**Research Proposal Submitted to the Northwest Potato Research Consortium**

**Fiscal Year 2023-24**

**Proposal Title**: Comparison of potato yields, soil health, and microbiome in virgin, non-virgin, and native soils

**Principal investigator and co-PIs:**

|  |  |  |  |
| --- | --- | --- | --- |
| **Name** | **Address** | **Phone number** | **Email address** |
| Timothy Paulitz | USDA-ARS | 509-335-7077 | [paulitz@wsu.edu](mailto:paulitz@wsu.edu) |
| Deirdre Griffin LaHue | Washington State University | 360-848-6127 | [d.griffin@wsu.edu](mailto:d.griffin@wsu.edu) |
| Cynthia Gleason | Washington State University | 509-335-3742 | [cynthia.gleason@wsu.edu](mailto:cynthia.gleason@wsu.edu) |
| Kenneth Frost | Oregon State University | 608-556-9637 | [kenneth.frost@oregonstate.edu](mailto:kenneth.frost@oregonstate.edu) |

**Total Funds Requested**: **$62,133**

Principal investigator portion: $28,951

Co-PI portion(s): $33,182

Second, third or more year funding request? x Yes No

**If Yes**, prior year(s) amount(s) funded:

2022-23: **$63,111**

2021-22: **$63,053**

**Research Plan (**2-page max with three components**)**

**Summary of problem:** After decades of raising potatoes in the Columbia Basin, producers have noticed that the history of a field influences both yield and quality. Fields previously planted with potatoes generally yield less than field soils not previously farmed (virgin soils) or fields never planted with potatoes. Indeed, conversations with potato growers indicated that 14-26% greater yields can be achieved from virgin soils compared to nearby non-virgin soils. These observations corroborate results from several empirical studies ([de Boer et al. 2001; Lamers, 1989](https://docs.google.com/document/d/1nNQURDXchifl7YGxWDf_2pDLYDsc5RyEP1b5hJDIN3g/edit)). The purpose of this project is to determine what soil and biological factors are responsible for these observations. This study has been ongoing for the past two years. We decided to expand this study and include a potato associated microbiome component for the 2022 growing season. Mainly, we are examining the diversity and abundance of microbial communities associated with the potato rhizosphere, endosphere and tuber skin in the soil planted with three different types of soil: virgin, non-virgin, and native. Virgin soil was adjacent to the cropped soil (non-virgin) but had never been cropped with potatoes. Native soil had never been cropped before and was mostly sagebrush. Although no yield benefit was observed in the virgin soil in our microplot trials, a comprehensive study on various soil characteristics (biological, chemical, and physical) will contribute towards understanding of the potato soil health in the Pacific Northwest region. Further data from an additional year of study is necessary to fully understand the soil factors contributing towards these differences in the soils with different history.

Many decades of research efforts on the impacts of virgin soils on crop health have painted a rich but somewhat complicated picture. For example, despite the higher yields obtained in virgin soils relative to non-virgin soils, fungal, bacterial, and nematode pathogens can be recovered from these soils ([de Boer et al. 2001; Pratt 1916, 1918](https://docs.google.com/document/d/1nNQURDXchifl7YGxWDf_2pDLYDsc5RyEP1b5hJDIN3g/edit)). Thus, pathogen density does not appear to be the only factor that explains the higher yields and lower disease intensity observed in virgin fields relative to non-virgin fields. Also, differences in nematode, bacterial and fungal diversity ([Chen et al. 2020; Werner and Zadworny 2002](https://docs.google.com/document/d/1nNQURDXchifl7YGxWDf_2pDLYDsc5RyEP1b5hJDIN3g/edit)), as well as soil physical and chemical properties ([Blank and Fosberg 1989; Zhang et al. 2018](https://docs.google.com/document/d/1nNQURDXchifl7YGxWDf_2pDLYDsc5RyEP1b5hJDIN3g/edit)) have been detected between virgin and non-virgin soils. Hence, multiple factors likely contribute to plant health in virgin soils. Unfortunately, the authors are not aware of any studies that have quantified the influence of all of these potential factors on potato health.

**Research Objectives:**

The goal of this project is to determine soil biological, physical, and chemical factors that contribute towards yield differences in virgin and non-virgin soils. The specific objectives of this project are: 1) Sample soils from virgin, non-virgin, and native fields 2) characterize soil physical, chemical, and biological properties in bulk soil 3) Quantify potato performance in microplots 4) Learn from data.

[**Experimental Approach:**](https://docs.google.com/document/d/1nNQURDXchifl7YGxWDf_2pDLYDsc5RyEP1b5hJDIN3g/edit)

**For objective 1**, in 2021 we collected soil samples and cropping history records from a total of 11 pairs of fields (n=22) with virgin and non-virgin soils. To capture environmental differences, present in the Northwest, in Spring of 2022, we collected a total of 54 samples in central Washington and Oregon, as well as western Washington. In 2022, we also included true virgin soils that had never been cropped, as well as non-cropped soils. This objective was completed by D Griffin LaHue, TC Paulitz, and K Frost. For 2023, we will keep the same soils that overwintered in the common garden plots in Pullman. These soils will be characterized as below.

**To complete objective 2**, each soil sample from objective 1 will be characterized for:

* soil physical, chemical, and biological properties following the suite of Tier 1 indicators used by the Soil Health Institute (Norris et al., 2020) and in the Comprehensive Assessment of Soil Health (CASH; Moebius-Clune et al., 2017) (to be completed by D Griffin LaHue);
* free living and plant-parasitic nematodes with DNA sequencing (to be completed by C Gleason);
* soilborne potato pathogen presence and abundance by culturing soils on semi-selective media (to be completed by K Frost);
* bacterial and fungal community composition with 16S rRNA and ITS amplicon sequencing, respectively (to be completed by D Griffin LaHue and TC Paulitz). We will also sequence 18sRNA to look at protists, using the 2022 and 2023 samples.

For 2022, we added additional sequencing, beyond just communities in the bulk soil, to examine the microbiomes closely associated with the potato plant. In addition to bulk soil, we collected rhizosphere soil and root tissues from the plants in the common garden at the reproductive stage. At harvest, we also sampled the tuberosphere, by taking slices of the tuber skin. All these samples will be sequenced with 16S rRNA and ITS, as well as 18S, to provide a comprehensive view of the potato microbiome in three different types of soils.

**For objective 3**, Russet Burbank potatoes will again be planted in common garden microplots containing the sampled soil that was collected in 2022 and overwintered to 2023 in Turkey Orchard in Pullman, WA. Russet Burbank potatoes will be used because they are susceptible to common soilborne plant pathogens. The treatment structure of the trial will be a two-way design where the soil factors (virgin, non-virgin and native) are nested within the location factor (Skagit Valley and the Columbia Basin). Microplots will be arranged in a randomized complete block design along the predominant environmental gradient at the site of installation. Overall plant senescence will be assessed at least five times throughout the growing season. Yields and tuber quality will be determined for each experimental unit (plant in microplot). Additionally, yield data will be requested from growers (if applicable) who managed potato crops in the fields selected. These data will be compared to our microplot data and used to test the research hypothesis that yields are different between virgin and nonvirgin fields. Objective 3 will be completed by TC Paulitz.

**Finally, for objective 4**, associations between virgin and non-virgin soils and soil properties will be visualized. Ordination methods (e.g., non-metric multidimensional scaling, principal components analysis, etc.), boxplots, and scatterplots will be used to visualize data from objective 2 and 3. Differences between soil properties, potato yields, and disease expression will be investigated with standard statistical procedures like analysis of variance (ANOVA) and permutational multivariate analysis of variance (PERMANOVA). The soil factor will be treated as a fixed effect and location and year factor will be treated as a random effect. Relationships between soil properties, potato yields, and disease expression will further be elucidated with various classical and machine learning models. Models will be compared and results from the models that perform the best will be communicated. Objective 4 will be completed by all PIs.

**Expected Outcome**: This multi-year study will identify the soil physical, chemical, and biological properties associated with the observed yield differences in virgin vs. non-virgin soils. This project will further contribute towards defining core potato microbiome and ultimately contribute towards establishing the soil health indicators for potato production in the Pacific Northwest region.

**Budget:** Please provide the following in a table format as shown, listing only the budget items appropriate for your project. Add columns or tables as needed to accommodate all scientists/labs seeking funding under this project. Add or subtract footnotes or addenda to the budget table as needed to fully explain your plans or needs. More detail is better than less. Personalize the budget table with the names of each funded scientist at the tops of the columns, delete unneeded rows/columns, and delete these instructions.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **FY 2022-223** | **Paulitz lab** | **Gleason lab** | **Griffin lab** | **Frost lab** | **Total** |
| **1Salaries:** Faculty |  | 7,280 | 10,158 |  | 17,438 |
| Graduate student | 18,264 |  |  |  | 18,264 |
| Other students |  |  |  |  |  |
| **2Employee Benefits (OPE):** Faculty |  | 2,617 | 3,187 |  | 5,804 |
| Graduate Student | 1,688 |  |  |  | 1,688 |
| Travel: | 3,000 |  |  |  | 3,000 |
| **Operating Expenses** |  |  |  |  |  |
| Sampling |  |  |  |  |  |
| Lab and microplot supplies | 4,000 | 655 |  |  | 4,655 |
| Culturing pathogens from soil |  |  |  | 2000 | 2,000 |
| DNA extraction and sequencing |  |  | 5,715 |  | 5,715 |
| Soil properties analysis |  |  | 3,570 |  | 3,570 |
| Shipping |  |  |  |  |  |
| **Total** | 26,951 | 10,552 | 22,630 | 2,000 | **62,133** |
| ¹Salary is to support employee for 0.60 FTE of 9 months at Paulitz lab, for 0.84 FTE for 1 month at Gleason's lab,  and for 0.36 FTE for 3 months at Griffin's lab. | | | | | | | |
| ²Benefits for Post-Doc/Research Associate and graduate student are 32.4% and 15.4% of salary respectively | | | | | | | |

**Anticipated Total Requests in Coming Years: 2024-2025: $0**

**Other Support of Project, Anticipated Supporting Grant Applications:** NA

**Progress Report**: (one page or less)

The goal of this project is to identify the soil physical, chemical, and biological properties that contribute towards increased potato yields in virgin soils. To accomplish this goal, we collected soil samples from a total of 76 fields including 22 from the 2021 and 54 from the 2022 growing seasons. Those fields include virgin (n= 30), non-virgin (n=30), and native (n= 16) soils collected from Columbia Basin (n=51) and Skagit Valley (n=25). The cropping history of each field was obtained from the growers. The collected soil was thoroughly mixed and used to characterize soil physical, chemical, and biological properties. Potato performance in virgin and non-virgin soils was evaluated in microplots and with yield data collected from growers who grew potatoes in each field.

Drs. Paulitz, Griffin LaHue, Gleason, and Frost are characterizing the soil physical, chemical, and biological properties of the sampled soils collected in 2021 and 2022. DNA extraction from bulk soil was completed using PowerSoil Pro DNA extraction kits. Also, samples from potato rhizosphere, roots and bulk soils were collected during mid-July and tuberosphere samples were collected from the tubers at the time of harvest for field season 2022. DNA extraction has been completed and will be sent to the University of Minnesota Genomics Center for amplicon sequencing (16s rRNA, ITS, 18sRNA) during January 2023. We decided to include the protist community analysis as well for 2022 season given the economic impact that protists can cause in potato crops. A bioinformatics pipeline has been developed to preprocess and analyzed the sequenced data. Thus, obtained sequenced data will be further processed to understand the abundance and diversity of bacterial, fungal, nematode and protist community in three different types of soil. In addition, for the nematode community analysis, DNA extraction was completed following nematode extraction from the bulk soil. The nematode community analysis results are obtained for 2021 season. There was a lot of nematode diversity between samples in the virgin and non-virgin sites. Many of the identified genera contained free-living nematodes. *Ditylenchus*, a genera of plant parasitic nematodes, was found in both virgin and non-virgin soil samples. In addition, for additional biological properties, the presence and abundance of major soil-borne pathogens of potato were quantified with culture dependent methods. Major soil-borne pathogens like *Fusarium* spp,, *Pythium* spp,, fungicide resistant strains of *Pythium* spp,, *Verticillium dahliae*, and Colletotrichum coccodes were detected using soil plating methods in both types of fields in samples collected in 2021. Analysis of additional soil physical and chemical properties, including soil texture, active carbon (i.e., permanganate-oxidizable C), potentially mineralizable C, soil protein content, plant-available nutrients, pH, and electrical conductivity have been completed for 2021 samples and are underway for 2022 samples.

Microplots were established in Pullman, WA during the spring of 2021 and 2022. Potatoes were harvested during mid-September and yield was recorded for each microplot. No difference in potato plant senescence, tuber yield, and count were detected between virgin and non-virgin fields in the microplot study conducted in Pullman, WA.

Finally, once, we obtain the sequenced data and other data we will proceed with comprehensive analysis and reporting in year 2023.

**Timothy C. Paulitz**

**Research Plant Pathologist**

USDA-ARS Wheat Health, Genetics and Quality Research Unit

Washington State University, Pullman, WA 99164-6430

**ORCID:** **0000-0002-8885-3803.**

**EDUCATION**

University of California, Riverside, PhD in Plant Pathology 1984

California State Polytechnic University, Pomona, BS in Botany and Plant Pathology, 1979

**RESEARCH AND PROFESSIONAL EXPERIENCE**

2000-present. GS 15. USDA-ARS Wheat Health, Genetics, and Quality Research Unit, Pullman, WA. Research Plant Pathologist. Soilborne fungal and nematode diseases of wheat, barley, canola, legumes and other rotation crops. Epidemiology, ecology, detection and quantification of soilborne pathogens. Microbiome of wheat and rotation crops, soil health, soil microbiomes

1989-2000 Dept. Plant Science, Macdonald Campus of McGill University, Ste. Anne de Bellevue, Quebec, Canada. Assistant and Associate Professor. Plant pathology of cereal, fruit, vegetable crops and greenhouse crops. Mycology, ecology, epidemiology.

1987-1989. USDA-ARS Horticultural Research Laboratory, Postdoctoral Research Associate. Biological control of fungal diseases with antagonistic bacteria and interactions with vesicular-arbuscular mycorrhizal fungi.

1984-1987. Department of Plant Pathology and Weed Science, Colorado State University. Visiting assistant professor. Biological control of greenhouse crops.

**Relevant Professional Experience and Synergistic Activities**

2019-present Section Editor, Canadian Journal of Plant Pathology

2007-2016 Editor-in-Chief, American Phytopathological Society Press

2009 Fellow, American Phytopathological Society

2007-2012 Associate Editor-in-Chief, American Phytopathological Society Press

2004-2007 Senior Editor, American Phytopathological Society Press

2005-present Collaborator with CIMMYT Global Initiative on Wheat Root Health in Rainfed System, teaching workshops in Turkey and hosting Turkish, Moroccan and Tunisian scientists.

2002-present Member, secretary, and chair of W-3147 Biological Control of Soilborne Pathogens Multistate CSREES project

1999-2002 Member of U.S. Wheat and Barley Scab Initiative Review Panel

2001-present Section Editor, Canadian Journal of Plant Pathology

1998-2002 Section Editor, Plant and Soil

1994-1997 Senior Editor, Phytopathology

1991-1994 Associate Editor, Phytopathology

From 1990-2000, I supervised to completion 18 MSc students, 4 PhD students, and 5 postdoctoral researchers. From 2000-2022, as an adjunct professor in the Dept. of Plant Pathology at Washington State University, I have supervised or co-supervised 9 PhD and 3 MSc students.

**PUBLICATIONS** (**More than 175 refereed publications over career, 17 book chapters and over 80 abstracts). Refereed publications for the last year are presented.**

Yin, C., Casa Vargas, J.M., Schlatter, D.C. *et al.* Rhizosphere community selection reveals bacteria associated with reduced root disease. *Microbiome* **9,** 86 (2021). <https://doi.org/10.1186/s40168-020-00997-5>

Yin C, Schlatter DC, Kroese DR, Paulitz TC, Hagerty CH. Responses of Soil Fungal Communities to Lime Application in Wheat Fields in the Pacific Northwest. *Front Microbiol*. 2021;12:576763. Published 2021 May 20. doi:10.3389/fmicb.2021.57676342. <https://doi.org/10.3390/agriculture10100447>

Bozoglu, T., Ozer, G., Mustafa, I, Paulitz, T. and Dababat, A. 2021 First report of crown rot caused by Fusarium redolens in Kazakhastan. Plant Disease <https://doi.org/10.1094/PDIS-01-21-0015-PDN>

Imren, M. Ozer, G., Paulitz, T. and Dababat, A. 2021. Plant-parasitic nematode communities associated with wheat-growing areas in central,eastern, and south-eastern Kazakhstan. Plant Disease: https://doi.org/10.1094/PDIS-11-20-2424- SR.

Wang, Z, Schlatter, D., Glawe, D., Edwards, C., Weller, D., Paulitz, T., Abatzouglou, J. and Okukara, P. 2021. Native yeast and non-yeast fungal communities of Cabernet Sauvignon berries from two Washington State vineyards, and persistence in spontaneous fermentation, International Journal of Food Microbiology,

<https://doi.org/10.1016/j.ijfoodmicro.2021.109225>.

Schlatter, D. C, Hansen, J, Carlson, B., Leslie, I. N. Huggins, D. R. and Paultiz, T. C. 2022. Are microbial communities indicators of soil health in a dryland wheat cropping system? Applied Soil Ecology 170: 10.1016/j.apsoil.2021.104302

Yin, C. T., Schlatter, D. C., Kroese, D. R., Paulitz, T. C. and Hagerty, C.H. 2021. Responses of Soil Fungal Communities to Lime Application in Wheat Fields in the Pacific Northwest. Frontiers in Microbiology 10.3389/fmicb.2021.576763

Gargouri, S., Boutrous, A., Murray, T. D., Paulitz, T. C., Khemir, E., Souissi, A. Chekali, S. and Burgess, L. W. 2021. Occurrence of eyespot of cereals in Tunisia and identification of *Oculimacula* species and mating types. Canadian Journal of Plant Pathology 10.1080/07060661.2021.1995501

Hagerty, C., Gardner, S., Kroese, D.R., Yin, C., Paulitz, T.C., Pscheidt, J.W. 2022. Occurrence of mummy berry associated with huckleberry (*Vaccinium membranaceum*) caused by *Monilinia* spp. in Oregon. Plant Disease. 106(2):357-359. https://doi.org/10.1094/PDIS-04-21-0691-SC.

Ahmadi, M., Mirakhorli, N., Erginbas-Orakci, G., Ansari, O., Braun, H., Paulitz, T.C., Dababat, A. 2022. Interactions among cereal cyst nematode *Heterodera filipjevi,* dryland crown rot *Fusarium culmorum*, and drought on grain yield components and disease severity in bread wheat. Canadian Journal of Plant Pathology. 44(3):415-431. https://doi.org/10.1080/07060661.2021.2013947.

**Cynthia Gleason**

**Associate professor**

**department of Plant pathology**

**Washington state university**

[**cynthia.gleason@wsu.edu**](mailto:cynthia.gleason@wsu.edu)

**Education and Training**

2003 Ph.D. University of California, Davis Biochemistry & Molecular Biology

1995 B.S. Santa Clara University, CA Biology

**Research and Professional Experience**

2022- present Associate Professor, Plant Pathology Department, Washington State University

2016-2022 Assistant Professor, Plant Pathology Department, Washington State University

2011-2016 Jr. Professor, Georg-August University, Goettingen, Germany

2006-2011 Post-doctoral fellow, Plant Industry, CSIRO, Perth, Australia

2003-2006 Post-doctoral fellow, Disease and Stress Biology, John Innes Centre, Norwich, UK.

**Professional Activities/Service**

**Trade publications:**

1) Cynthia Gleason and Sagar Sathuvalli “Genetic Diversity in Columbia Root-Knot Nematode, and a Request for Help in Research,”Potato Progress**,** Vol XX, No. 13, 2020

2) Zhang and Gleason, “Loop-Mediated Isothermal Amplification for the Diagnostic Detection of *Meloidogyne chitwoodi,”* Potato ProgressVol XX, No. 1, 2020

**Tools & Products:** Patent Application Number: 6302464, Application Filing Date: May 12, 2021;Title: Bacterial secreted immunostimulants to protect plants against pathogens

**Invited Talks in Past Four Years:**

1. 7th International Congress of Nematology, Antibes, France May 2022

2. 57th Annual Meeting of the Society of Nematologists, Gulf Shores, AL September 2021

2. Plant pathogen effectors- the nematode perspective. The Cluster of Excellence on Plant Sciences, zoom, June 1, 2021.

3. UC Riverside Plant Pathology Seminar, UC Riverside, October 2020

4. Washington*-*Oregon Potato Conference, Kennewick, WA January 2020

5. Plant Pathology Department, University of Wisconsin, Madison, WI. October 2019.

6. Entomology and Nematology Department,Florida State University, Gainesville, FL, 2019

**Synergistic Activities**

**Reviewer of Professional Journals (2020-2022):** Molecular Plant; Phytopathology; Frontiers in Plant Science; PLOS One; Molecular Plant-Microbe Interaction; Plant Physiology, Journal of Nematology; Scientific Reports; Physiological and Molecular Plant Pathology; The Plant Cell; Current Opinion in Biotechnology, BMC Genomics, Plant Disease, Frontiers in Plant Science, Plant Physiology, International Journal of Molecular Sciences, New Phytologist

**Reviewer for Grant Proposals:** US-Israel Binational Agricultural Research and Development Fund (BARD) (2019), USDA-National Science Foundation Plant Biotic Interactions (2020), Israel Science Foundation (2020), German DFG Walter Benjamin Programme (2020)

USDA NIFA (2017, 2019), USDA NSF (2022).

**Refereed Publications (last four years)**

Anderson, S.D., **Gleason, C. “**A Molecular Beacon Real-Time Polymerase Chain Reaction

Assay for the Identification of *M. chitwoodi*, *M. fallax*, and *M. minor.”* Frontiers in Plant Science, under review.

Hu, S., Franco, J., Bali, S., Chavoshi, S., Brown, C., Mojtahedi, H., Quick,R., Cimrhakl, L.,

Ingham, R., **Gleason, C.,** Sathuvalli, V. “Diagnostic molecular markers for identification of different races and a pathotype of Columbia Root-Knot Nematode.” Phytofrontiers, under review.

Baker, H.V, Ibarra Caballero, J.R., **Gleason, C.,** Jahn, C.E., Hesse, C.N., Stewart, J.E. Zasada, I.A. "NemaTaxa: A new taxonomic database for analysis of nematode community data.” Phytobiomes, under revision.

Rutter, W.R., Franco, J., **Gleason, C.** (2022) “Rooting out the mechanisms of plant-nematode

interactions.” Annual Review of Phytopathology 2022 60:1.

Zhang L. and **Gleason, C**.,(2021)“Transcriptome analyses of pre-parasitic and

parasitic *Meloidogyne Chitwoodi* Race 1 to identify putative effector genes.” Journal of Nematology, 53:e2021-84.

Bali, S, Zhang, L., Franco, J., **Gleason, C.** (2021) “Biotechnological advances with applicability

in potatoes for resistance against root-knot nematodes.”Current Opinion in Biotechnology,70: 226-233.*DOI:*https://doi.org/10.1016/j.copbio.2021.06.010

Bali, S., Shengwei, H., Vining, K., Brown, C., Mojtahedi, H., Zhang, L., **Gleason**, **C.,** Sathuvalli, V. (2021) “Nematode genome Announcement: Draft genome of *Meloidogyne chitwoodi,* an economically important pest of potato in the Pacific Northwest.” Mol Plant Microbe Interact Mar 29. doi: 10.1094/MPMI-12-20-0337-A.

Zhang, L. and **Gleason C**. (2020) “Enhancing potato resistance against root-knot nematodes

using plant elicitors delivered by bacteria.” Nature Plants, **6**, pages 625–629.

Bali, S., Vining, K., **Gleason, C**., Majtahedi, H., Brown, C.R., Vidyasagar Sathuvalli, (2019)

“Differential gene expression analysis provides insights into salicylic acid mediated resistance response to *Meloidogyne chitwoodi* derived from Mexican wild potato species *Solanum bulbocastanum*.”BMC Genomics, 20(1):907, DOI: 10.1186/s12864-019-6257-1.

Aharen, I., Habash, S.H., **Gleason, C**., Inada, M., Grundler, F.M.W., Elashry, A. (2019)

“*Heterodera schachtii* glutathione peroxidase (HsGPx) is a parasitism protein.” Journal of Plant Disease and Protection, 1-8, DOI 10.1007/s41348-019-00256-2.

Vieira, P. and **Cynthia Gleason** (2019) “Plant-parasitic nematode effectors – insights into their

diversity and new tools for their identification.” (2019) Current Opinion in Plant Biology, 50:37-43.

Zhang, L. and **Cynthia Gleason** (2018) “Loop-Mediated Isothermal Amplification for the

Detection of *Meloidogyne chitwoodi* and *M. fallax*.” Plant Disease, DOI:10.1094/PDIS-01-18-0093-RE

Leelarasamee, N., Zhang, L., **Gleason**, **C.** (2018)“The root-knot nematode effector MiPFN3 disrupts plant actin filaments and promotes parasitism” PLOS Pathogens 14(3): e1006947. https://doi.org/10.1371/journal.ppat.1006947.

**Kenneth Frost**

Department of Botany and Plant Pathology, Oregon State University

Hermiston Agricultural Research & Extension Center, 2121 S 1st ST, Hermiston, OR 97838

**Education**

Institution Major Degree Year

University of Wisconsin, Madison Biochemistry B.S. 2001

University of Wisconsin, Madison Plant Pathology M.S. 2005

University of Wisconsin, Madison Plant Pathology Ph.D. 2012

**Research and Professional Experience**

Associate Professor & Extension Plant Pathologist, Oregon State University, 2021‑present

Assistant Professor & Extension Plant Pathologist, Oregon State University, 2015‑2021

Postdoctoral Research Associate, University of Wisconsin, Madison, 2013-2015

Research Specialist, United States Dairy Forage Research Center, Madison, 2005-2007

**Principle duties in current position**

Lead a statewide extension program related to the diagnosis and management of diseases of vegetable and other high value irrigated crops. Maintain an applied research program in plant pathology to support the extension program and meet the needs of the agricultural industry in north central Oregon with an emphasis on high value irrigated crops.

**Research Interests**

Ecology and epidemiology of plant disease; agricultural systems; insect vectored plant pathogens; agricultural microbiome; disease diagnostics and integrated pest management

**Synergistic Activities**

* American Phytopathological Society Member (2002 – present)
* Senior Editor, Plant Disease (2019-present)
* Participant in Multistate Projects WERA-89 Potato Virus Management (Chair 2017-18) & W4147 Managing Plant-Microbe Interactions in Soil to Promote Sustainable Ag.
* National Potato Council Scientific Advisory Panel on Grower Pesticides
* Oregon State University Seed Certification, Foundation Seed & Plant Materials Board
* Conduct master gardener training on plant pathology for Oregon State University Extension

**Publications (peer reviewed last 4 years)**

Delventhal, K., Busby, P., and Frost, K.E. 202X. Tare soil alters the composition of the developing the potato rhizosphere microbiome. Phytobiomes XX:XXX-XXX (Accepted November 2022).

Delventhal, K.,Skillman, V., Li, X., Busby, P., and Frost, K.E. 202X. Characterizing variation in the bacterial and fungal tare soil microbiome of seed potato. Phytobiomes XX:XXX-XXX (Accepted November 2022).

Li, X., Skillman, V., Dung., J., and Frost, K.E. 2022. Legacy effect of fumigation on soil bacterial and fungal communities and their response to metam sodium application. Environmental Microbiome 79:59 <https://doi.org/10.1186/s40793-022-00454-w>.

Rivedal, H., Funke, C.N., and Frost, K.E. 2022. An overview of pathogens associated with biotic stresses in hemp crops in Oregon, 2019-2020. Plant Disease 106:1334-1340.

Ma, X., Brazil, J., Rivedal, H., Frost, K., Perry, K., and Swingle, B. 2022. First report of *Pectobacterium versatile* causing potato soft rot of potato in Oregon and Washington. Plant Disease (Note) 106:1292.

Arstingstall, K.A., DeBano, S.J., Li, X., Wooster, D., Rowland, M.M., Burrows, S. and Frost, K. 2021. Capabilities and limitations of using DNA metabarcoding to study plant-pollinator interactions. Molecular Ecology 30:5266-5297.

Rivedal, H., Brazil, J., and Frost, K.E. 2021. Diversity and pathogenicity of *Pectobacterium* species responsible for soft rot of potato in the Columbia Basin of Oregon and Washington. American Journal of Potato Research 98:267-284.

Swisher Grimm, K.D., Crosslin, J.M., Cooper, W.R., Frost, K.E., du Toit, L.J., and Wohleb, C.H. 2021. First report of Curly Top of *Coriandrum sativum* L. caused by Beet curly top virus in the Columbia Basin of Washington State. Plant Disease (Note).

Clements, J., Lamour, K., Frost, K., Dywer, J., Huseth, A. and Groves, R. 2021. Targeted RNA sequencing within *Leptinotarsa decemlineata* populations reveal patterns of transcript expression correlated with insecticide resistance in discrete geographic locations Pest Management Science 76:3436-3444.

Dung, J.K.S. et al. 2021. Molecular and alkaloid characterization of *Claviceps purpurea* sensu lato from grass seed production areas of the U.S. Pacific Northwest. Phytopathology 111:831-841.

Aloqaili, F., Good, S., Frost, K., and Higgins, C. 2020. Differences in soil evaporation between row and inter-row positions in furrowed agricultural fields. Vadose Zone Journal 19:e20086. <https://doi.org/10.1002/vzj2.20086>.

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Kroese, D., Schonneker, L., Bag, S., Frost, K., Cating, R.and Hagerty, C. 2020. Soilborne wheat mosaic virus: yield loss and distribution in the inland PNW. Crop Protection 132:105102.

Dundore-Arias, J.P. et al. 2020. Community-driven metadata standards for agricultural microbiome research. Phytobiomes <https://doi.org/10.1094/PBIOMES-09-19-0051-P>.

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Kaur, N. et al. 2019. Potential for insect-mediated dispersal of *Claviceps* spp. in grass seed crop in the Columbia Basin of Oregon and Washington. Crop Forage and Turfgrass Management 5:190020. doi:10.2134/cftm2019.04.0020.

Huang, D., Yan, G., Gudmestad, N., Ye, W., Whitworth, J., Frost, K., and Crow, W. 2018. Developing a one-step multiplex PCR assay for rapid detection of four stubby-root nematode species, *Paratrichodorus allius*, *P. minor*, *P. porosus*, and *Trichodorus obtusus*. Plant Disease 103:404-410.

Dung, J., Jeness, S., Cheng, Q., Alderman, S., Kaur, N., Walenta, D., Frost, K.E., and Hamm, P. 2018. Detection and quantification of airborne *Claviceps purpurea sensu lato* ascospores from Hirst-type spore traps using real-time quantitative PCR. Plant Disease 102:2487-2493.

Kroese, D., Bag, S., Frost, K., Murray, T., and Hagerty, C. 2018. A diagnostic guide for wheat soilborne mosaic disease of wheat. Plant Health Progress 19:163-167.

**Deirdre Griffin LaHue,** Assistant Professor

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**EDUCATION AND TRAINING**

University of Maryland Environmental Science & Policy B.S. 2012

University of California, Davis Soils & Biogeochemistry M.S. 2015

University of California, Davis Soils & Biogeochemistry Ph.D. 2018

**RESEARCH AND PROFESSIONAL EXPERIENCE**

2019 – Current Assistant Professor of Soil Quality and Sustainable Soil Management, Washington State University, Mount Vernon, WA. (80% Research & Extension, 20% Teaching)

2012 – 2018 Graduate Student Researcher, NSF Graduate Research Fellow, University of California, Davis

**SYNERGISTIC ACTIVITIES**

**Teaching Activities**

* Food Systems of Western Washington, AFS/HORT 350, Undergraduate level (3 credits)
* Regenerative Farming and Ranching, ENTOM 490/590, Undergrad/Grad level (2 credits)
* Special Topics in Soil Science: Soil Health Across Scales, SSC 502, Graduate level (2 credits)

**Professional Activities/Service**

* WA Soil Health Initiative Executive Steering Committee Member, 2019-present
* ASA-SSSA Member, 2011-present
* Leading soil health Extension efforts in NW Washington and statewide

**SELECTED GRANTS**

* From Farmers to Soil Health Managers -- Participatory Design of On-Farm Trials to Stimulate Adoption of Innovative Conservation Techniques by Historically Underserved Farmers in the Puget Sound Region. M. Frazier, M. Ostrom, R. Smith, **D. Griffin LaHue**, G. LaHue, M. Brady. NRCS Conservation Innovation Grant, 1/2022 – 12/2025, $910,126 ($127,509 to program)
* Optimizing Human Health and Nutrition from Soil to Society. K. Murphy, G. Ganjyal, G., **D. Griffin LaHue (Agriculture Team Leader and Co-PI)**, P. Monsavais, R. Brueggeman, F. Carbonero, K. Garland-Campbell, S. Jones, G. LaHue, V. McCracken, R. McGee, C. Neely, M. Perrigue, P. Solverson, K. Szlavecz, J. Tang, A. Thom-Lyman, A. Warner. USDA NIFA AFRI Sustainable Agricultural Systems, 1/2022 – 12/2026, $10 million ($478,332to program)
* Enhancing Human Health and Nutrition from Soil to Society using Quinoa as a Model Crop Species. K. Murphy, **D. Griffin LaHue**, G. Ganjyal, F. Carbonero. Foundation for Food and Agriculture Research (FFAR): Seeding Solutions, 1/2021 - 12/2024, $1,000,000 ($249,818).
* Assessing the soil health of Eastern Washington specialty crops: hops, onion, potato, pulses, sweet corn, tree fruit, and wine grapes. **D. Griffin LaHue** (Co-Lead PI, WSU lead), D. Gelardi, L. Michel, P. Beale, A. McGuire. Washington State Department of Agriculture, Specialty Crop Block Grant Program (WSDA SCBG), 9/2019 – 9/2022, $499,996 ($477,697).

**PEER-REVIEWED PUBLICATIONS (last 4 years)**

* Madrid, B., H. Zhang, C.A. Miles, M. Kraft, **D. Griffin-LaHue**, L.W. DeVetter. 2022. Humic and acetic acid have the potential to enhance deterioration of select plastic BDMs in a Mediterranean climate. *Agriculture* 12, 865.
* Bagnall, D.K., G.M. Bean, D. Liptzin, S.B. Cappellazzi, M. Cope, K.L.H. Greub, E.L. Rieke, C.E. Norris, P.W. Tracy, …, **D. Griffin-LaHue**, …, C.W. Honeycutt. 2022. Selecting soil hydraulic properties as indicators of soil health: Measurement response to management and site characteristics. *Soil Science Society of America Journal* 86(5), 1206-1226.
* Liptzin, D., C.E. Norris, S.B. Cappellazzi, G. Mac Bean, M. Cope, K.L.H Greub, E.L. Rieke, P.W. Tracy,…, **D. Griffin-LaHue,** …., C.W. Honeycutt. 2022. An evaluation of carbon indicators of soil health in long-term agricultural experiments. *Soil Biology and Biochemistry* 172, 108708.
* Una, T.M., D. McMoran, S.S. Seefeldt, B. Maupin, E. Myhre, **D. Griffin-LaHue.** 2022. Short-term impacts of cover crops in maritime potato (*Solanum tuberosum*) systems. *Agrosystems, Geosciences, and Environment* 5, 1-11.
* Bagnall, D.K., C.L.S. Morgan, M. Cope, G.M. Bean, S.B. Cappellazzi, K.L.H. Greub, D. Liptzin, C.E. Norris, E.L. Rieke, P.W. Tracy, …, **D. Griffin-LaHue**, …C.W. Honeycutt. 2022. Carbon‐sensitive pedotransfer functions for plant available water. *Soil Science Society of America Journal*. 1–18.
* Rieke, E.L., S.B. Cappellazzi, M. Cope, D. Liptzin, G.M. Bean, K.L.H. Greub, C.E. Norris, P.W. Tracy, …, **D. Griffin-LaHue,** …C.L.S. Morgan, C.W. Honeycutt. Linking soil microbial community structure to potential carbon mineralization: A continental scale assessment of reduced tillage. *Soil Biology and Biochemistry.* 168, 108618.
* **Griffin-LaHue, D.**, Ghimire, S., Yu, Y., Scheenstra, E.J., Miles, C.A., Flury, M., 2022. In-field degradation of soil-biodegradable plastic mulch films in a Mediterranean climate. *Science of the Total Environment*. 806, 150238.
* Sullivan, D.M., A. Tomasek, **D. Griffin-LaHue,** E. Verhoeven, A.D. Moore, L.J. Brewer, A.I. Bary, C.G. Cogger, D. Biswanath. 2022. PNW 508: Fertilizing with biosolids. *Pacific Northwest Extension.*
* Yu, Y., **Griffin-LaHue, D.**, Miles, C.A., Hayes, D.G., Flury, M., 2021. Are micro- and nanoplastics from soil-biodegradable plastic mulches an environmental concern? *Journal of Hazardous Materials Advances,* 4, 100024.
* Zhang, H., C. Miles, B. Gerdeman, **D.G. LaHue**, and L.W. DeVetter. 2021. Plastic mulch use in perennial fruit cropping systems - A review. *Scientia Horticulturae*. 281:109975.
* Sullivan, D.M., **D. Griffin-LaHue**, B. Dari, A.I. Bary, C.G. Cogger. 2021. PNW 511: Worksheet for calculation biosolids application rates in agriculture. *Pacific Northwest Extension*.
* Li, M., Schmidt., J.E., **LaHue, D.G**., Lazicki, P.A., Kent, A., Machmuller, M.B., Scow, K.M., Gaudin, A.C. 2020. Impact of irrigation strategies on tomato root distribution and rhizosphere processes in an organic system. *Frontiers in Plant Science*. 11:360.
* Shackelford, G.E., Kelsey, T.R., Sutherland, W.J., Kennedy, C.M., Wood, S.A., Gennet, S., Karp, D.S., Kremen, C., Seavy, N.E., Jedlicka, J.A., Graveur, K., Kross, S.M., Bossio, D.A., Muñoz-Sáez, A., **LaHue, D.G**., Garbach, K., Ford, L.D., Felice, M., Reynolds, M.D., Rao, D.R., Boomer, K., LeBruhn, G., Dicks, L.V. 2019. Evidence synthesis as the basis for decision analysis: A method of selecting the best agricultural practices for multiple ecosystem services. *Frontiers in Sustainable Food Systems*. 3:83.
* Margenot, A.J., **D.E.** **Griffin,** B.S.Q. Alves, D.A. Rippner, C. Li, S.J. Parikh. 2018. Substitution of peat moss with softwood biochar for soil-free marigold growth. *Industrial Crops and Products*. 112: 160.