget:**

| | Year 1 | Year 2 | Year 3 |
|---|---|---|---|
| Projected Salary Expenses | | | |
| Senior Personnel | 0 | 0 | 0 |
| Senior Associates | 0 | 0 | 0 |
| Research Associates | 0 | 0 | 0 |
| Other Professionals | 0 | 0 | 0 |
| Graduate Students | 0 | 0 | 0 |
| Hourly Labor | 1500 | 0 | 0 |
| Secretarial-Clerical | 0 | 0 | 0 |
| Technical/Shop/Other | 0 | 0 | 0 |
| Fringe Benefits | 150 | 0 | 0 |
| Other Projected Expenses | | | |
| Non-expendable Equipment | 0 | 0 | 0 |
| Materials and Supplies | 2900 | 100 | 0 |
| Travel (domestic) | 9791 | 5067 | 0 |
| Publication Costs | 0 | 1000 | 0 |
| Computer Costs | 0 | 0 | 0 |
| Other Direct Costs | 900 | 1300 | 0 |
| Indirect Costs | 1524 | 747 | 0 |
| Totals | 16765 | 8214 | 0 |