



Objective 1 - *Develop small fruit germplasm through cooperative breeding and evaluation programs.*

Objective 2 - *Develop practices for small fruit production tailored for climatic and market needs of growers.*

Objective 3 - *Evaluate pre- and postharvest fruit quality components, including enhanced flavor, texture/firmness, shelf life, and phytonutrients.*

Objective 4 – *Identify opportunities and collaborate on the development of extension resources for multistate, regional, national, and/or international audiences.*

1. Please list your research and extension projects according to crop and objective.

Blackberry and Raspberry:

Polyethylene and biodegradable plastic mulches for improved establishment of raspberry planted as tissue culture transplants. 2018-2022.

L.W DeVetter, B. Madrid, H. Zhang, C. Miles, C. Benedict, S. Watkinson, Washington State University (WSU), Mount Vernon, WA; I.A. Zasada, USDA-ARS, Corvallis, OR; S. Ghimire, University of Connecticut, Vernon, CT.

Objective 2

Dissemination of results: Results were shared at grower conferences, field days (in WA and CA), and academic conferences.

Plans for next reporting period: Complete degradation studies and disseminate findings via presentations and a peer-reviewed publication.

Impacts of mycorrhizal fungal inoculants and fertilizer sources on red raspberry. 2019-2021.

Lu, Q, and L.W. DeVetter, WSU, Mount Vernon, WA; and R. Bunn and E. Whitney, Western WA University, Bellingham, WA.

Objective 2

Dissemination of results: Results were shared at grower conferences.

Plans for next reporting period: Complete project, final presentations, and publish results in peer-reviewed journal.

Real-time nutrient analyses of raspberry using petiole sap. 2019-2021.

L.W. DeVetter, Q. Lu, and C. Miles, WSU, Mount Vernon, WA.

Objective 2

Dissemination of results: Results were shared at grower conferences and via a newsletter.



Plans for next reporting period: Complete project, final presentations, and publish results in peer-reviewed journal (article submitted).

Evaluation of red raspberry selections for yield and fruit quality in the Pacific Northwest. 1986-ongoing.

W. Hoashi-Erhardt, WSU, Puyallup, WA; L.W. DeVetter, WSU, Mount Vernon, WA; B. Strik and P. Jones, Oregon State University (OSU), North Aurora OR; M. Hardigan, USDA-ARS Corvallis, OR; M. Dossett, BC Blueberry Council, Abbotsford, BC.

Objective 1 and Objective 3

Dissemination of results: Results were disseminated to raspberry growers in WA by field day and conference.

Plans for next reporting period: Repeat of field trials, transition to grower hosted trials.

Evaluation of adaptation of red raspberry selections to machine harvesting and in grower trials. 2003-ongoing.

W. Hoashi-Erhardt, WSU, Puyallup, WA; M. Hardigan, USDA-ARS Corvallis, OR; M. Dossett, BC Blueberry Council, Abbotsford, BC.

Objective 1 and Objective 3

Dissemination of results: Results were disseminated to raspberry growers in WA by field day and conference.

Plans for next reporting period: Repeat of field trials, transition to grower hosted trials.

Evaluation of raspberry selections to root rot. 1986-ongoing.

W. Hoashi-Erhardt, WSU, Puyallup, WA; M. Hardigan, USDA-ARS Corvallis, OR; M. Dossett, BC Blueberry Council, Abbotsford, BC.

Objective 1 and Objective 3

Dissemination of results: Results were disseminated to raspberry growers in WA by field day and conference.

Plans for next reporting period: Repeat of field trials, transition to grower hosted trials.

Evaluation of performance of red raspberry cultivars to individually quick frozen processing. 2020-2023.

Tom Walters, Walters Ag Research, Anacortes, WA; W. Hoashi-Erhardt, WSU, Puyallup, WA.

Objective 1 and Objective 3

Dissemination of results: Results were disseminated to raspberry growers in WA by field day and conference.

Plans for next reporting period: Repeat of field trials, transition to grower hosted trials.



Genomic prediction for quantitative resistance to root lesion nematode in raspberry. 2021-2024.

W. Hoashi-Erhardt, WSU, Puyallup, WA; I. Zasada and M. Hardigan, USDA-ARS Corvallis, OR; M. Dossett, BC Blueberry Council, Abbotsford, BC.

Objective 1 and Objective 3

Dissemination of results: Preliminary results will be shared at grower and academic conferences beginning 2022.

Plans for next reporting period: Establish seedling populations and Rubus selections in screening environment.

Measuring and mitigating soil compaction in raspberry alleyways. 2020-2021.

D. Griffin-LaHue, G. LaHue, WSU Mount Vernon; H. Neely, WSU Pullman; C. Benedict, WSU Whatcom County Extension

Objective 2

Dissemination of results: Preliminary results were shared with growers at the Small Fruit Conference in Whatcom County, WA in December 2020. Additional results will be shared at the Small Fruit Conference in December 2021.

Plans for next reporting period: Continue to optimize measurement methods and discuss other specific compaction management strategies to trial with growers.

Blueberry & Huckleberry:

Optimizing blueberry pollination to ensure future yields. 2020-2024.

R. Isaacs and M. Milbrath, Michigan State University, Lansing, MI; L.W. DeVetter, WSU, Mount Vernon, WA; S. Galinato, WSU, Pullman, WA; R. Malinger, University of Florida, Gainesville, FL; A. Melathopoulos, OSU, Corvallis, OR.

Objective 2

Dissemination of results: Results will be shared at grower and academic conferences winter 2021/2022.

Plans for next reporting period: Repeat some field studies, assess cultivar cross-pollination requirements, model development for pollination decision aid tool, and disseminate findings.

Improving machine harvest efficiency and fruit quality for fresh market blueberry. 2018-2022.

L.W. DeVetter and Y. Cai, WSU, Mount Vernon, WA; S. Sankaran and C. Zhang, WSU, Pullman, WA; J. Chen, University of Georgia, Athens, GA; W. Yang, OSU, Aurora, OR; F. Takeda, USDA-ARS, Kearneysville, WV; S. Korthuis, B. Foote, and K Van Weerdhuizen, Oxbo, Lynden, WA.

Objective 2

Dissemination of results: Results have been shared at grower and academic conferences, as well as an Extension FactSheet (in press).



Plans for next reporting period: Final project webinar and wrap-up project.

Optimizing nutrient management for organically grown blueberries in eastern Washington. 2018-2023.

L.W. DeVetter and A. Bhasin, WSU, Mount Vernon, WA; J. Davenport and G. Hoheisel, WSU, Prosser, WA; N. Stacey, WSU, Puyallup, WA.

Objective 2

Dissemination of results: Results have been shared at grower and academic conferences.

Plans for next reporting period: Repeat field study and report results for this long-term trial.

Determining blueberry cold hardiness in Washington. 2014-2021.

G. Hoheisel, WSU, Prosser, WA; L.W DeVetter, WSU, Mount Vernon, WA; C. Kogan, WSU, Spokane, WA.

Objective 2

Dissemination of results: Results have been shared at grower and academic conferences; a beta-model was also shared among growers winter 2020/2021.

Plans for next reporting period: Finalize project and upload final cold hardiness model on WSU AgWeatherNet (<http://weather.wsu.edu/>).

Valuing nitrogen release from high organic matter soils. 2019 – 2021 (ongoing).

G. LaHue, C. Sloan, L.W. DeVetter, D. Griffin LaHue, C. Benedict WSU, Mount Vernon, WA.

Objective 2

Dissemination of results: Results have been shared at the Washington Small Fruit Conference, the Western Washington Berry Workshop, and at the Washington Blueberry Commission Research Review and an academic journal article is in preparation.

Plans for next reporting period: Continuation of the project will be based on feedback from growers and the Washington Blueberry Commission. If the project does not continue, final results will be shared through the journal article and an extension newsletter.

Management techniques to optimize soil pH and nutrient availability in organic highbush blueberry grown east of the Cascade Range. 2019-2023.

S. Lukas, OSU, Hermiston, OR; L.W. DeVetter, WSU, Mount Vernon, WA; J. Davenport and G. Hoheisel, WSU, Prosser, WA; S. Galinato, WSU, Pullman, WA, D. Bryla, USDA-ARS, Corvallis, OR; B. Strik, D. Sullivan, and K. Trippe, OSU, Corvallis, OR.

Objective 2

Dissemination of results: Results have been shared at regional field days.

Plans for next reporting period: Repeat field study in Hermiston, OR and test pomace



from wine grapes in fields in Washington.

Optimizing the management of mummy berry using an online decision support tool. 2021-2023.

C. Mattupalli, T. Peever, and L.W. DeVetter, WSU, Mount Vernon, WA; M. Cucak, Pennsylvania State University, State College, PA; and D. Hartevelde, formerly at Wageningen University, Netherlands.

Objective 2

Dissemination of results: Results will be shared at grower conferences in the region.

Plans for next reporting period: Validate mummy berry model and present final results.

VacciniumCAP: Leveraging genetic and genomic resources to enable development of blueberry and cranberry cultivars with improved fruit quality attributes. 2019-2023.

M. Iorizzo, North Carolina State University (NC State), Raleigh, NC; et al. (project team at: <https://www.vacciniumcap.org/team>).

Objective 1 and Objective 4

Dissemination of results: Results have been shared at statewide, regional, national, and international grower and academic events focusing on blueberry and cranberry.

Plans for next reporting period: Continue marker and trait identification for fruit quality in blueberry and cranberry, breeding improvement, enhancing coordination among the Vaccinium breeding community, and dissemination of findings.

Strawberry:

Planning grant: Implementation of new technologies and improved end-of-life management for sustainable use of agricultural plastics. 2018-2022.

L.W. DeVetter, C. Miles, D. Griffin LaHue, WSU, Mount Vernon, WA; M. Flury, Puyallup, WA; H. Liu, T. Marsh, K. Englund, S. Galinato, J. Goldberger, T. Chi, M. Perez-Garcia, WSU, Pullman, WA; C. Benedict, WSU, Bellingham, WA; S. Agehara, UF, Wimauma, FL, M. Bolda, University of California Extension, L. McGowen, NC State, Raleigh, NC; P. Krone and J. Mejia-Muñoz, California Marine Sanctuary Foundation, Monterey, CA.

Objective 2 and Objective 4

Dissemination of results: Results have been shared at statewide, regional, and international events via field days and conference presentations.

Plans for next reporting period: Complete project, publish literature review on end-of-life management (submitted), and re-submit SCRI CAP grant to continue work.

Novel production systems for improved production and disease management in strawberry. 2019-2022.

L.W. DeVetter, C. Miles, X.M. Wang, L. Tymon, WSU, Mount Vernon, WA; S. Galinato, WSU, Pullman, WA; S. Jung, Cornell University, Ithaca, NY.

Objective 1



Dissemination of results: Results have been shared grower and academic conferences, as well as student field days.

Plans for next reporting period: Complete project, publish findings, and expand pathology splash dispersal work through another grant.

Strawberry plant breeding for the Pacific Northwest. ongoing.

W. Hoashi-Erhardt, WSU, Puyallup WA.

Objective 1

Dissemination of results: Results have been shared with growers through report.

Plans for next reporting period: Plant and make selections of late season strawberries.

Wine Grapes

Calibrating soil health metrics for wine grape systems in arid and semi-arid climates.

2020-2021.

D. Griffin LaHue, M. McIlquham, K. Sarpong, WSU Mount Vernon; D. Gelardi, L. Michel, P. Beale, WSDA NRAS, Olympia, WA; C. Kogan, WSU Spokane.

Objective 2

Dissemination of results: Results have been shared grower and academic conferences, including the Washington State Grape Society in 2020 and 2021 and the ASA-CSSA-SSSA conference in 2021.

Plans for next reporting period: Continue with data analysis and final publications.

2. Include any data, germplasm/cultivar descriptions, research results, etc. that you would like to discuss at the meeting.

- Our research on soil-biodegradable plastic mulches (BDMs) has continued to show yields and fruit quality of raspberry and strawberry plants grown with BDMs are equivalent to plants grown with non-degradable polyethylene mulch. In-soil degradation of BDMs is slow due to soil temperature in western Washington and exceeds 2 years. Application of “degrading” products (e.g., compost, compost tea, humic acid, and acetic acid) has no influence on the rate of in-soil degradation, however, cover cropping appears to enhance degradation rates. Raspberry growers are reluctant to adopt BDMs due to perceived costs, aesthetics, and questions about durability, degradability, and the unknown impacts on the environment if BDM fragments don’t degrade. Strawberry growers in California express concerns with costs, compatibility with fumigation operations, color, and rate of in-soil degradation. The WSU Small Fruit Horticulture and Vegetable Horticulture programs can provide free training to extension specialists, crop consultants, and growers on BDMs upon request.
- Field- and landscape-level honey bee hive stocking density effects were studied in 16 blueberry fields in western Washington in 2021. In contrast to previous research, no



clear relationship between farm area and field-level hive density was observed. Honey bee abundance was best predicted by landscape level hive density within a radius of 500 and 1000 m. Landscape characterization showed presence of natural habitat around the field did not reduce honey bee visitation to blueberry flowers. Assessments of alleyway vegetation [e.g., dandelion (*Taraxacum officinale*) and buttercup (*Ranunculus* sp.)] showed presence of these plants in the field did not influence the number of honey bees foraging on blueberry flowers nor pollination success. Given natural habitat and alleyway vegetation had no effect on honey bee abundance and pollination success, we encourage establishment or maintenance of these additional sources of habitat and forage that could benefit both honey bee and wild pollinators.

- Our research on N mineralization from soil organic matter and implications for N management in northern highbush blueberry has shown that (1) N mineralization from SOM provides a meaningful contribution to plant available N and soil total N is a reasonable predictor of this contribution despite a lot of variability, and (2) differing N supply from SOM did not appear to have an effect on N fertilizer requirements after 3 years, as even the lowest N rates applied were sufficient of maximum fruit yield and quality.

3. List retrievable or archived publications arising from your collaborative research and extension projects.

Journal articles:

- Bhasin, A., J. Davenport, S. Lukas, Q. Lu, G. Hoheisel, and L.W. DeVetter. 2021. Evaluating postharvest organic nitrogen fertilizer applications in early fruiting northern highbush blueberry. HortScience. *In press*.
- Cai, Y., F. Takeda, B. Foote, and L.W. DeVetter. 2021. Effects of machine-harvest interval on fruit quality of fresh market northern highbush blueberry. Horticulturae, 7:245. doi: <https://doi.org/10.3390/horticulturae7080245>.
- DeVetter, L. W., S. Galinato, T. Kortus, and J. Maberry. 2021. Alternate-year production is not profitable in Washington florican red raspberry systems. HortTechnology. doi: <https://doi.org/10.21273/HORTTECH04864-21>.
- Grant, K.J., L. DeVetter, and A. Melathopoulos. 2021. Honey bee (*Apis mellifera*) colony strength and its effects on pollination and yield in highbush blueberries (*Vaccinium corymbosum*). PeerJ. 9:e11634 <https://doi.org/10.7717/peerj.11634>.
- 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. <https://doi.org/10.1016/j.scienta.2021.109975>.
- Smith, O.M., B. Gerdeman, M. Arrington, H. Spitler, and L.W. DeVetter. 2020. Pollination, crop productivity, and arthropod and bird communities are



marginally impacted by border vegetation in highbush blueberry production. HortTechnology. <https://doi.org/10.21273/HORTTECH04735-20>.

Theses:

- Cai, Y. 2021. Machine harvesting comparison and optimization of machine harvest intervals in fresh market blueberry. MS Thesis, Washington State University, Pullman.
- McCoy, M. 2021. Assessing sprayer technology and grower education in Washington viticulture. PhD Dissertation, Washington State University, Pullman.
- Sloan, C. 2021. Nitrogen supply from soil organic matter: Predictors and implications for nutrient management in northern highbush blueberry. MS. Thesis, Washington State University, Pullman.

Proceedings

- DeVetter, L.W., J.R. Goldberger, C. Miles, and J. Gomez. 2021. Grower acceptance of new end-of-life management strategies for plastic mulch in strawberry systems. Acta Horticulturae 1309: IX International Strawberry Symposium. doi: <https://doi.org/10.17660/ActaHortic.2021.1309.95>.
- Pottorff, M., M. Iorizzo, M.A. Lila, P. Perkins-Veazie, C. Finn, N. Vorsa, P. Edger, N. Bassil, P. Munoz, K. Gallardo, A. Atucha, D. Main, L. Giongo, C. Li, J. Polashock, C. Sims, E. Canales, L.W. DeVetter, D. Chagne, R. Espley, and M. Coe. 2021. VaccinumCAP, a community-based project to develop advanced genetic tools to improve fruit quality in blueberry and cranberry. Acta Hort. *In press*.

Abstracts – none to report

Extension Publications

- DeVetter, L.W., W.Q. Yang, F. Takeda, and J. Chen. 2021. Harvesting blueberries: A guide to hand and machine pick blueberries for fresh market. WSU Extension FactSheet. *In Press*.

Websites

- WSU Small Fruit Horticulture website: <https://smallfruits.wsu.edu/>
 - Website specific on plastic mulch application and alternatives to plastic mulch: <https://smallfruits.wsu.edu/plastic-mulches/>
- WSU Small Fruit Plant Breeding website: <https://puyallup.wsu.edu/smallfruit/>