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Research Progress Reports

for the

OREGON RASPBERRY AND BLACKBERRY COMMISSION

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Blackberry Pomace for Disease Prevention in Dairy Cows

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Project Objectives: The objective of this proposal is to evaluate the effect of feeding blackberry pomace during the last 4 weeks before and the first 4 weeks after calving on serum markers of inflammation, oxidative damage, and metabolic status. The central hypothesis of the proposal is that feeding blackberry pomace will improve markers of inflammation (lower haptoglobin and serum amyloid A), markers of oxidative damage (lower malondialdehyde and greater vitamin E), and markers of metabolic status (lower non-esterified fatty acids and β-hydroxybutyrate and greater glucose) in multiparous dairy cows.

Project Status: We secured over Summer sufficient blackberry pomace to start the experiment. As first step, blackberry pomace was dried and stored at refrigeration temperature. As next step, we set up germination experiments as our animal units were concerned regarding germinating blackberry seeds in the manure. After proving that the blackberry seeds did not germinate, we started the experiment in October. Currently, we have the first 6 cows on the study, of those the first 3 cows have calved last week. The cows consume the blackberry pomace within two days of adaptation. We have not observed any problems with cows rejecting the pomace as feed. All cows on the studies are doing very well health-wise. We hope to complete the animal trial by July 2016 and then finish the blood analysis by Fall 2016.We will present preliminary results at this year's Oregon Raspberry & Blackberry Annual Growers Meeting as well as at the regional meetings of the Oregon Dairy Farmers Association. The final results of this study will be published into extension materials and scientific literature.

Report to the Agricultural Research Foundation

for the Oregon Raspberry and Blackberry Commission

Title: Caneberry Pesticide Registration, Tracking, and New Chemistries

Principal Investigator: Joe DeFrancesco
Oregon State University
North Willamette Research and Extension Center

Funding Period: 2014-2015

Progress:

I. We continue to keep track of pesticide issues affecting the Oregon caneberry industry. Each week, I monitor the published US Federal Register, which is the official venue for notices and actions relating to pesticide registrations at EPA, and follow-up on any issues that may affect the Oregon caneberry industry. Some new US-registered caneberry pesticides are quick to obtain an MRL in foreign markets, while others are slower and still in progress. I continue to work with the USDA-Foreign Agricultural Service and pesticide registrants to get tolerances (MRLs) established for caneberries in foreign markets.

II. The Pesticide Registration Update Chart I develop for caneberry growers and field representatives is updated at least three times a year, most often prior to the ORBC annual meeting, in spring prior to the growing season, and at the NWREC Caneberry Field Day. Growers and other industry representatives indicate this list is widely used as a reference for pest management decisions. I also develop and distribute a list of MRLs (maximum residue levels) for caneberries in the US, Canada, Japan, the EU/UK, Korea, Taiwan, and Codex (international). This helps growers and processor/packers develop a pest management spray regime based on the anticipated destination of their fruit.

III. We communicate with representatives of the caneberry industry and continue to identify and prioritize pest management gaps and needs, which may be created by the loss of currently registered pesticides. The ORBC is kept updated on important pesticide issues via grower meetings, ORBC meetings, newsletters, or personal communication

IV. ***New Pesticide Registrations - 2015:***
The residue and efficacy data we generated and submitted to EPA for review allowed the registration of the following products in caneberries:

(1) Scala (pyrimethanil). Scala is a new fungicide from Bayer for control of Botrytis fruit rot. It is in FRAC Group #9, which is the same group as one of the components of Switch.

(2) Protexio (fenpyrazamine). Protexio is a new fungicide from Valent also for control of Botrytis fruit rot. It is in FRAC Group #17, which is the same group at Elevate (fenhexamid), and a group that is known for good control of *Botrytis cinerea.* Valent improved the formulation of Protexio from when it was first registered and the product is now more resistant to photodegradation, which will increase longevity and activity once on the plant. Protexio is currently registered for use in raspberries only; residue data supports a blackberry registration so why blackberries are not on the label is still a mystery I'm trying to solve.

(3) QuiltXcel (azoxystrobin + propiconazole). QuiltXcel is a new fungicide from Syngenta containing two active ingredients for broader disease control. QuiltXcel controls anthracnose, Septoria, rusts, and powdery mildew. FRAC Group # 3 and #11. Azoxystrobin and propiconazole are registered individually for use in caneberries as Abound and Tilt, respectively.

V. ***IR-4 Residue Trials Completed in 2015:***

Residue trials generate data that are required by EPA for the registration of a pesticide. In 2015, we conducted six magnitude of residue field trials in raspberries and blackberries for two active ingredients that will provide the data and information needed to allow a registration in caneberries.

(1) Clopyralid (Stinger). Stinger is a postemergence, contact herbicide that will be effective in controlling clovers and hard-to-control weeds like Canada thistle. Caneberry growers have wanted a Stinger registration for many years and this is the first time that Dow AgroScience has agreed let us pursue a registration. The field trials were successfully completed and samples are at the laboratory awaiting residue analysis.

(2) Isoxaben (Trellis). Isoxaben is also sold as "Gallery" but the Trellis formulation will be the product registered for use in berry crops. Gallery is currently registered for use in non-bearing caneberry fields; the residue data we've collected will allow isoxaben to be registered for use in bearing fields. Trellis is a broad-spectrum preemergence herbicide that is effective in controlling many broadleaf weeds, including wild carrot, horseweed (an emerging problem in the PNW), sowthistle, prickly lettuce, and dandelion. It also provides partial control of bindweed seedlings, which can be a major pest problem in some fields. Isoxaben has been shown to be very safe on caneberries.

VI. The IR-4 Food Use Workshop is an annual event where researchers from across the USA come together to discuss and prioritize pest management residue projects for all minor/specialty food crops grown in the USA. High priority projects are financially supported by IR-4 for the coming field season, which ensures that the necessary residue data will be collected and submitted to EPA for registration. I attended the 2015 workshop and presented the pest management needs of the Oregon caneberry industry.

IR-4 Residue Trials Slated for 2016:

(1) **Oxathiopiprolin (Orondis).** A new fungicide from Dupont with a novel mode of action that is effective in controlling Phytophthora root rot. Oxathiapiprolin is the only fungicide in FRAC group #U15 and is not cross-resistant to any other fungicide. This product is soil-applied and could be used in rotation with mefenoxam (Ridomil).

(2) **FTH545**. This is a new fungicide from Syngenta that does not currently have a trade name. Results from field trials show excellent efficacy for control of Botrytis fruit rot and other diseases.

VII. ***Phosphorous Acid /European Union MRL Project Slated for 2016:***

Phosphorous acid products, such as Phosphite, Phostrol, Aliette, etc., are currently registered for use in caneberries for control of Phytophthora root rot via foliar application. Some phosphorous acid products don't make claims of fungicidal activity and are used for nutrition and plant health. Using phosphorous acid products for both Phytophthora control and for nutrition/plant health has resulted in excessive residue levels in fruit being shipped to the European Union (EU). The EU has temporarily increased the Maximum Residue Level (MRL) to 75 ppm for all crops in order to reduce the likelihood of an MRL violation and/or impeding international trade. (The current MRL of phosphorous acid for caneberries in the EU is 2.0 ppm.)

In 2016, I will participate in a national and international residue project to collect data from field trials that will evaluate residue levels using a protocol that calls for multiple applications of phosphorous acid. In the interim, we are hoping the EU will keep the temporary MRL in place for caneberries until we can provide the additional data and information that will support multiple applications of phosphorous acid. Even though the EU is not a major foreign market for Oregon caneberries, it is believed that other countries, such as Japan, Korea, and Taiwan, are looking to the phosphorous acid situation in the EU to determine how they may or may not alter their national MRLs for phosphorous acid.

VIII. ***Impacts and Benefits of this Project:***

The registration of safe and effective pest management solutions helps growers produce a high quality crop, remain economically viable, and enables them to be competitive in the national and international marketplace. Providing growers and the caneberry industry with current information about pest management and pesticide issues helps them be up-to-date and better informed as they make important pest management and marketing decisions that affect their operation. In addition, the registration of new chemistries, with unique modes of action, helps reduce the likelihood of the development of resistance and increase the chances of successful pest management.

Report to the Agricultural Research Foundation
2015

Title: Supplement to SCRI grant "Developing the Genomic Infrastructure for Breeding Improved Black Raspberries"

Principal investigators: Chad Finn, USDA/ARS Geneticist, NCSFR
Nahla Bassil and Jill Bushakra, USDA/ARS National Clonal Germplasm Repository
Jungmin Lee, USDA/ARS HCRL, Parma, ID

Cooperators: *Scientists:* G. Fernandez (NC State), P. Perkins-Veazie(NC State), C. Weber (Cornell University), T. Mockler (OSU), R. Agunga (Ohio State Univ.), E. Rhoades(Ohio State Univ.), J.C. Scheerens(Ohio State Univ.), W. Yang (OSU), K. Lewers (USDA-ARS, Beltsville), J. Graham (James Hutton Institute, Scotland), F. Fernández Fernández (East Malling Research, UK), S.J. Yun (Chonbuk University).
Growers: In Oregon: Oregon Berry Packing, Riverbend, Sandy Farm, Townsend Farms; In New York- Orchard Dale; in North Carolina, SunnyRidge Farms; In Washington: Wyckoff Farms.

Objectives:
The real objective is to show support for the Specialty Crop Research Initiative Grant that we received funding for in 2011. The specific objectives for that project are:

1) Transcriptome sequencing and high throughput genomic sequencing.
2) Developing molecular markers from genomic and EST sequences.
3) Studying genotype by environment interaction in crosses involving diverse wild black raspberry germplasm.
4) Using molecular markers for mapping specific traits of interest in crosses involving diverse wild black raspberry germplasm.
5) Evaluate transferability of SSR markers developed in black raspberry to red raspberry.
6) Better understanding of consumer preferences and factors promoting black raspberry market expansion.
7) Delivering research results and training in molecular breeding to the industry, breeders, and students through a multifaceted outreach and extension program.

If you would like to see the entire proposal I would be happy to share it with you.

Progress:

We completed propagation of the mapping populations and either shipped them to locations in the eastern US or planted them at our location and the commercial grower locations in the Pacific Northwest. All populations established well with almost no plant losses. We began the discussion on phenotyping protocols. The USDA-ARS NCGR group isolated DNA from parents and each individual in the mapping populations. The OSU CGRB generated transcriptome sequences from leaves, stems, canes, green berries, red berries, and ripe berries of 'Jewel'. These

RNA sequences will be assembled next and then used to develop additional markers to populate the black raspberry linkage map. We have presented our results at several international and regional conferences. Our summer intern assisted in the collection and analysis of several fruit and growth traits at the Corvallis location and screened more than 200 markers for potential use in the mapping project.

We have constructed and published a genetic linkage map and placed on it a locus associated with aphid resistance. We are in the process of characterizing this and other aphid-resistance associated loci to improve its usefulness as a breeder-friendly marker. Our summer intern screened the populations at the Corvallis location for the presence of *Raspberry bushy dwarf virus* and found only 10 % of the plants to be infected. We are collecting the final season of phenotypic data at the four research locations.

We have completed sensory evaluations using trained and untrained panels. We have shown that consumers have a distinct preference for flavor in black raspberry.

Results:
We are on track. Research plots have been established and lab work is progressing. We are gathering phenotypic data on each individual plant at the different locations. Our genetic linkage map is being used by other researchers to identify regions of interest in other berry crops.

Publications:
Peer-reviewed Publications (PDs in bold font):

Lee, J. 2015. Analysis of bokbunja products show they contain *Rubus occidentalis* L. fruit. *Journal of Functional Foods*. 12:144-149.

Bushakra JM, Bryant DW, Dossett M, Vining KJ, VanBuren R, Gilmore BS, **Lee J,** Mockler TC, **Finn CE, Bassil NV**.2015. A genetic linkage map of black raspberry (*Rubus occidentalis*) and the mapping of Ag_4 conferring resistance to the aphid *Amphorophora agathonica*. Theor Appl Genet. 128(8):1631-1646.

Perkins-Veazie P, Fernandez G, Ma G, Bradish C, Bushakra JM, **Bassil N**, Scheerens J, Weber C, **Finn CE.**In press.Black raspberry fruit composition from seedling populations grown at four geographic locations in the U.S. Acta Hort.

Bradish C, Fernandez G, Bushakra JM, **Bassil N, Finn CE**, Dossett M. In press.Evaluations of sustained vigor and winter hardiness of black raspberry (*Rubus occidentalis*) grown in the southeastern U.S. Acta Hort.

Bushakra JM, **Bassil N**, Weiland J, **Finn CE**, Vining K, Filichken S, Bryant D, Mockler T, Dossett M. In press. Comparative RNA-seq for the investigation of tolerance to Verticillium wilt in black raspberry. Acta Hort.

Bassil N, Gilmore B, Hummer K, Weber C, Dossett M, Agunga R, Rhodes E, Mockler T, Scheerens JC, Filichkin S, Lewers K, Peterson M, **Finn CE,** Graham J, **Lee J,** Fernández-Fernández F, Fernandez G, Yun SJ, Perkins-Veazie P. 2014. Genetic and developing genomic resources in black raspberry. *Acta Hort.* 1048:19-24.

Lee J. 2015. Sorbitol, *Rubus* fruit, and misconception.*FoodChem.* 166:616-622.

Lee J,Dossett M, **Finn CE.** 2014. Mistaken identity: clarification of *Rubus coreanus* Miquel (bokbunja). *Molecules- special Anthocyanin issue* 19:10524-10533.

Lee J. 2014. Marketplace analysis demonstrates quality control standards needed for black

raspberry dietary supplements. *Plant Foods Human Nutr.* 69:161-167.
Lee J, Dossett M, **Finn CE.** 2014. Anthocyanin rich black raspberries can be made even better*Acta Hort.* 1017:127-133.
Lee J, Dossett M,**Finn CE.** 2013. Anthocyanin fingerprinting of true bokbunja (*Rubus coreanus* Miq.) fruit. *J Funct Foods.* 5:1985-1990.
Paudel L,Wyzgoski FJ,Giusti MM, Johnson JL, Rinaldi PL, Scheerens JC,Chanon AM,Bomser JA, Miller AR, Hardy JK, Reese RN. 2014. NMR-based metabolomic investigation of bioactivity of chemical constituents in black raspberry (*Rubus occidentalis* L.) fruit extracts. *J Agric Food Chem.*62:1989-1998.
Paudel L,Wyzgoski FJ, Scheerens JC,Chanon AM, Reese RN,Smiljanic D,Wesdemiotis C, Blakeslee JJ,Riedl KM, Rinaldi PL. 2013. Non-anthocyanin secondary metabolites of black raspberry (*Rubus occidentalis* L.) fruits: Identification by HPLC-DAD, NMR, HPLC-ESI-MS and ESI-MS/MS analyses. *J Agric Food Chem.*61:12032-12043.

Additional Publications (PDs in bold font):

Lee, J. 2015. *Rubus* myths vs. reality.http://www.black-raspberries.com (Factsheet/Other)
Lee J, Dossett M, **Finn CE.** 2014. Chemotaxonomy of black raspberry: deception in the marketplace? Polyphenols Communications 2014 (Proceedings of XXVIIth International Conference on Polyphenols, Nagoya, Japan). 2014:347-348. (Conference Proceedings)
Lee J, Dossett M, **Finn CE.** 2013. Black raspberry: Korean vs. American. http://www.black-raspberries.com (Other)
Lee J, Dossett M, **Bassil NV, Finn CE.** 2013. A black berry that is not a blackberry. http://www.black-raspberries.com (Other)

Presentations (PDs and presenters in bold font):

Lee, J. Poster. Adulteration and its detection of black raspberry products.American Chemical Society (ACS) 250th National meeting. Boston, MA. August 2015.
Bushakra JM(presenter), Bryant D, Bradish CM, Dossett M, Vining K, Weiland JE, Filichkin S, Perkins-Veazie P, Scheerens JC, Weber CA, Buck EB, Agunga R, Yang W, Fernández-Fernández F, Yun SJ, Lewers K, Graham J, Fernandez G, Mockler T, **Lee J, Finn CE, Bassil NV.**Oral presentation.Developing the genomic infrastructure for black raspberry breeding improvement: An update. North American Raspberry Blackberry Association (NARBA), Fayetteville, AR, 24-27 February 2015.
Bushakra JM (presenter), Dossett M, Lee JC, **Lee J, Bassil NV, Finn CE.** Oral presentation.Molecular evaluation of aphid-resistant black raspberry germplasm for improved durability in black and red raspberry.American Society for Horticultural Science(ASHS), New Orleans, LA, 4-7 August 2015.
Bushakra JM, Dossett M, Sandefur P (co-presenters).Oral presentation.From wild germplasm to molecular tools for applied breeding: Black raspberry as a case study, Pre-conference Symposium, ASHS New Orleans, LA, 3 August 2015.
Bushakra JM(presenter), Bryant D, Dossett M, Vining K, VanBuren R, Gilmore B, Filichkin S, Weiland JE, Peterson M, Bradish CM, Fernandez G, Lewers K, Graham J, **Lee J**, Mockler T, **Bassil NV, and Finn CE.** Poster.Developing black raspberry genetic and genomic resources.ASHS,New Orleans, LA, 4-7 August 2015.
Bushakra JM (presenter), Bryant D, Dossett M, Vining K, Van Buren R, Gilmore B, Filichkin S, Weiland J, Peterson M, Bradish C, Fernandez G, Lewers K, Graham J, **Lee J**, Mockler T, **Bassil N, Finn CE.** Poster.Developing black raspberry genetic and genomic

resources.International Society of Horticultural Sciences (ISHS). Asheville, NC, 22-25 June 2015.

Bushakra JM(presenter), **Bassil N, Finn CE**, Peterson M, Bradish C, Fernandez G, Dossett M, Weber C, Scheerens J, Robbins L. Poster.Toward understanding genotype x environment interactions on flowering and fruiting in black raspberry (*Rubus occidentalis* L.).ISHS Asheville, NC, 22-25 June 2015.

Bradish CM,**Bushakra JM**, Dossett M, **Bassil NV, Finn CE, Fernandez GE** (presenter). Poster.Genotyping and phenotyping heat tolerance in black raspberry (*Rubusoccidentalis*L.). International Horticulture Congress (IHC), Brisbane, Australia. August 2014.

Bradish C (presenter), Fernandez G, **Bushakra J**, Perkins-Veazie P,Dossett M,**Bassil N, Finn C**. North Carolina's role in a nationwide effort to improve black raspberry. Oral presentation.Southern Region – American Society for Horticultural Science (ASHS), Dallas, TX, February 2014.

Bradish C(presenter), Fernandez GE,**Bushakra JM**,Bassil NV, Perkins-Veazie P, Dossett M, and**Finn CE**. Phenotypic evaluations of heat tolerance and fruit quality traits in segregating black raspberry (*Rubusoccidentalis* L.) populations in North Carolina.Oral presentation.National Association of Plant Breeding, Minneapolis, MN, August, 2014.

Bradish C (presenter). Fernandez G, **Bushakra J**, Perkins-Veazie P, Dossett M, **Bassil N, Finn C**. Phenotypic evaluations of yield and fruit quality traits in segregating black raspberry (Rubusoccidentalis L.) populations in North Carolina. Oral presentation.Southern Region – ASHS, Dallas, TX, February 2014.

Bryant D(co-presenter), **Bushakra JM** (co-presenter), Dossett M, Vining K, Filichkin S, Weiland JE, Lee J, Finn CE, Bassil NV, Mockler T. Oral presentation. Building the genomic infrastructure in black raspberry. ASHS, Orlando, FL. July 2014.

Bryant D(presenter), **Bushakra JM**, Vining K, Dossett M, **Finn CE**, Filichkin S, Weiland JE, **Bassil NV**, Mockler T. Poster & Oral presentation. Development of genomic resources in black raspberry.RGC7, Seattle, WA. June 2014.

Bushakra JM (presenter), Bradish CM, Weber CA, Scheerens JC, Dossett M, Peterson M, Fernandez G, **Lee J, Bassil NV, Finn CE**. Poster.Toward understanding genotype x environment interactions in black raspberry (*Rubusoccidentalis* L.).ASHS, Orlando, FL. July 2014.

Bushakra JM (presenter), Bryant D, Bradish CM, Dossett M, Vining K, Weiland JE, Filichkin S, Perkins-Veazie P, Scheerens JC, Weber CA, Buck EB, Agunga R, Yang W, Fernández-Fernández F, Yun SJ, Lewers K, Graham J, Fernandez G, Mockler T, **Lee J, Finn CE, Bassil NV.**Oral presentation.Developing the genomic and genetic infrastructure for black raspberry. ASHS, Orlando, FL. July 2014.

Bushakra JM (presenter), Bryant D, Dossett M, Gilmore B, Filichkin S, Weiland JE, Peterson M, Bradish CM, Fernandez G, Lewers K, Graham J, **Lee J**, Mockler T, Bassil NV, **Finn CE**. Poster.Black raspberry genetic and genomic resource development.American Society of Plant Biologists, Portland, OR. July 2014.

Bushakra JM, Bryant D, Vining K, Dossett M, Mockler T, **Finn CE** (presenter), **Bassil NV.**Poster.Developing a genotype by sequencing protocol for linkage map construction in black raspberry (*Rubusoccidentalis* L.).IHC, Brisbane, Australia. August 2014.

Bushakra JM, Bradish CM, Weber CA, Scheerens JC, Dossett M, Peterson M, Fernandez G, **Lee J, Bassil NV, Finn CE** (presenter). Oral presentation.Toward understanding genotype x environment interactions in black raspberry (*Rubusoccidentalis* L.).IHC, Brisbane, Australia.

August 2014.

Bushakra JM (presenter), Bryant D, Vining K, Dossett M, Mockler T, **Finn CE, Bassil NV**. Poster & Oral presentation.Linkage mapping of black raspberry.7thRosaceae Genome Conference (RGC7), Seattle, WA. June 2014.

Lee J (presenter), Dossett M, and **Finn CE.**Poster. Chemotaxonomy of black raspberry: issues with marketplace products. 2014 XXVIIth International Conference on Polyphenols (The 8th Tannin conference jointly hosted), Nagoya, Japan. September 2014.

Lee J (presenter), Dossett M, **Finn CE**. Poster. What's really in our black raspberry products?: chemotaxonomy by anthocyanin. Botany 2014-Botanical Society of America Conference, Boise, ID. July 2014.

Perkins-Veazie P (presenter), Fernandez G, Bradish CM, Ma G, Scheerens JC, Weber CA, **Finn CE, Bassil NV, Bushakra JM**. Poster. Black raspberry fruit composition from seedling populations planted at multiple locations. ASHS, Orlando, FL. July 2014.

PROGRESS REPORT TO OREGON RASPBERRY AND BLACKBERRY COMMISSION
November, 2015

TITLE: Development of New Raspberry Cultivars for the Pacific Northwest

PROJECT LEADER: Patrick P. Moore, Professor
Wendy Hoashi-Erhardt, Scientific Assistant
WSU Puyallup Research and Extension Center

PROJECT STATUS: Continuing (indefinite)

FUNDING:
2014-2015 funding from Oregon Raspberry and Blackberry Commission $4,400. Funds were used for timeslip labor, supplies and services. Other sources of funds for raspberry work at Puyallup include Washington Raspberry Commission and Northwest Center for Small Fruits Research.

OBJECTIVES:
Develop summer fruiting red raspberry cultivars with improved yields and fruit quality, and resistance to root rot and raspberry bushy dwarf virus. Selections adapted to machine harvesting or fresh marketing will be identified and tested further.

PROGRESS:
Three WSU selections and 'Rudi' were planted in grower trials in 2012. Some plants were harvested in 2013 and the first harvest of the other locations were in 2014. One of the selections planted in the trial was WSU 1507, was released as 'Cascade Harvest' in late 2013. One of the other selections harvests well with good fruit quality and with root rot tolerance, but there are concerns about yield. Four WSU selections were planted in grower trials in 2014. All of these selections appeared very promising in small plots in Machine Harvesting trials. Larger plantings of these selections will be planted again in 2016.

Crosses/seedlings/selections. Seventy-seven crosses were made in 2015 with emphasis on parents that are machine harvestable and root rot resistant. An additional eight crosses were made for germplasm development. Fifty-one selections were made in 2015 with 45 having an RBDV resistant parent and 47 selections had a root rot resistant parent. Sixteen of the selections had 'Boyne' as a parent, 15 had 'Cascade Harvest', 14 had WSU 1980 and 14 had WSU 0836. This seedling field had high levels of root rot and significant mortality.

Machine Harvesting Trials. A new machine harvesting trial was planted in 2015 in Lynden with 35 WSU selections, 18 BC selections and 'Cascade Harvest', 'Meeker' and 'Willamette' for reference. This planting will be harvested in 2017 and 2018. The most promising of the selections planted in the 2012 and 2013 machine harvesting trials will be planted with a cooperating grower for additional evaluation.

Selection Trial Puyallup. The 2012 and 2013 replicated plantings at Puyallup were hand harvested in 2015. The 2015 yield and fruit weight in the 2012 planting was about 75% of that in 2014 (Table 1). WSU 1980, WSU 1984, WSU 1977 and WSU 1956 had the firmest fruit.

'Squamish' had a midpoint of harvest similar to 'Willamette', but in this planting had low yields in both harvest seasons. In the 2013 planting, 'Cascade Harvest' had the highest yield and largest fruit weight. WSU 2130 and WSU 2068 combined a similar season to 'Willamette' with higher yields and firmer fruit.

Summary

This project will develop new raspberry cultivars using conventional breeding methods. Controlled pollinations will be made, seedlings grown, selections made among the seedlings and these selections evaluated. The primary goal of the program is to develop new summer fruiting red raspberry cultivars with improved yields and fruit quality, and resistance to root rot. Selections adapted to machine harvesting or fresh marketing will be identified and tested further. The most promising selections will be tested in grower trials and evaluated for their IQF potential.

Several raspberry selections tested in machine harvesting trials appear very promising: machine harvesting well, productive, with good fruit integrity, good flavor and some with probable root rot tolerance. Three WSU selections were planted in grower trials in Oregon and Washington in 2012 and four WSU selections in grower trials in 2014.

WSU 1507 was planted in the 2012 grower trial and was released as **Cascade Harvest** in 2013. **Cascade Harvest** is a machine harvestable, root rot tolerant, raspberry bushy dwarf virus resistant cultivar with good flavor.

Table 1. 2015 harvest of 2013 planted raspberries, Puyallup, WA

	Yield (t/a)	Fruit weight (g)	Fruit firmness (g)	Culls (%)	Midpoint harvest	Length of season
C Harvest	7.8 a	3.21 a	192 ab	11.2 a	6/28 cd	28 ab
WSU 2130	7.2 a	2.46 c-f	187 ab	3.5 de	6/23 e	25 bc
WSU 2068	6.1 a	2.94 a-c	140 c-e	6.2 b-e	6/23 e	23 bc
Meeker	5.8 a	2.38 d-f	157 b-e	9.6 ab	7/1 a-c	25 bc
WSU 2069	5.8 a	2.86 a-d	163 b-d	5.5 b-e	6/25 dc	25 bc
WSU 2022	5.7 a	2.97 ab	159 b-e	7.9 a-c	6/25 dc	25 bc
WSU 2075	5.7 a	2.02 fg	127 ef	2.7 e	6/22 e	21 c
WSU 1914	5.4 ab	3.14 a	141 c-e	4.6 c-e	6/30 bc	26 a-c
WSU 1985	5.1 ab	2.39 d-f	214 a	7.2 a-d	7/3 ab	26 a-c
WSU 1962	5.0 ab	2.37 d-f	173 bd	7.3 a-d	7/5 a	31 a
WSU 1958	4.8 ab	2.12 e-g	96 fg	7.2 a-d	6/23 e	23 bc
Willamette	4.7 ab	2.34 e-g	131 de	4.0 c-e	6/22 e	23 bc
WSU 2010	4.7 ab	1.85 g	137 de	4.9 c-e	6/24 dc	25 bc
WSU 1908	2.3 b	2.59 b-e	82 g	4.9 c-e	6/23 e	22 bc
Average	5.4	2.55	150	6.2	6/26	25

Table 2. 2014 and 2015 harvest of 2013 planted raspberries, Puyallup, WA

	Yield (t/a)			Fruit weight (g)		Culls (%)		Fruit firmness (g)		Midpoint of harvest	
	2015	2014	Total	2015	2014	2015	2014	2015	2014	2015	2014
WSU 1956	9.7 a	11.6 a	21.3 a	2.77 d	3.78 ab	6.7 ab	4.1 a	211 bc	119 bc	7/10 a	7/10 ab
WSU 2011	5.3 b	11.7 a	17.0 ab	2.04 d	3.05 c	5.2 ab	1.8 a	150 d	79 d	7/3 bc	7/5 b-c
WSU 1964	7.1 ab	9.5 ab	16.6 ab	2.28 d	3.34 bc	5.0 ab	2.7 a	158 d	86 d	7/1 c	7/1 d
WSU 1984	6.2 b	10.3 ab	16.5 ab	2.80 bc	3.82 ab	6.3 ab	3.0 a	254 ab	136 b	7/5 b	7/6 b-c
WSU 1980	5.6 b	10.3 ab	15.9 ab	2.87 bc	3.83 ab	4.4 ab	2.7 a	292 a	171 a	7/8 a	7/12 a
WSU 1977	6.7 ab	8.5 ab	15.2 ab	3.19 ab	4.30 a	6.5 ab	3.8 a	218 bc	109 cd	7/8 a	7/7 bc
Willamette	6.0 b	6.6 ab	12.6 b	3.04 bc	3.47 bc	2.8 b	2.7 a	153 d	96 cd	6/25 d	6/25 e
Meeker	6.9 ab	5.1 b	12.0 b	2.87 bc	3.33 bc	8.0 a	3.5 a	184 cd	110 cd	7/5 b	7/4 cd
Squamish	6.5 ab	5.4 ab	12.0 b	3.50 a	3.69 ab	6.6 ab	4.7 a	178 cd	107 cd	6/24 d	6/23 e
Average	6.7	8.8	15.4	2.82	3.62	5.7	3.2	200	112	7/3	7/3

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12-month Small Fruit Update Progress Report

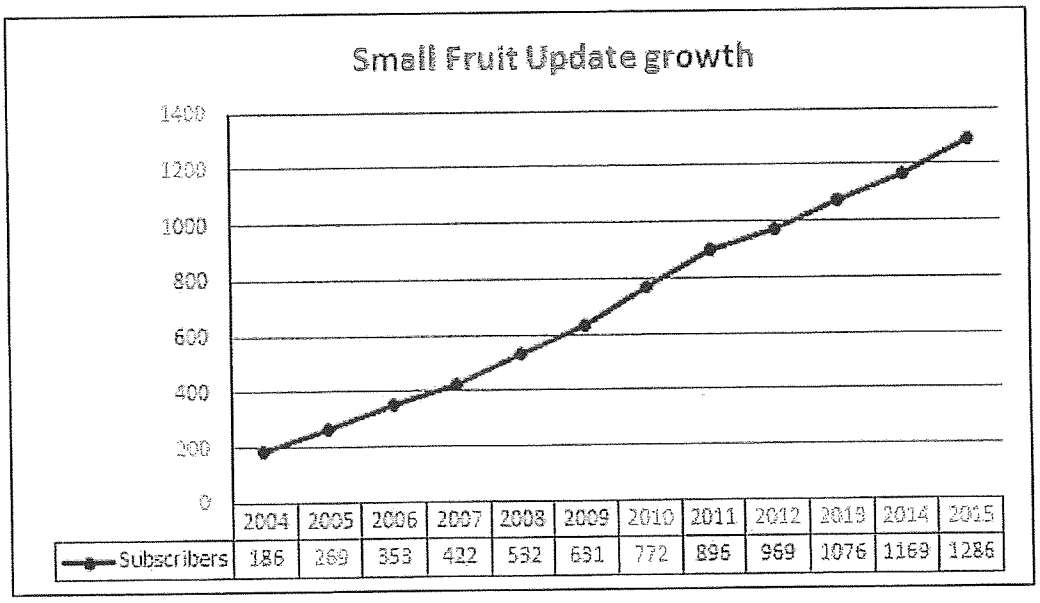
November 2014 to November2015

Objectives:

- Increase industry communication.
- Increase grower knowledge of IPM strategies.
- Accelerate the dissemination of pesticide information such as label changes to growers.
- Facilitate real time pest alerts to growers throughout the growing season.
- Inform industry personnel of upcoming meetings as well as other relevant commission news such as elections, seat vacancies and/or legislative activities.

Overview

Peerbolt Crop Management has been providing a weekly emailed Small Fruit Update to an increasing number of growers, industry personnel, and researchers since February 2000. At the time of this report, the email list grew from 1169addresses in November 2014, to 1286 addresses in November2015. There were 170 new subscribers to the SFU, while 27 individuals were unsubscribed. The net addition of143 Small Fruit Update Subscribers represents an8.8% increase in total subscribed recipients. As a number of recipients regularly pass it on to others, we estimate the total number receiving the Update to be well over 1,300 people.

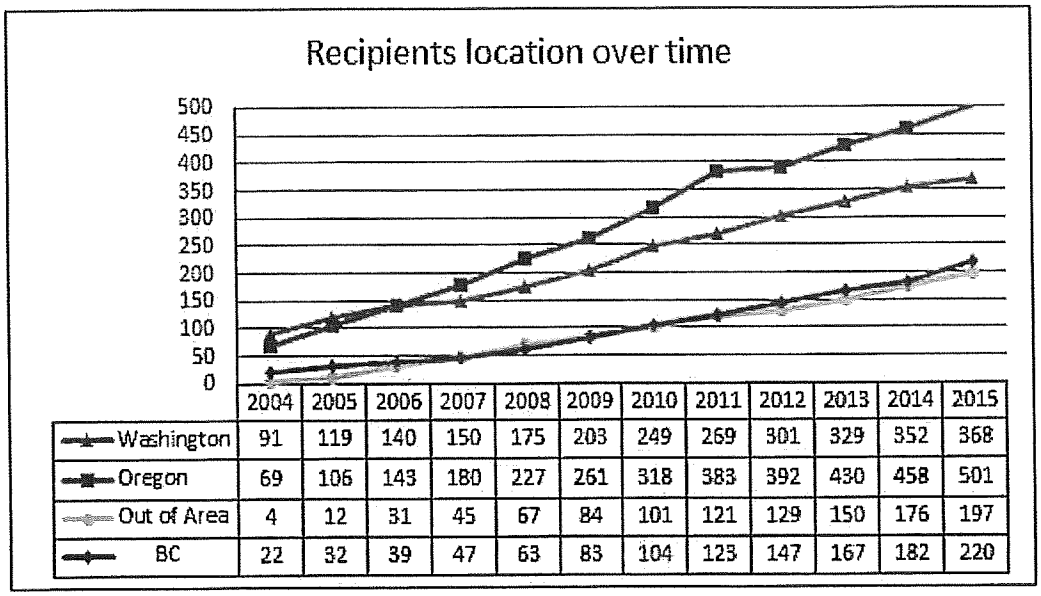


	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Subscribers	186	269	353	422	532	651	772	896	969	1076	1169	1286

2015 Profile of the Small Fruit Update

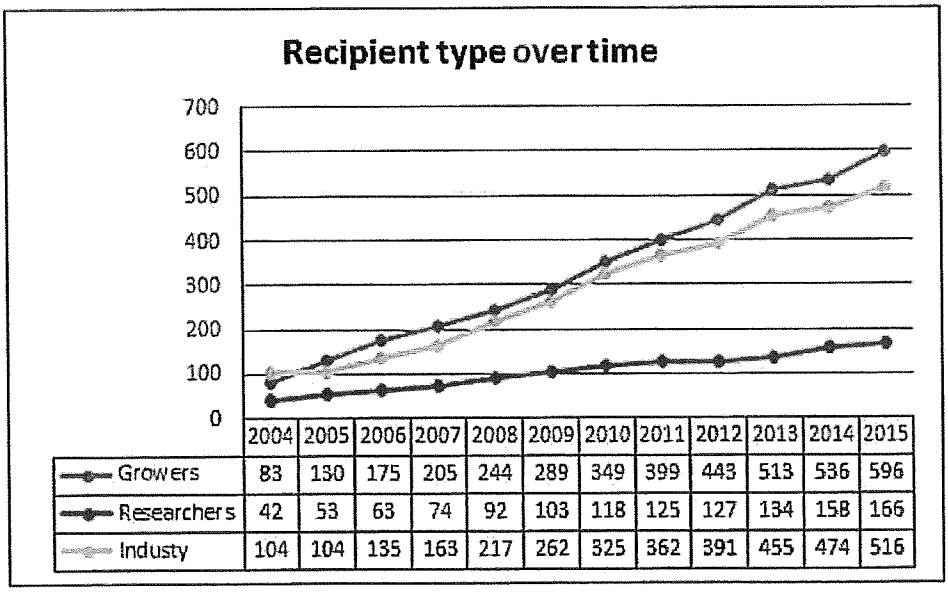
The following charts illustrate the profile of the Small Fruit Update recipients in our database as of November 2015.

We make every effort to provide you with accurate information.We don't mandatethose who sign up for the Update to give us anyinformation beyond theiremail address, name, address, and phone number. We also request that growers note what crops they grow. Sometimes they do, and sometimes they do not. This means that our annual demographic reports often change previous report's numbers. Also note that each year we lose a certain number of recipients (this year there were 27unsubscribers). Some drop out because of a job change, but there are always a few droppedsimply because their email address no longer works and we are unable to rectify the situation after attempting to contact them.However, you can see that even with these individuals dropped, the overall trend for the SFU is an *increase* in recipients across all locations.



	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Washington	91	119	140	150	175	203	249	269	301	329	352	368
Oregon	69	106	143	180	227	261	318	383	392	430	458	501
Out of Area	4	12	31	45	67	84	101	121	129	150	176	197
BC	22	32	39	47	63	83	104	123	147	167	182	220

Between November 2014 and November 2015, there has been a subscriber increase of 38recipients in BC, 43in Oregon and 16 in Washington.The remaining recipients are located throughoutthe U.S., Canada, and the rest of the world.That segment increased by 21 subscribers. We screen new subscribers from potentially competitive markets until such time that the funding entities decide that is not necessary.

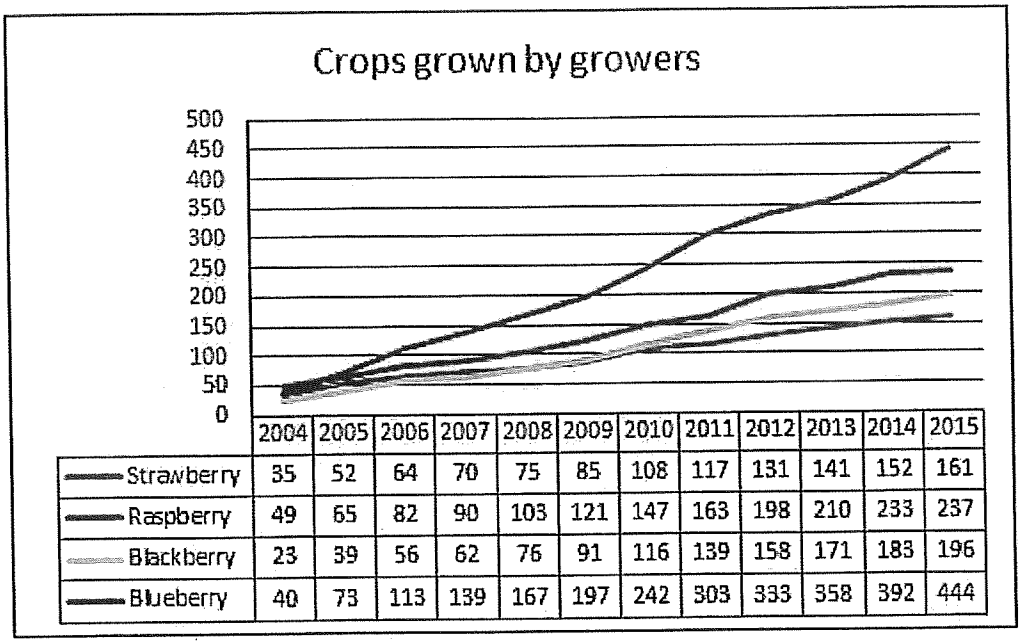


	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Growers	83	130	175	205	244	289	349	399	443	513	536	596
Researchers	42	53	63	74	92	103	118	125	127	134	158	166
Industy	104	104	135	163	217	262	325	362	391	455	474	516

The "Researchers" category includes anyone associated with USDA, ARS, a college or university, as well as state or federal departments of agriculture, and others who work for public agencies. Over the past year, researchers receiving the Small Fruit Update has grown by 8 individuals. This may reflect a natural pause after the growth in researchers who subscribed in 2014,

The category "Industry" includes suppliers, newspaper reporters, propagators, processors, nurseries, fruit buyers, manufacturers, sales reps, and even bankers. This year the number of industry recipients grew by 42 individuals.

Our signup form (http://www.berriesnw.com/SFU.asp) encourages those wanting the Update to give us demographic information. The crop data reflects the fact that some growers do not indicate what crop they grow and some growers are harvesting more than one small fruit.



	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Strawberry	35	52	64	70	75	85	108	117	131	141	152	161
Raspberry	49	65	82	90	103	121	147	163	198	210	233	237
Blackberry	23	39	56	62	76	91	116	139	158	171	183	196
Blueberry	40	73	113	139	167	197	242	303	333	358	392	444

In general, the trend over the past 10 years is that strawberry recipients have grown at a slow rate, blackberry and raspberry growers have been growing steadily, and blueberry producers have been rising exponentially.In 2015, the numberof recipients identifying themselves asblackberry growers increased 7.0%, strawberry growers increased 6%, and blueberry growers increased 12%, whileraspberry growers only increased 2%.

As noted at the start of this report the Small Fruit Update continues to expand its recipient list and the quality and quantity of the information provided. The past ten years have seen a 691% increase in subscribed recipients of the Small Fruit Update, and become an informationresource to the Northwest berry industry.Over the years to come, the Small Fruit Update will strive to be a pivotal resource for an ever growing network of people involved in the small fruit industry.

Progress Report to the Oregon Raspberry & Blackberry Commission

November 20, 2015

Project Title: Coordinated Regional on-farm Trials of Advanced Blackberry & Raspberry Selections (Third year 2015)

Principal Investigator:
Thomas Peerbolt –Peerbolt Crop Management Inc, Portland, OR
Co PIs
Chad E. Finn – USDA-ARS-HCRU, Corvallis, OR
Patrick Moore – Washington State University, Puyallup, WA

Justification

– The Northwest blackberry and raspberry breeding programs have been a cornerstone of the industry's success. Their ability to produce cultivars of commercial value is crucial to continued success. Global competition is increasing and public funding for these programs at our land grant institutions is under increasing budget constraints. Accelerating the commercialization of the cultivars produced by these programs is of great economic value to the northwest caneberry industry.

Objectives

– Organize, put in place and manage a pilot network of regional on-farm grower trials for evaluating blackberry and raspberry advanced selections issuing from the USDA-ARS/OSU caneberry breeding program in Corvallis, the WSU raspberry breeding program in Puyallup and the industry supported raspberry breeding program in British Columbia.

– Place trials on farms located in a variety of regional growing conditions. This network would connect growers, commodity commission contractors, wholesale nursery propagators, public small fruit breeders, and small fruit researchers for the purposes of
(1) Improving the quality and breadth of information available on advanced selections,
(2) Improving the efficiency of this information's distribution to the grower/processor base.

– The overall goal of the project is to combine public and private resources in ways that would accelerate the commercialization of our genetic resources.

Progress to date:

Infrastructure developments (end of second year)

- Established grower cooperator network and have two successive trial blackberry plantings in the ground (see listings on next page).
- Developed Microsoft Access database for organizing, archiving and retrieving all the data.
- Developed yearly timeline for trial activities.
- Developed protocols for consistent evaluation of trials and site visits.
- Established network between participating growers, propagators, breeders, and other industry and commission participants.
- Developed draft overall budget for determining annual costs for maintaining an ongoing program.

Information Products Produced

- **First cultivar/selection trail performance report.** (see attachment)
  - Information will be disseminated via the Small Fruit Update Newsletter as well as at meetings and posted on website.
- **Second cultivar/selection factsheet handout**
  - *Will be produced annually.*
  - *These will be handed out at meetings, posted on industry websites*
  - *Since the oldest plantings have only been in the ground for two years and have not yet produced a sizable crop, these factsheets are preliminary. Factsheets done after the third and fourth years of the plantings will have much more useable information.*
- **Variety development Small Fruit Update**
  - *Costs covered by numerous sources.*
  - *Linked to www.berriesNW.com website.*

On-Farm Blackberry Trials

What's in the ground by planting year, grower and number of plants per trial

2015

- No new trials of processing blackberry or black raspberry selections were planted in 2015 since no advanced selections were at the stage where it was deemed useful and/or the appropriate numbers of plants were not available.
- Plantings established the previous two years continued to be evaluated as they reached bearing age.
- In 2016 there are three potential blackberry selections to be planted as well three potential black raspberry selections.

Processed Blackberry

2014

	ORUS 3172-1 (2 wk later than Marion)	ORUS 2635-1 (Erect-thorny)
Jerry Dobbins	200	
Don Sturm	200	100
Dave Kunkel	200	
RBO	10	

2013

	ORUS 3447-1	ORUS 2707-1	Newberry
Ken Van Dyke	200	200	200
Larry Duyck	200		
Tim Kreder	240		240
Dave Kunkel	250	250	250
Don Sturm	200	200	200

Fresh Blackberry

2014

	ORUS 1939-4 (Early-will release)	ORUS 3447-2 (Giant size)	ORUS 2816-4 (Late-Chester time)	ORUS 2635-1 (Erect-thorny)
Don Sturm	10	10	10	10
Tony Schedeen	10	10	10	10
Matt Unger	10	10	10	10
RBO		10	10	
Richard Sakuma		10		
Mike Christensen		10		

2013	Onyx	ORUS 1793-1
Don Sturm	10 Onyx	10 ORUS 1793-1
Richard Sakuma	10 Onyx	10 ORUS 1793-1
RBO	10 Onyx	10 ORUS 1793-1
Matt Unger	10 Onyx	10 ORUS 1793-1
Tony Schedeen	10 Onyx	10 ORUS 1793-1

Additional Information on Establishing a Regional Onfarm Blackberry and Raspberry Selection/Variety Trials

The above report covers the work funded by ORBC and covers blackberry selections for the processed market. Below is relevant information produced by a similar project funded by the Washington Red Raspberry Commission for processed red raspberry selections.

On-Farm Raspberry Trials

What's in the ground by planting year, grower and number of plants per trial

Processed Red Raspberry

2014	WSU 1980	WSU 2122	WSU 2166	WSU 2188
Jerry Dobbins	79	100	100	39
(Dobbins also planted 200 Cascade Harvest (WSU 1507) & commercial #'s of Rudi in same field)				
Ralph Minaker	125	250	250	125
Don Sturm		100	85	
Jon Maberry	42	200	160	11
RBO		10		
Adam Enfield	45			

2013	Lewis	BC 92-9-15 (Squamish)
Rob Dhaliwal	250	
Ralph Minaker	250 (died out)	
Darryl Ehlers	200 (died out)	200
Don Sturm	100	100
Richard Sakuma	12	12
Adam Enfield	250	

2012	WSU 1507	WSU 1912	WSU 1948	Rudi
Adam Enfield	250	250	250	250
Ralph Minaker	225	225	225	225
Richard Sakuma		200	200	200
Don Sturm	150	275	175	

Fresh Red Raspberry

2014	ORUS 4090-1
Don Sturm	10
Tony Schedeen	10
Matt Unger	10
RBO	10
Richard Sakuma	10

2013	Vintage	ORUS 1142-1
Don Sturm	10	10
Richard Sakuma	10	10
RBO	10	10
Matt Unger	10 ++	10
Tony Schedeen	10	10

Blackcaps

2014	ORUS 3735-3	ORUS 3038-1	ORUS 3013-1 (2X Munger)	ORUS 3217-1 (2X Munger)	ORUS 3409-1 (2X crops/season)
Don Sturm	1 40	25	15	25	15
OBPI	150	25	25	25	
RBO	10		10		10

2013	ORUS 3735-3
Don Sturm	25

Grower Locations

Columbia Farms Dave Kunkel, Owner/manager Sauvie Island—Portland, OR

Dhaliwal Farms, Rob Dhaliwal, Lynden, WA

Dobbins Berry Farm, Jerry Dobbins, Owner/manager Ridgefield, WA

Duyck Farm, Larry Duyck, Banks, OR

Ehlers Farms, Darryl Ehlers, Lynden, WA

Enfield Farms, Adam Enfield, Lynden, WA

Grandpa's Fresh Market, Mike Christensen, Owner/manager Albany, OR

Kreder Farms, Tim Kreder, Dayton, OR

Maberry Farms, Jon Maberry, Lynden, WA

Minaker Berry Farm, Ralph Minaker, Owner/manager Everson, WA

Oregon Berry Packing, Inc., Joe Duyck, Farm Manager Hillsboro, OR

Riverbend Organic Farm (RBO), TJ Hafner, manager Jefferson, OR

Sakuma's Brothers Farms, Richard Sakuma, Manager Burlington, WA

Schedeen's Berry Farm, Tony Schedeen, Owner/manager Boring, OR

Sturm's Berry Farm, Don Sturm, Owner/manager Corbett, OR

Unger Berry Farms, Matt Unger, Owner/manager Cornelius, OR

Van Dyke Farms, Ken Van Dyke Cornelius, OR

Oregon Raspberry and Blackberry Commission

On Farm Variety/Selection Trials

Initial Trial Performance Evaluations, October 21, 2015
from Tom Peerbolt, Principal Investigator

Blackberries:

- **Columbia Star** (ORUS 3447-1) (Planted in 2013)—Fruit quality is great. Could be a dual use berry (both processed and fresh). Overall yield potential remains the major question to answer. As far as trials go, we have enough plantings and realistic evaluation of its potential. Don't need more. Besides its being planted so much commercially that we're going to know all we need to soon.

- **ORUS 2707-1** (2013)—Large, very sweet fruit but didn't hold up at all to this season's hot weather conditions. Problems with softness, sunburn. Will continue evaluation another year or two. Right now it doesn't seem very promising.

- **Newberry** (2013)—Fruit is good. Nice unique flavor. Yields, machine harvestability good. But it doesn't have a market. Not sure there's a reason to continue evaluations for Northwest processed blackberry growers. I hope it finds a fresh market niche. I like it but....processors and these machine harvest growers don't presently have a use for it. A lesson I've learned with this one—don't have growers do large trials for something they don't have a definite market for unless they specifically request it.

- **ORUS 3172-1** (2014) —Looks good for fruit, yields, etc but it's early in evaluations. Hard sell right now because it's later the Marion/Black Diamond. Growers don't have much interest in this window presently. I think this could change and want to continue looking at it but don't need more trials right now.

Blackberry--Present Plans for 2016 Season

- **ORUS 4057-3**—Extremely early. 7-10 days before Black Diamond. Need to accelerate development/evaluation. This one could find a profitable grower niche.
- **ORUS 3453-2**—Large fruit. Always sweet. Good yields. Similar season to Marion.
- **ORUS 3448-2** Hopefully can get enough plants for trial. It shares some things with ORUS 4057-3... early, high yielding, thornless, sweet. It is shares a parent with Columbia Star..

Raspberries

(Sister project, funded by the Washington Red Raspberry Commission)

- **Rudi** (Year planted: 2012)—Produces a very early crop (Before Willamette). Harvest period is very concentrated. Good yields of fruit with IQF potential. Berry size is average. Tendency to mold especially since its early and has very heavy picks. Have enough plantings and realistic evaluation of its potential. Don't need more. Growers could remove trials if desired.

- **Cascade Harvest** (2012)—It's showing susceptibility to root rot on heavier sites. Disappointing. Need to continue observing the trials already in the ground for at least a couple more years to get a better reading on how much root rot resistance it has compared to standards. Fruit quality and yields look excellent. Plenty of commercial plantings now in for observation also. For me, I'm going to discourage growers from planting on heavier soils and warn about its now unknown root rot resistance.

- **WSU 1912** (2012)—Showing good root rot resistance, good fruit flavor and appearance. However berry size is too small and it fall fruits. A sibling--WSU 1914 has a larger size fruit in the small trials. We could trial it in 2016 as well as continuing observations on WSU 1912. (Note on WSU 2014: Enfield small trial had very low yield. Do we want to try a couple of trials anyway?)

- **WSU 1948** (2012)—Main drawback is poor flavor. Will observe trials in the ground for another year but most likely not going to go any further with it.

- **Lewis** (2013)—Had three larger trials all die out in Northern Washington in the first year after planting. Was thinking possible problem with planting stock and might need a couple more trials to fully evaluate whether it's as susceptible to root rot as it presently appears. I just haven't seen any plantings that would contradict that it's pretty susceptible. Am inclined at this point to not do more trials. Some growers have planted it. Probably just keep an eye on those.

- **Squamish (BC 92-9-15)** (2013)—We put in a couple trials last year. One of which was on a heavy site and died out. Seems there's a fair amount being planted in B.C. I'm inclined to not put in any more of it in these trials and rely on feedback from the B.C. growers.

- **WSU 1980** (2014)—Went down to apparent root rot in one trial. Also reported to have crumbly fruit virus symptoms in first year of harvest. Not planning on any further trials.

- **WSU 2122/WSU 2155/WSU 2188** (2014)—We've got some trials of these in that are just a year old but didn't have adequate plant numbers. So they're being included for more trials in 2016.

Raspberry--Present Plans for 2016 Season

- *WSU 2122; WSU 2166; WSU 2188; WSU 2010* As

stated above-We've got some trials of these put in 2014 that are just a year old but didn't have adequate plant numbers. So they're being included for more trials in 2016.

- **WSU 1914** This is a sibling of WSU 1912 that we've had in the trials planted in 2012. WSU 1912 is showing good root rot resistance, good fruit flavor and appearance. However berry size is too small and fall fruits. WSU 1914 has a larger size fruit in the small trials at North Willamette in Oregon and at Enfield Farms in Lynden.

- **WSU 2010** Very high yielding in some small trials

Progress Report to the Agricultural Research Foundation
2015-16

Title: Cooperative breeding program - Caneberries

Principal investigators: Bernadine Strik, Professor, Horticulture
Berry Production System Research Leader, NWREC
Chad Finn, USDA/ARS Geneticist

Pat Jones & Amanda Vance Faculty Research Assistants NWREC
Ted Mackey & Mary Peterson, USDA/ARS Technicians

Cooperators: Pat Moore, WSU, Puyallup
Michael Dossett; Agriculture and Agri-Foods Canada
Brian Yorgey, OSU, Dept. Food Science & Tech.
Bob Martin, USDA-ARS
Enfield Farms/Northwest Plants
Lassen Canyon Nursery
North American Plant
Northwest Plants
NorCal/Sakuma Brothers Farms
Oregon Raspberry and Blackberry Commission
USDA-ARS Northwest Center for Small Fruit Research
Oregon and Washington berry growers

Objectives:

- To develop new blackberry cultivars for the Pacific Northwest that are high yielding, thornless, winter tolerant, adapted to mechanical harvesting, and that have excellent fruit quality.While the primary emphasis is on blackberries with excellent processed fruit quality, high quality fresh market cultivars will be pursued as well.
- To develop raspberry cultivars for the Pacific Northwest in cooperation with Agriculture and Agri-Foods Canada and Washington State University that are high-yielding, machine harvestable, disease/virus resistant and that have superior processed fruit quality.While the priority will be on the processed market, fresh market cultivars will be pursued as well.
- To evaluate black raspberry selections and cultivars for their adaptation to the Pacific Northwest and to develop selections that combine similar processed fruit quality to 'Munger' with greater yields and plant longevity (disease tolerance).
- To collect, evaluate and incorporate new *Rubus* germplasm into the breeding program.

Progress:

The USDA-ARS breeding program in cooperation with Oregon State University and the Pacific Northwest industry continues to develop red and black raspberry, blackberry, andstrawberry cultivars that meet the industry stated objectives. A primary objective for the Oregon caneberry industry has been the development of thornless blackberry cultivars with outstanding flavor/processing characteristics that can be machine harvested for processing and ideally are a bit firmer and more winter tolerant than 'Marion'. 'Black Diamond' has been the most widely planted cultivar from this effort and has been the #1 for plant sales for several years. In addition, while thorny, 'Obsidian', 'Metolius', 'Newberry', and 'Onyx', have been released to provide different options for the blackberry fresh market.'Columbia Star' in its first years of plant sales was 2nd only to

'Black Diamond' in sales. Remarkably, in 2014-15 'Black Diamond' accounted for 32% of plants sold in the PNW, 'Columbia Star' was at 30% and 'Marion' was at 2.7%.This coming year we will see 'Columbia Giant' available to growers as a very large fruited and thornless blackberry that is probably for fresh but can be machine harvested. Towards an improved floricane red raspberry,the high quality and high yielding 'Coho' was released butit was too susceptible to root rot to become a major cultivar.We have been very active in testing WSU and AgCanada raspberry selections to assess what is appropriate for Oregon and we were partners in the new release 'Cascade Harvest' as well as the release of 'Saanich', 'Cascade Bounty', and 'Cascade Gold'. The relatively recent primocane fruiting release 'Vintage' is performing well for some growers and we are planning to release ORUS 4090-1 in the coming year.We identified several black raspberry selections for processing that we are moving to the nurseries with the goal of having quantities available for commercial trial soon.

In 2015, we evaluated about 4,000 red raspberry and black raspberry seedlings. Due to winter damage to the seedlings in 2013 that should have been evaluated in 2014, we kept them for an additional year and so evaluated over 5,000 blackberry seedlings this past summer. We made red raspberry (35 floricane, 19 primocane),10 black raspberry, and47 blackberry (25 trailing, 12 erect/semi-erect, and 10 primocane fruiters) selections.Below are the highlights of the genotypes at various stages of evaluation.

Blackberry

Cultivar Releases

'Columbia Giant' released and patent application filed

A sibling of 'Columbia Star', this thornless genotype produces a very large berry (12-13 g) that has excellent quality. The yields are higher than 'Marion' and even with a night at 8-9 °F in December 2014, produced a good crop of fruit. While greatest interest may be for local fresh market, it machine harvests and the fruit are excellent when processed, so it could be used for the processed markets.

Slated for release depending on grower trial results. Need names, patent data or plant propagation.

- **ORUS 1793-1** is a trailing blackberry with very high quality, firm fruit that ripens after the very early ripening 'Obsidian'. Has been trialed in the NW and California. It was identified by fresh shippers as one with excellent potential. Very good yields of very sweet fruit. Suffered severe injury due to a late freeze in 2006 but was still only slightly worse than 'Marion' in the same planting.Struggling with finding time for paperwork.
- **ORUS 1939-4 is a trailing blackberry with** large, very firm, sweet, glossy, and attractive fruit on thorny plants. Ripens after 'Obsidian' and 'Metolius'. Very good yields. Struggling with finding time for paperwork.
- **ORUS 2711-1** is a semi-erect type blackberry (ie 'Triple Crown', 'Chester Thornless' type) that is 25% western trailing and 75% eastern blackberry. Productive, firm, medium sized berry, very good quality. Ripens about 3 weeks after 'Marion' and 1 week before 'Navaho'. Has done well in California.
- **ORUS 2816-4** is a semi-erect type blackberry (ie 'Triple Crown', 'Chester Thornless' type) that is 25% western trailing and 75% eastern blackberry. Productive, firm, medium sized berry, very good quality. Ripens with 'Chester Thornless'. Tested well in California where its primocane vigor and erectness was greater than ORUS 2711-1.
- **ORUS 4024-3** has 'Willamette' as a grandparent. Very attractive glossy red fruit that look like a

'Tayberry'. Picks easily and may even be machine harvestable. Wonderful flavor and commercial growers want it after 1st look. May be winter tender.

Grower trials

In addition to the above, the following have been/are being propagated for grower trials

- ORUS 2635-1 A trailing blackberry with a very erect habit. Best suited to fresh market as excellent quality and high yields but thorny
- ORUS 2785-2 A trailing blackberry best suited to processing. High yields of small fruit similar to 'Wild Treasure' in size.
- ORUS 2816-3. Semi-erect types that are 25% western trailing and 75% eastern blackberry. Productive, firm, medium sized berry, very good quality. Ripens with 'Chester Thornless'.
- ORUS 2855-1. Thornless hybrid that is 50% wild. This and ORUS 2785-2 are the last two small fruited types we will push forward; 'Marion' yields, very small, good quality fruit
- ORUS 3172-1 While medium sized and moderate yield (comparable to 'Marion'). Very high quality and very late for a trailing, about 2 weeks later than 'Marion'. Identified in grower trial by commercial grower/processor as one of interest. Most importantly, it survived -2 to 0 °F temperatures in December 2013 with no apparent injury.
- ORUS 3448-2. A half sib of 'Columbia Star'. Thornless, high yielding with excellent fruit quality. Very early ripening (7-10 days before 'Black Diamond') and sweeter flavor than 'Columbia Star' as a fresh fruit.
- ORUS 3453-2. A half sib of 'Columbia Star'. Thornless, high yielding, with outstanding fruit quality. Consistently perceived as being sweeter than 'Columbia Star' fresh.
- ORUS 3636-1. Is a thorny trailing blackberry that produces high yields of good sized fruit a week ahead of 'Black Diamond' and a few days ahead of 'Obsidian'/'Metolius' in some years. Probably discard in favor of thornless ORUS 3448-2.
- ORUS 4057-3. Thornless that produces high yields of high quality fruit 7-10 days ahead of 'Black Diamond' and ahead of 'Metolius'/'Obsidian' in some seasons.
- NZ 9607R-4 had yield and fruit size comparable to 'Chester Thornless' and while very firm had just okay flavor (like 'Chester Thornless'!). Slightly later than 'Chester Thornless'. Too soft so will be discarded.

2011 Trailing Planting (Tables BLK1 and BLK8)

- 'Columbia Giant' continues to have good yields. While less than 'Black Diamond' in 2015 was greater in 2013 and 2014. It was damaged by cold temperatures in December 2013 but still had better yield than 'Marion' and 'Black Diamond'. Thornless, high yielding, and good fruit quality but its fruit size is what sets it apart as it has beautiful berries that average 12+ g.
- ORUS 4024-3 has 'Willamette' as a grandparent. Very attractive glossy red fruit that look like a 'Tayberry'. Picks easily and may even be machine harvestable. Severely damaged by 8-9 °F in December 2013. While recovered from that freeze, was not back to full size by 2015.

2012 Trailing Planting (Tables BLK2 and BLK8)

- Very exciting planting with several interesting selections.
- ORUS 3448-2 Had a comparable yield to Marion' in each harvest year. What has set it apart is that it is early ripening, very sweet and has good ripening uniformity. Earlier ripening is one way to potentially reduce (through avoidance) spotted winged drosophila damage. A high yielding and thornless genotype with large fruit and excellent quality that ripens early is exciting. A number of growers have expressed interest in trialing it on their farms.
- ORUS 4057-3 is thornless with excellent yields of large fruit. The plant is thornless and the fruit

ripen earlier than 'Black Diamond'. ORUS 3448-2 was similarly early and with good quality but 1st year yields were only the same as 'Marion'.

- ORUS 4222-1While slightly smaller than 'Marion' and 'Black Diamond', yields were comparable to 'Black Diamond' and it is thornless producing a very high quality, very uniformly shaped fruit with outstanding flavor.

2013 Trailing Planting (Tables BLK3 and BLK8)

- While a number of thornless selections in this trial, nothing stood out for yield or quality over the current standards.

2011, 2012, and 2013 Semi-erect trials (Tables BLK4, BLK5, BLK6 and BLK8)

- NZ 9607R-4 had shown promise in a grower field. Is about a week later ripening than 'Chester Thornless' and has a midpoint of harvest a couple weeks later than it, but is smaller and its fruit quality is nothing special. Hard to get excited about.
- ORUS 4278-2 is about a week ahead of 'Chester Thornless' and ORUS 4273-2 isabout two weeks ahead of 'Chester Thornless. These two have a grandparent that is *Rubus georgicus*. While thorny, these two taste good, are firm, have fruit size comparable to, or larger than 'Chester Thornless', and ripen early. While thorny, it is Tt for Merton Thornlessness. Both will be propagated for further trial.
- ORUS 4066-2, with a grandparent that is *R. caucasicus*, had excellent yields and fruit quality and ripened earlier than 'Chester Thornless'.
- ORUS 4370-1 A mixture of mostly eastern and some western blackberry. Had outstanding fruit quality, particularly skin toughness and fruit size, and yields comparable to 'Chester Thornless' in its first year.
- ORUS 2816-4In grower trial and continues its steady performance. Both of these thornless selections are earlier ripening than 'Chester Thornless' with comparable 1st picks but a midpoint of harvest about two weeks earlier
- 'Von' had excellent fruit quality early in the season, and ripened about 2 weeks ahead of 'Triple Crown' and 'Chester Thornless'.
- In a trial with a commercial wholesale fresh market blackberry packer, the selections and cultivars fell in the following order of acceptability for shipping from best to worst:
  - Excellent: ORUS 2711-1, ORUS 4370-1, 'Chester Thornless', ORUS 4278-2
  - Very good: ORUS 4266-2, ORUS 4266-1, ORUS 2816-4
  - Good: Von, ORUS 4066-2
  - OK: ORUS 4273-2
  - Fair: 'Triple Crown', NZ 9607R-4

2012, 2013 and 2014 Planted Primocane-fruiting blackberry trials (Table BLK7 and BLK8)

- None of the genotypes were high yielding in open field production even in a harvest season that began up to 2 weeks earlier than normal. While 'Prime-Ark® Freedom' had no ripe fruit its first year it had a small crop of very large fruit in 2014 and 2015.
- While all of the ORUS selections are thorny, several of them are heterozygous for thornlessness and will hopefully be valuable parents. Compared to 'PrimeArk®45', the ORUS selections are generally comparable or smaller in size, softer and in a similar or later season and therefore are not viable. However, the pool of selections is improving as most have better flavor and are higher yielding than 'PrimeArk®45' and some are nearly as firm. Thornless selections with excellent flavor, size and firmness were made in 2015.

Winter hardiness and machine harvestability evaluation

Since 2001, over 250 blackberry selections have been planted at Enfield Farms (Lynden Wash.), which sits on the Canadian border, to evaluate winter hardiness and machine harvestability in a commercial setting. Most but not all selections have been machine harvestable.

'Columbia Star' has done well in this climate and with these harvesters although in 2015 it was out of balance with huge amounts of foliage and smaller yield than desired. 'Columbia Giant' seems to have comparable hardiness to 'Marion' in Lynden.

Seedlings, germplasm/cultivar development

- Because of the severe cold in Corvallis in December 2014 (0 °F) most of our trailing and semi-erect blackberries were killed to the ground. As a result in 2015, we evaluated 2012 and 2013 planted seedlings. We made 63crosses, planted about 2,700 seedlings and made 47 selections (25 trailing, 12 erect/semi-erect, and 10 primocane fruiters).

Red Raspberry

Being named

- ORUS 4090-1 is primocane fruiting with very large fruit, excellent fruit quality and yields comparable to or better than 'Heritage'. It is root rot susceptible but not horribly so. Did very well in commercial fresh market trial in Mexican production system.

Grower trial

- 'Lewis', a floricane fruiter, was released originally due to performance in New Zealand and is a parent of the recently introduced 'Wakefield'. In initial grower trial, many plants died during the 1st year for unknown reasons. While it may have been root rot, it has not exhibited root rot in Oregon sites.
- ORUS 4090-1, a primocane fruiter, needs testing in the PNW. It moved quickly in trials in Mexico and so will be named to protect it, but needs testing here.

2012 Floricane Fruiting Trial (Tables RY1 and RY6)

- While 'Lewis did not separate itself from the others in trial for yield it still did well and had the largest fruit size in a late season.
- 'Squamish' was impressive for early season yield and is definitely worth trialing as a 'Malahat' replacement. The fruit quality was good but it can be dull. Supposed to have some root rot tolerance but is susceptible to RBDV.
- ORUS 4284-1 while 'Meeker'-sized fruit and yield, the flavor is mediocre and tendency towards softness.

2013 Floricane Fruiting Trial (Tables RY2 and RY6)

- None of the selections stood out for yield in the replicated trial. Most of the selections were not so outstanding in quality in their 1st year to make up for the not significantly higher yield than the checks.
- ORUS 4373-1 was promising for fruit size and quality albeit it's a bit dull/frosty and the yield was comparable to 'Meeker'. It appears to separate easily from the plant and held up well in a part of the field where some genotypes were collapsing due to root rot. Worth watching.
- WSU 2029 was very good for yield and amazing for its late season. It began ripening as others were almost done. It will not machine harvest

- WSU 2075 had a huge crop of small light berries that were hard to pick until dead ripe.
- ORUS 4380-3 was promising in the first year. It was later than 'Lewis', but the fruit may be too rough in appearance.

2012 Primocane Fruiting Trial (Tables RY3 and RY6)

- The ORUS 4289s are incredibly impressive for ease of harvest (they could easily be machine harvested) and incredible flavor. ORUS 4289-4 had the best yield and this year the fruit size was comparable to 'Heritage' but it may be too soft. We will try to get some plants out for trial but probably just a parent.
- ORUS 4291-1 was impressive for earliness. It was about 2 weeks earlier than most other selections or cultivars and 18-19 days ahead of 'Heritage'. This is worthy of small scale grower trial although it may be lower yielding than later ripening cultivars. Concerns with root rot susceptibility.
- Of the Cornell- Geneva cultivars and selections, NY 02-57 had the best yield and decent size; 'Crimson Giant' was impressive for size and had a decent yield however it was really bland; 'Crimson Night' is supposed to be dark fruited and it is and as such not sure where it fits as it looks overripe when it is ripe; and 'Double Gold' is too low yielding to be commercially viable.

2013 Primocane Fruiting Trial (Tables RY4 and RY6)

- Unfortunately, one of the reps for this trial is right over a hot spot for root rot and everything suffered.
- ORUS 4487-1 had decent sized fruit and was about 10 days ahead of 'Heritage' with bright good quality fruit. The plant appears to have some root rot tolerance. We will propagate it for grower trial.

2014 Primocane Fruiting Trial (Tables RY5 and RY6)

- Unfortunately, all the selections in replicated trial did not reliably fruit. ORUS 4493-1 showed promise for yield, very early ripening and decent fruit size but is too dark and crumbly for commercial use.

Evaluation of Root Rot resistance at WSU

Pat Moore at WSU has been screening raspberries in a root rot trial. Based on his results he identified a range of responses to root rot. While many would appear to be susceptible, it was exciting to see some at the high end of the graph. The results:

- Probably better than 'Meeker' but not as good as 'Cascade Bounty': ORUS 3539-1, ORUS 3718-2 and ORUS 3722-2
- Probably comparable to 'Meeker': ORUS 3237-2, ORUS 3705-2, ORUS 3718-1 and ORUS 3702-3

Seedlings, Germplasm/Cultivar development

We planted ~2,000 red raspberry seedlings (60:40, floricane:primocane). Made 17 floricane and 10 primocane crosses and selected 35 floricane and 19 primocane red raspberry genotypes.

Black Raspberry

Developing the Genomic Infrastructure for Breeding Improved Black Raspberries (Bushakra et al.), SCRI Grant

In its final year this project has looked to develop improved tools for breeding black raspberries and identify useful germplasm for breeding. In this process, multiple sites, approaches and disciplines

along with consumer panels have been used to try to improve the process of black raspberry breeding and better target the consumers' desires.

Sites for phenotyping:

Usable vigor data was collected at grower fields including Oregon Berry, Townsend Farms, Riverbend Farms, Wyckoff Farms and Lincolnton, NC for at least two full years (spring and fall assessments). Data from Sandy Farms in Oregon is not indicative of the genotypes as these plants were not watered for the first year of establishment. Data was never received for the NY grower. All grower data are now collected.

L-B Farms, Cornell, Sandhills, NC and Ohio State sites have collected data for three years. Most is complete, though there is variation in what traits were collected. Final data will be submitted to me later this year. I am currently organizing the data and evaluating what can be done for quantitative trait locus analyses.

Verticillium:

The verticillium wilt (VW) soil infestation results do not seem to correlate with plant health at Wyckoff Farms in Eastern WA. More analysis needs to be done to verify this statement. More work needs to be done to develop experiments that will properly test tolerance to VW.

Aphids:

Resistance to aphid feeding was conducted on 23 crosses with single (MI, ME and ON) and two (ON+ME, ON+MI, ME+MI) sources of resistance over two years (2014-15). All parents used in these crosses have been genotyped. A genetic linkage map constructed and published for population ORUS 4305 (ON source) places the region associated with aphid resistance on RLG 6. This is the same linkage group on which resistance to red raspberry aphid is located. Based on this information, we have developed two molecular markers that can determine the presence of and distinguish between ON and MI resistance. We are currently working to refine these markers to make them easy to use. We are in the process of constructing linkage maps for population ORUS 4304 (ME source) and ORUS 4811/4812 (populations developed using Munger and two siblings with the MI source). We have used genotyping by sequencing to generate loci for use in linkage mapping. We have performed association analyses comparing the phenotype data to the sequencing data and have identified several segments of RLG 6 that are promising for discovering genes with the potential to be involved in aphid resistance.

Fruit:

All available fruit for populations 4304 and 4305 were collected over the summer. Fruit from all individuals was sent to Penny Perkins-Veazie (NCSU) for evaluation of total soluble solids, Brix, and total anthocyanins. Fruit from the first 120 fruiting individuals of population 4304 was sent to Jungmin Lee at USDA, Parma, ID for individual anthocyanin analysis. This provides a second year of nearly complete fruit collection. This is the last year for this collection.

Grower Trial

- Major setback on ORUS 3735-3 as every plant that came from the nursery was crumbly and it was not due to RBDV; suspect a mutation in propagation. We have started over with plants from original stock. It has large fruit and typically high yields, better than 'Munger'. There are concerns with it for machine harvesting but it definitely has promise for the fresh market.
- ORUS 3013-1 High yields of fruit that appear to machine harvest well. Not the long-lived replacement we want for 'Munger' but may be better for the short-run.
- ORUS 3217-1. High yields of fruit that appear to machine harvest well. 'Munger' size not sure

color is dark enough. Not the long-lived replacement we want for 'Munger' but may be better for the short-run.
- ORUS 3038-1. High yields of very tasty fruit.
- ORUS 3409-1 is a primocane fruiting black raspberry that is somewhat similar to 'Niwot' but seems to be more reliably productive.

2011 Planted Trials (Tables BLKRY1 and BLKRY5).
- ORUS 3021-1 had yields similar to 'Munger' with larger fruit and excellent quality. It was the most consistent selection in rep trial.
- ORUS 3381-3 was impressive for fruit quality in the very late season. It appears to be much nicer than 'MacBlack' in a similar season and will be put in rep trial.
- Many of the selections in nonreplicated trial have at least one source of resistance to aphids. This should make them resistant to the aphid born viruses. Unfortunately 1 source of resistance is often overcome quickly by aphids and we hope to have more than one source of resistance (pyramid) in something before we release it. Having said that ORUS 4159-1, ORUS 4159-2, and ORUS 4158-3 have either a Maine or Ontario source of aphid resistance in them, were high yielding and had berry size comparable to or larger than that of 'Munger'. ORUS 3219-2 has performed well in the past and was among the highest yielders in this trial too.

2012 Planted Trials (Tables BLKRY2 and BLKRY5).
- This field suffered from being in a hot spot for root rot. Nothing stood out although in the second year, ORUS 3219-2s yield did not drop as substantially as 'Munger's did.

2013 Planted Trials (Tables BLKRY3 and BLKRY5).
- Overall, fruit size was small for all genotypes but they were not worse than 'Munger'. Several selections in observation plot had excellent yield potential and will be propagated for rep trial.

Primocane Fruiting Black Raspberry Trials (Tables BLKRY4 and BLKRY5).
- None of the PF types are very high yielding. We have two selections that appear to be comparable to 'Niwot'. ORUS 3413-1 has better flavor, but ORUS 3409-1 is more reliably productive with good size and will be put into grower trial or named.

Seedlings, Germplasm/Cultivar development
- We planted 1,400 black raspberry seedlings, made 25 crosses and selected 8 floricane and 2 primocane fruiting genotypes.

Table BLK1. Fruit size and yield in 2013-15 for trailing blackberry genotypes at OSU-NWREC. Planted in 2011.

Genotype	Thorny or Thornless[y]	Berry size (g) 2013-15	Yield (tons·a^{-1}) 2013	2014	2015	2013-15
2013		7.6 a				6.73 a
2014		8.0 a				3.26 b
2015		7.1 a				3.22 b
Replicated						
Columbia Giant	Thls	12.0 a	8.86 a	4.30 ab	3.90 a	5.69 a
ORUS 4017-2	Thls	8.0 b	8.34 a	4.87 a	2.52 a	5.24 ab
Black Diamond	**Thls**	**5.7 d**	**6.24 b**	**2.78 c**	**4.44 a**	**4.49 b**
Marion	**Thny**	**5.2 d**	**5.08 b**	**2.88 bc**	**3.02 a**	**3.66 c**
ORUS 4024-3 "Tay"[x]	Thny	6.9 c	5.14 b	1.46 c	2.23 a	2.94 c

[z] Mean separation within columns by LSD, p≤0.05.
[y]Thl=Thornless; Thny=Thorny
[x]Selectionlooks like a 'Tayberry', a pretty red fruit that picks like a blackberry.

Table BLK2. Fruit size and yield in 2014-15 for trailing blackberry genotypes at OSU-NWREC[z]. Planted in 2012.

Genotype	Thorny or Thornless[y]	Type[x]	Berry size (g) 2014-15	Yield (tons·a^{-1}) 2014	2015	2014-15
2014			6.0 a			6.44 a
2015			5.7 b			4.11 b
Replicated						
ORUS 4057-3	Thls	Tr	7.4 a	7.56 a-c	5.73 a	6.64 a
Black Diamond	**Thls**	**Tr**	**5.6 c**	**8.37 a**	**3.81 bc**	**6.09 ab**
ORUS 4222-1	Thls	Tr	4.6 d	7.88 ab	3.15 c	5.52 a-c
Marion	**Thny**	**Tr**	**4.8 d**	**5.16 b-d**	**4.56 ab**	**4.86 bc**
ORUS 3448-2	Thls	Tr	6.3 b	5.06 cd	3.74 bc	4.40 c
ORUS 4057-2	Thls	Tr	6.3 b	4.60 d	3.66 bc	4.13 c
Nonreplicated						
ORUS 4200-1	Thls	Hyb	6.4	5.83	3.87	4.85
ORUS 4207-2	Thls	Tr	4.7	5.17	3.76	4.47
ORUS 4239-1	Thls	Hyb	5.2	5.14	3.57	4.35

[z] Mean separation within columns by LSD, p≤0.05.
[y]Thl=Thornless; Thny=Thorny
[x]Tr=Trailing;Hyb=mix of western and eastern blackberry germplasm; Thny=Thorny.

Table BLK3. Fruit size and yield in 2015 for trailing blackberry genotypes at OSU-NWREC. Planted in 2013

Genotype	Thornless or thorny[y]	Type[y]	Berry size (g)[z] 2013	Yield (tons·a^{-1}) 2013
Replicated				
ORUS 4344-2	Thls	Tr	7.0 a	3.87 a
Marion	**Thny**	**Tr**	**4.6 c**	**3.87 a**
ORUS 4235-2	Thls	Tr	6.9 a	3.60 a
Columbia Star	**Thls**	**Tr**	**6.1 b**	**3.33 a**
Black Diamond	**Thls**	**Tr**	**6.1 b**	**2.55 a**
ORUS 3172-1	Thls	Tr	5.2 c	2.55 a
ORUS 4342-1	Thls	Tr	6.1 b	1.22 a
Nonreplicated				
ORUS 2707-1	Thls	Tr	6.5	7.97
ORUS 4344-1	Thls	Hyb	6.8	5.96
ORUS 4356-1	Thny	Hyb	7.3	3.56
ORUS 4344-3	Thls	Hyb	5.4	2.94
ORUS 4325-1	Thny	Tr	5.7	2.94
ORUS 4329-2	Thny	Hyb	6.8	2.93
ORUS 3453-2	Thls	Tr	5.0	2.51
ORUS 4324-1	Thny	Tr	9.4	2.34
ORUS 4329-3	Thny	Hyb	5.6	1.53

[z] Mean separation within columns by LSD, $p \leq 0.05$.
[y]Thl=Thornless; Thny=Thorny; Tr=Trailing; Hyb=mix of eastern and western germplasm.

Table BLK4. Fruit size and yield in 2013-2015 for semi-erect blackberry genotypes in replicated trial at OSU-NWREC[z]. Planted in 2011.

Genotype	Thorny or Thornless[y]	Type[y]	Berry size (g)[z] 2013-15	Yield(tons·a^{-1}) 2013	2014	2015	2013-15
Replicated							
2013			4.7 b				7.51 a
2014			5.4 a				6.04 a
2015			4.3 b				3.58 b
Chester Thls	**Thl**	**SE**	**5.2 a**	**7.64 a**	**6.43 a**	**5.92 a**	**6.49 a**
NZ 9607R-4	Thl	SE	4.4 b	7.37 a	5.65 a	1.55 a	4.92 a
Nonreplicated							
Navaho	Thl	Er	5.8	5.71	8.93	6.49	7.04

[z] Mean separation within columnsby LSD, p≤0.05.
[y]Thl=ThornlessSE= Semi-erect; Er- Erect;

Table BLK5. Fruit size and yield in 2014-2015 for semi-erect blackberry genotypes in replicated trial at OSU-NWREC[z]. Planted in 2012.

Genotype	Thorny or Thornless[y]	Type[y]	Berry size (g)[z]	Yield(tons·a^{-1}) 2014	2015	2014-15
Replicated						
2014			6.4 a			9.89 a
2015			6.1 a			8.80 a
Chester Thls	**Thl**	**SE**	**5.9 b**	**12.57 a**	**11.63 a**	**12.10 a**
ORUS 4278-2	Thny	SEHyb(1/4georg)	6.6 a	7.21 a	5.97 b	6.59 b
Nonreplicated						
ORUS 4273-2	Thny	SEHyb(1/4georg)	4.9	22.73	8.84	15.79
ORUS 4066-2	Thny	SEHyb (1/8cauc)	7.9	10.75	10.57	10.66
Osage	Thl	Er	6.7	3.80	7.45	5.62

[z] Mean separation within columnsby LSD, p≤0.05.
[y]Thl=Thornless; Thny=Thorny SE= Semi-erect; Er+ Erect; Hyb.=Mixture of erect or semi-erect with trailing and/or different species.

Table BLK6. Fruit size and yield in 2015 for semi-erect blackberry genotypes in replicated trial at OSU-NWREC planted in 2013.

Genotype	Thorny or Thornless[y]	Type[y]	Berry size (g)[z]	Yield (kg·plt^{-1})	Yield (tons·a^{-1})
Replicated					
Triple Crown	**Thl**	**SE**	**7.9 a**	**11.44 a**	**10.98 a**
Chester Thornless	**Thl**	**SE**	**5.9 b**	**8.40 b**	**8.06 b**
ORUS 4370-1	Thl	Hyb	8.3 a	8.26 b	7.93 b
ORUS 2816-4	Thl	Hyb	6.4 b	6.65 b	6.38 b
Nonreplicated					
Von	Thl	Er	7.0	11.35	10.89

[z] Mean separation within columnsby LSD, p≤0.05.
[y]Tr=Trailing; Er=Erect.; SE= Semi-erect;PFEr= Erect primocane fruiting.Hyb.Mixture of erect or semi-erect with trailing.

Table BLK 7. Primocane fruiting genotypes planted in **nonreplicated**, observation plots in 2012, 2013, or 2014 with harvesting starting 15 months after planting.

Genotype	Thorny or Thornless[y]	Type[y]	Mean Berry size (g)[z]	Yield(tons·a^{-1}) 2013	2014	2015	2013-15
2012 planted							
Prime-Ark®Traveler	**Thl**	**PFEr**	**6.4**	**0.56**	**3.32**	**2.81**	**2.23**
Prime-Ark®Freedom	**Thl**	**PFEr**	**13.3**	**0.00**	**1.82**	**1.98**	**1.27**
ORUS 4258-1	Thny	PFEr	6.0	0.49	1.17	1.92	1.19
					2014	2015	2014-15
2013 Planted							
ORUS 4355-2	Thny	PFEr	4.5		0.56	0.64	0.60
ORUS 4355-3	Thny	PFEr	5.4		0.55	0.32	0.44
						2015	
2014 Planted							
ORUS 4545-1	Thny	PFEr	5.3			2.79	
ORUS 4545-2	Thny	PFEr	3.8			2.58	
ORUS 4545-3	Thny	PFEr	3.2			2.11	
Prime-Ark®45	**Thny**	**PFEr**	**4.8**			**1.69**	
ORUS 4546-1	Thny	PFEr	3.1			1.28	

[z] Mean separation within columnsby LSD, p≤0.05.

Table BLK8. Ripening season, date at which each genotype's yield passed the givenpercentage, for blackberry genotypes at OSU-NWREC.

Genotype	Type	Year planted	Harvest season 5%	50%	95%	No. yrs. in mean	Rep/ Obsv
ORUS 4325-1	Tr	2013	9-Jun	16-Jun	30-Jun	1	Obsv
ORUS 3448-2	Tr	2012	13-Jun	20-Jun	4-Jul	2	Rep
ORUS 4057-2	Tr	2012	16-Jun	20-Jun	30-Jun	2	Rep
ORUS 4324-1	Tr	2013	16-Jun	23-Jun	23-Jun	1	Obsv
Columbia Star	**Tr**	**2013**	**16-Jun**	**23-Jun**	**7-Jul**	**1**	**Rep**
ORUS 3453-2	Tr	2013	16-Jun	23-Jun	7-Jul	1	Obsv
Black Diamond	**Tr**	**2013**	**16-Jun**	**23-Jun**	**14-Jul**	**1**	**Rep**
ORUS 4057-3	Tr	2012	16-Jun	24-Jun	14-Jul	2	Rep
ORUS 2707-1	Tr	2013	16-Jun	30-Jun	14-Jul	1	Obsv
ORUS 4235-2	Tr	2013	16-Jun	30-Jun	14-Jul	1	Rep
Marion	**Tr**	**2013**	**23-Jun**	**30-Jun**	**14-Jul**	**1**	**Rep**
ORUS 4344-3	Tr	2013	23-Jun	30-Jun	14-Jul	1	Obsv
ORUS 4329-2	Tr	2013	30-Jun	30-Jun	7-Jul	1	Obsv
ORUS 4342-1	Tr	2013	30-Jun	30-Jun	7-Jul	1	Rep
Black Diamond	**Tr**	**2012**	**20-Jun**	**30-Jun**	**14-Jul**	**2**	**Rep**
ORUS 3447-2	Tr	2011	22-Jun	3-Jul	17-Jul	3	Rep
Black Diamond	**Tr**	**2011**	**24-Jun**	**3-Jul**	**17-Jul**	**3**	**Rep**
ORUS 4222-1	Tr	2012	24-Jun	4-Jul	18-Jul	2	Rep
Marion	**Tr**	**2012**	**27-Jun**	**4-Jul**	**15-Jul**	**2**	**Rep**
ORUS 4207-2	Tr	2012	27-Jun	4-Jul	21-Jul	2	Obsv
Marion	**Tr**	**2011**	**26-Jun**	**5-Jul**	**15-Jul**	**3**	**Rep**
ORUS 3172-1	Tr	2013	30-Jun	7-Jul	14-Jul	1	Rep
ORUS 4266-2	SEHyb(1/4georg)	2012	7-Jul	7-Jul	28-Jul	1	Obsv
ORUS 4017-2	Tr	2011	28-Jun	8-Jul	19-Jul	3	Rep
ORUS 4024-3	Tr	2011	3-Jul	10-Jul	17-Jul	3	Rep
ORUS 4344-1	Tr	2013	30-Jun	14-Jul	28-Jul	1	Obsv
ORUS 4344-2	Tr	2013	30-Jun	14-Jul	28-Jul	1	Rep
ORUS 4356-1	Tr	2013	30-Jun	14-Jul	28-Jul	1	Obsv
ORUS 4266-1	SEHyb(1/4georg)	2012	7-Jul	14-Jul	28-Jul	1	Obsv
ORUS 4358-3	PF	2013	7-Jul	14-Jul	28-Jul	1	Obsv
ORUS 4370-1	SE	2013	7-Jul	14-Jul	4-Aug	1	Rep
Von	**SE**	**2013**	**7-Jul**	**14-Jul**	**4-Aug**	**1**	**Obsv**
ORUS 4370-2	SE	2013	14-Jul	14-Jul	14-Jul	1	Obsv
ORUS 2816-4	SE	2013	23-Jul	14-Jul	4-Aug	1	Rep
Osage	**Er**	**2012**	**11-Jul**	**14-Jul**	**8-Aug**	**2**	**Obsv**
ORUS 4239-1	Tr	2012	11-Jul	18-Jul	1-Aug	2	Obsv
ORUS 4273-2	SEHyb(1/4georg)	2012	7-Jul	25-Jul	4-Aug	2	Obsv
Triple Crown	**SE**	**2013**	**14-Jul**	**28-Jul**	**4-Aug**	**1**	**Rep**
Chester Thornless	**SE**	**2013**	**14-Jul**	**28-Jul**	**11-Aug**	**1**	**Rep**
ORUS 4066-2	SEHyb (1/8cauc)	2012	14-Jul	28-Jul	11-Aug	2	Obsv

ORUS 4278-2	SEHyb(1/4georg)	2012	18-Jul	28-Jul	15-Aug	2	Rep
ORUS 4200-1	Tr	2012	19-Jul	28-Jul	11-Aug	2	Obsv
ORUS 4230-3	Tr	2012	15-Jul	29-Jul	5-Aug	1	Obsv
Navaho	**SEThnl**	**2011**	**15-Jul**	**31-Jul**	**23-Aug**	**3**	**Obsv**
Chester Thornless	**SE**	**2012**	**21-Jul**	**4-Aug**	**25-Aug**	**2**	**Rep**
Chester Thornless	**SEThnl**	**2011**	**31-Jul**	**12-Aug**	**30-Aug**	**3**	**Rep**
NZ 9607R-4	SEThnl	2011	7-Aug	23-Aug	20-Sep	3	Rep
ORUS 4258-1	PF	2012	8-Aug	25-Aug	22-Sep	2	Obsv
Prime-Ark®Freedom	**PF**	**2012**	**22-Aug**	**29-Aug**	**22-Sep**	**2**	**Obsv**
ORUS 4545-2	PF	2014	18-Aug	1-Sep	22-Sep	1	Obsv
Prime-Ark®Traveler	**PF**	**2012**	**22-Aug**	**1-Sep**	**22-Sep**	**2**	**Obsv**
ORUS 4545-1	PF	2014	18-Aug	8-Sep	29-Sep	1	Obsv
Prime-Ark®45	**PF**	**2014**	**18-Aug**	**15-Sep**	**29-Sep**	**1**	**Obsv**
ORUS 4545-3	PF	2014	25-Aug	15-Sep	29-Sep	1	Obsv
ORUS 4355-2	PF	2013	12-Sep	19-Sep	30-Sep	2	Obsv
ORUS 4546-1	PF	2014	18-Aug	22-Sep	29-Sep	1	Obsv
ORUS 4355-3	PF	2013	12-Sep	23-Sep	29-Sep	2	Obsv

[y]Tr=Trailing; Er=Erect; SE= Semi-erect; PFEr= Erect primocane fruiting.
Hyb. Mixture of erect or semi-erect with trailing, Where fraction of species (*R. georgicus*, *R. caucasicus*) listed the remainder is cultivated germplasm.
[x]Stopped harvest of PF blackberries 10/7/2015.

Table RY1. Mean yield and berry size in 2014-15 for floricane fruiting raspberry genotypes at OSU-NWREC planted in 2012.

Genotype	Berry size (g) 2014-15[z]	Yield (tons·a^{-1}) 2014	2015	2014-15
2014	3.5 a			3.65 a
2015	2.6 b			2.56 b
Replicated				
Lewis	3.9 a	5.11 a	2.44 a-c	3.78 a
Squamish	3.6 b	3.90 b	3.03 a	3.47 ab
ORUS 4284-1	2.9 c	3.41 b	2.89 ab	3.15 bc
WSU 2011	2.5 d	3.34 b	1.86 c	2.60 c
WSU 1964	2.7 cd	3.23 b	2.85 ab	3.04 bc
Meeker	**2.7 cd**	**2.94 b**	**2.27 bc**	**2.61 c**
Nonreplicated				
ORUS 4283-2	3.3	4.01	2.75	3.38
ORUS 4089-2	3.0	3.59	1.63	2.61

[z] Mean separation within columnsby LSD, p≤0.05.

Table RY2. Mean yield and berry size in 2015 for floricane fruiting red raspberry genotypes in replicated and observation trials at OSU-NWREC planted in 2013.

Genotype	Berry size (g)[z]	Yield (tons·a^{-1})
Replicated		
ORUS 4371-4	3.2 ab	2.81 a
ORUS 3722-1	3.4 ab	2.74 a
ORUS 3702-3	3.5 a	2.65 a
ORUS 4373-1	2.9 bc	2.03 a
Meeker	**2.4 c**	**2.01 a**
Lewis	**2.9 bc**	**1.55 a**
Nonreplicated		
WSU 2029	2.3	4.54
WSU 2075	2.2	4.18
ORUS 4380-3	3.6	3.92
WSU 2010	1.8	2.90
WSU 1914	3.0	2.87
WSU 1996	2.5	2.85
ORUS 4380-1	3.7	2.71
ORUS 1040-1	2.9	2.49
ORUS 4371-5	3.1	2.48
TulaMagic	3.3	2.36
ORUS 4371-3	2.4	2.14
ORUS 4465-1	3.3	2.13
WSU 2068	2.6	2.03
BC 97-30-20	2.8	1.45

[z] Mean separation within columnsby LSD, p≤0.05.

Table RY3. Mean yield and berry size in 2013-2015 for primocane fruiting raspberry genotypes at OSU-NWREC planted in 2012.

	Berry size (g) 2013-15	Yield (tons·acre^{-1}) 2013	2014	2015	2013-15
Replicated					
2013	2.9 a				1.80 a
2014	2.4 b				1.76 a
2015	2.0 c				1.35 a
ORUS 4289-4	2.0 c	2.20 a	2.41 a	1.97 a	2.19 a
Heritage	**2.0 c**	**2.11 a**	**2.11 a**	**1.80 ab**	**2.01 a**
Crimson Giant	4.2 a	2.03 a	2.25 a	0.95 b	1.74 ab
ORUS 4289-3	2.0 c	1.35 a	1.26 b	1.27 ab	1.29 bc
ORUS 4289-1	1.9 c	1.29 a	1.28 b	1.09 ab	1.22 c
ORUS 4291-1	2.3 b	-	1.23 b	1.01 b	1.12 c
Nonreplicated					
NY 02-57	2.4	1.96	2.95	2.09	2.33
Crimson Night	2.6	2.01	1.25	1.22	1.49
NY 05-44	2.1	0.96	1.45	1.54	1.32
Double Gold	2.2	0.65	0.29	0.68	0.54

Mean separation within columns by LSD, $p \leq 0.05$.

Table RY4. Mean yield and berry size in 2014-15 for primocane fruiting red raspberry genotypes at OSU-NWREC planted in 2013.

	Berry size (g)	Yield (tons·a^{-1})		
	2014-15	2014	2015	2014-15
Replicated				
2014	2.3 a			1.69 a
2015	1.6 b			0.92 b
ORUS 4487-1	1.9 c	2.88 a	1.50 a	2.19 a
Heritage	**1.6 d**	**2.03 b**	**1.24 a**	**1.64 b**
Vintage	**2.2 ab**	**1.13 d**	**0.75 b**	**0.94 c**
ORUS 4086-2	2.0 bc	1.66 c	0.22 c	0.94 c
ORUS 4090-2	2.3 a	0.77 e	0.90 b	0.83 c
Nonreplicated				
ORUS 4494-1	2.9	3.55	2.67	3.11
ORUS 4486-1	1.7	3.01	1.05	2.03
ORUS 4487-2	2.0	2.55	1.49	2.02
ORUS 4487-3	2.1	2.16	1.46	1.81
ORUS 4388-3	2.7	2.14	0.94	1.54
ORUS 4384-1	2.2	1.58	1.27	1.43
ORUS 4388-2	2.7	1.67	1.11	1.39
TulaMagic	3.1	1.49	0.27	0.88

Mean separation within columns by LSD, p≤0.05.

Table RY5. Mean yield and berry size in 2015 for primocane fruiting red raspberry genotypes at OSU-NWREC planted in 2014.

Genotype	Berry size (g)	Yield (tons·a^{-1})
Replicated		
Heritage	**1.7 b**	**1.62 a**
Vintage	**2.6 a**	**1.04 a**
ORUS 4599-2	2.6 a	0.16 b
Nonreplicated		
ORUS 4493-1	2.0	2.06
ORUS 4090-1	2.8	1.80
ORUS 4494-3	3.1	1.41
ORUS 4487-4	3.1	1.17
ORUS 4097-3	3.3	0.81
ORUS 4617-1	1.5	0.43
ORUS 4499-1	2.2	0.22
ORUS 4599-3	3.8	0.19

Mean separation within columns by LSD, p≤0.05.

Table RY6. Ripening season for floricane fruiting red raspberry genotypes at OSU-NWREC. Planted in 2012 or 2013 and harvested 2014 and/or 2015.

Genotype	Year planted	Harvest season 5%	50%	95%	No. years in mean	Rep/ Obsv
Squamish	**2012**	**9-Jun**	**16-Jun**	**30-Jun**	**2**	**Rep**
WSU 2010	2013	9-Jun	23-Jun	30-Jun	1	Obsv.
WSU 2068	2013	9-Jun	23-Jun	30-Jun	1	Obsv.
ORUS 3722-1	2013	9-Jun	23-Jun	7-Jul	1	Rep
TulaMagic (Frutafri)	2013	9-Jun	23-Jun	7-Jul	1	Obsv.
ORUS 3702-3	2013	9-Jun	23-Jun	14-Jul	1	Rep
ORUS 4371-3	2013	16-Jun	23-Jun	30-Jun	1	Obsv.
ORUS 4465-1	2013	16-Jun	23-Jun	30-Jun	1	Obsv.
BC 97-30-20	2013	16-Jun	23-Jun	7-Jul	1	Obsv.
Meeker	**2013**	**16-Jun**	**23-Jun**	**7-Jul**	**1**	**Rep**
ORUS 1040-1	2013	16-Jun	23-Jun	7-Jul	1	Obsv.
WSU 1914	2013	16-Jun	23-Jun	7-Jul	1	Obsv.
WSU 2075	2013	16-Jun	23-Jun	7-Jul	1	Obsv.
ORUS 4283-2	2012	9-Jun	23-Jun	4-Jul	2	Obsv.
Meeker	**2012**	**16-Jun**	**27-Jun**	**11-Jul**	**2**	**Rep**
ORUS 4089-2	2012	16-Jun	27-Jun	11-Jul	2	Obsv.
WSU 1964	2012	16-Jun	27-Jun	11-Jul	2	Rep
WSU 2011	2012	16-Jun	27-Jun	18-Jul	2	Rep
ORUS 4284-1	2012	20-Jun	27-Jun	11-Jul	2	Rep
ORUS 4371-5	2013	16-Jun	30-Jun	7-Jul	1	Obsv.
ORUS 4380-1	2013	16-Jun	30-Jun	7-Jul	1	Obsv.
Lewis	**2013**	**16-Jun**	**30-Jun**	**14-Jul**	**1**	**Rep**
ORUS 4371-4	2013	16-Jun	30-Jun	14-Jul	1	Rep
ORUS 4373-1	2013	16-Jun	30-Jun	14-Jul	1	Rep
ORUS 4380-3	2013	23-Jun	30-Jun	14-Jul	1	Obsv.
Lewis	**2012**	**20-Jun**	**4-Jul**	**21-Jul**	**2**	**Rep**
WSU 1996	2013	23-Jun	7-Jul	14-Jul	1	Obsv.
WSU 2029	2013	7-Jul	21-Jul	11-Aug	1	Obsv.

Table RY7. Ripening season for primocane fruiting red raspberry genotypes at OSU-NWREC. Planted in 2012, 2013, or 2014 and harvested 2013-15.

Genotype	Year planted	Harvest season 5%	50%	95%	No. years in mean	Rep/ Obsv
ORUS 4493-1	2014	28-Jul	28-Jul	25-Aug	1	Obsv.
ORUS 4291-1	2012	18-Jul	1-Aug	15-Aug	3	Rep
ORUS 4487-2	2013	21-Jul	8-Aug	5-Sep	2	Obsv.
ORUS 4494-1	2013	1-Aug	11-Aug	29-Aug	2	Obsv.
NY 05-44	2012	2-Aug	12-Aug	26-Aug	3	Obsv.
NY 02-57	2012	2-Aug	14-Aug	4-Sep	3	Obsv.
ORUS 4494-2	2013	1-Aug	15-Aug	29-Aug	2	Rep
ORUS 4090-2	2013	1-Aug	15-Aug	8-Sep	2	Rep
ORUS 4487-1	2013	1-Aug	15-Aug	8-Sep	2	Rep
ORUS 4086-2	2013	8-Aug	18-Aug	15-Sep	2	Rep
ORUS 4289-4	2012	5-Aug	19-Aug	6-Sep	3	Rep
Heritage	**2012**	**7-Aug**	**19-Aug**	**9-Sep**	**3**	**Rep**
ORUS 4289-5	2012	7-Aug	19-Aug	11-Sep	3	Obsv.
ORUS 4289-3	2012	7-Aug	21-Aug	4-Sep	3	Rep
ORUS 4289-1	2012	12-Aug	21-Aug	6-Sep	3	Rep
ORUS 4487-3	2013	28-Jul	22-Aug	19-Sep	2	Obsv.
ORUS 4384-1	2013	1-Aug	22-Aug	15-Sep	2	Obsv.
ORUS 4486-1	2013	11-Aug	22-Aug	8-Sep	2	Obsv.
Vintage	**2013**	**8-Aug**	**25-Aug**	**5-Sep**	**2**	**Rep**
Heritage	**2013**	**11-Aug**	**25-Aug**	**12-Sep**	**2**	**Rep**
Niwot (black rasp)	2012	16-Aug	26-Aug	16-Sep	2	Obsv.
ORUS 4388-2	2013	18-Aug	1-Sep	15-Sep	2	Obsv.
Crimson Night	2012	14-Aug	2-Sep	18-Sep	3	Obsv.
Double Gold	2012	16-Aug	4-Sep	18-Sep	3	Obsv.
Crimson Giant	2012	21-Aug	11-Sep	25-Sep	3	Rep
TulaMagic (Frutafri)	2013	29-Aug	12-Sep	19-Sep	2	Obsv.
ORUS 4388-3	2013	1-Sep	12-Sep	19-Sep	2	Obsv.
ORUS 4097-3	2014	28-Jul	15-Sep	29-Sep	1	Obsv.
Heritage	**2014**	**18-Aug**	**15-Sep**	**6-Oct**	**1**	**Rep**
ORUS 4599-2	2014	15-Sep	19-Sep	29-Sep	1	Rep
ORUS 4090-2	2014	25-Aug	22-Sep	6-Oct	1	Obsv.
ORUS 4494-3	2014	25-Aug	22-Sep	6-Oct	1	Obsv.
Vintage	**2014**	**25-Aug**	**22-Sep**	**6-Oct**	**1**	**Rep**
ORUS 4499-1	2014	1-Sep	22-Sep	29-Sep	1	Obsv.
ORUS 4090-1	2014	8-Sep	29-Sep	6-Oct	1	Obsv.
ORUS 4487-4	2014	8-Sep	29-Sep	6-Oct	1	Obsv.
ORUS 4599-3	2014	29-Sep	6-Oct	6-Oct	1	Obsv.

Table BLKRY1. Mean yield and berry size in 2013-2015 for black raspberry genotypes at OSU-NWREC planted in 2011.

	Berry size (g)	Yield (tons·acre^{-1})			
	2013-15	2013	2014	2015	2013-15
Replicated					
2013	2.1 a				2.91 a
2014	1.6 b				3.66 a
2015	1.0 c				1.65 b
ORUS 3021-1	1.8 b	2.88 a	3.69 a	2.11 a	2.89 a
Munger	**1.3 c**	**2.81 a**	**4.14 a**	**1.48 a**	**2.81 a**
ORUS 3032-3	2.0 a	2.75 a	3.49 a	1.73 a	2.66 a
ORUS 4156-1	1.1 c	3.19 a	3.30 a	1.28 a	2.59 a
Nonreplicated					
ORUS 4158-3	1.5	3.91	5.57	1.98	3.82
ORUS 3219-2	1.5	4.40	4.52	2.35	3.76
ORUS 4159-1	1.4	4.74	5.18	0.91	3.61
ORUS 4159-2	1.5	3.33	4.63	1.67	3.21
ORUS 4153-1	1.6	3.18	3.79	2.50	3.16
ORUS 4155-3	1.6	3.40	3.60	1.15	2.72
ORUS 3808-2	1.4	3.14	3.29	1.47	2.64
ORUS 3381-3	1.7	2.39	3.40	1.52	2.44
ORUS 4074-3	1.8	2.29	3.55	1.45	2.43
ORUS 4155-2	1.6	1.87	3.78	1.30	2.32
ORUS 4157-1	1.7	3.74	1.22	1.53	2.16
ORUS 4158-2	1.5	2.17	2.05	1.57	1.93

Mean separation within columns by LSD, $p \leq 0.05$.

BLKRY2. Yield, berry size and harvest season in 2014-15 for black raspberry genotypes planted in replicated (3, 3-plant plots) or single, 3-plant observation plots in 2012 at the OSU-NWREC.

Genotype	Berry size (g)	Yield (tons·a-^{1}) 2014	2015	2014-15
Replicated				
2014	1.6 a			2.22 a
2015	1.3 b			1.28 a
Munger	**1.4 a**	**2.85 a**	**1.17 ab**	**2.01**
ORUS 3219-2	1.4 a	1.98 a	1.69 a	1.83
ORUS 3412-1	1.5 a	1.85 a	0.97 b	1.41
Nonreplicated				
ORUS 3038-1	1.7	2.90	2.00	2.45
ORUS 4153-3	1.0	2.14	0.99	1.56

Mean separation within columns by LSD, $p \leq 0.05$.

BLKRY 3. Yield and berry size in 2015 for black raspberry genotypes planted in replicated trial and single observation plots in 2013 at the OSU-NWREC.

Genotype	Berry size (g)	Yield (tons·a^{-1})
Replicated		
ORUS 4306-1	1.0 a	2.34 a
Munger	**1.1 a**	**1.79 a**
Nonreplicated		
ORUS 4396-1	1.4	3.29
ORUS 4311-1	0.9	2.79
ORUS 4401-1	1.2	2.79
ORUS 4302-1	1.0	2.65
ORUS 4399-1	1.1	2.44
ORUS 4310-2	0.9	2.22
ORUS 4310-1	0.8	2.21
ORUS 4396-2	1.2	2.05
ORUS 4395-1	1.2	1.95
ORUS 4398-1	1.6	1.69

Mean separation within columns by LSD, p≤0.05.

BLKRY4. Yield and berry size in 2012 and 2014-15 for primocane fruiting black raspberry genotypes planted in replicated (3, 3-plant plots) or single, 3-plant observation plots in 2011or 2012 at the OSU-NWREC.

Genotype	Berry size (g)	Yield (tons·a-^{1})			
Replicated 2011 planted					
	2012, 2014-15	2012	2014	2015	2012, 2014-15
2012	2.4 a				0.29 b
2014	1.9 a				0.69 a
2015	1.5 c				0.62 a
ORUS 3409-1	2.0 a	0.23 b	0.75 a	1.04 a	0.67 a
ORUS 3413-1	1.8 b	0.36 a	0.62 a	0.20 a	0.40 b
Observation 2012 planted					
	2013-15	2013	2014	2015	2013-15
Niwot (black rasp)	**2.2**	**0.46**	**1.05**	**0.45**	**0.65**

Mean separation within columns by LSD, p≤0.05

Table BLKRY5. Ripening season for floricane and primocane fruiting black raspberry genotypes at OSU-NWREC. Planted in 2011-13 and harvested 2013-15.

Genotype	Year planted	Harvest season 5%	50%	95%	No. years in mean	Rep/ Obsv
Munger	**2012**	**16-Jun**	**20-Jun**	**30-Jun**	**2**	**Rep**
ORUS 4153-3	2012	16-Jun	23-Jun	23-Jun	1	Obsv
Munger	**2013**	**16-Jun**	**23-Jun**	**30-Jun**	**1**	**Rep**
ORUS 4306-1	2013	16-Jun	23-Jun	30-Jun	1	Rep
ORUS 4310-2	2013	16-Jun	23-Jun	30-Jun	1	Obsv
ORUS 4311-1	2013	16-Jun	23-Jun	30-Jun	1	Obsv
ORUS 4395-1	2013	16-Jun	23-Jun	30-Jun	1	Obsv
ORUS 4401-1	2013	16-Jun	23-Jun	30-Jun	1	Obsv
ORUS 4302-1	2013	16-Jun	23-Jun	7-Jul	1	Obsv
ORUS 4310-1	2013	16-Jun	23-Jun	7-Jul	1	Obsv
ORUS 4396-1	2013	16-Jun	23-Jun	7-Jul	1	Obsv
ORUS 4396-2	2013	16-Jun	23-Jun	7-Jul	1	Obsv
ORUS 4398-1	2013	16-Jun	23-Jun	7-Jul	1	Obsv
ORUS 4399-1	2013	16-Jun	23-Jun	7-Jul	1	Obsv
ORUS 3038-1	2012	20-Jun	23-Jun	4-Jul	2	Obsv
ORUS 4159-1	2011	14-Jun	24-Jun	3-Jul	3	Obsv
ORUS 4155-2	2011	17-Jun	24-Jun	3-Jul	3	Obsv
ORUS 4156-1	2011	17-Jun	24-Jun	3-Jul	3	Rep
ORUS 4158-2	2011	19-Jun	24-Jun	1-Jul	3	Obsv
ORUS 4157-1	2011	19-Jun	24-Jun	5-Jul	3	Obsv
ORUS 3842-1	2011	17-Jun	24-Jun	5-Jul	2	Obsv
ORUS 4115-4	2011	21-Jun	24-Jun	1-Jul	2	Obsv
ORUS 3841-2	2011	21-Jun	24-Jun	5-Jul	2	Obsv
ORUS 4155-3	2011	17-Jun	26-Jun	1-Jul	3	Obsv
ORUS 3032-3	2011	17-Jun	26-Jun	3-Jul	3	Rep
ORUS 4153-1	2011	17-Jun	26-Jun	3-Jul	3	Obsv
ORUS 4158-3	2011	17-Jun	26-Jun	3-Jul	3	Obsv
ORUS 4159-2	2011	17-Jun	26-Jun	3-Jul	3	Obsv
ORUS 4074-3	2011	19-Jun	26-Jun	1-Jul	3	Obsv
Munger	**2011**	**19-Jun**	**26-Jun**	**3-Jul**	**3**	**Rep**
ORUS 3021-1	2011	19-Jun	26-Jun	3-Jul	3	Rep
ORUS 3219-2	2012	20-Jun	27-Jun	4-Jul	2	Rep
ORUS 3805-2	2011	21-Jun	28-Jun	1-Jul	2	Obsv
ORUS 3219-2	2011	19-Jun	28-Jun	5-Jul	3	Obsv
ORUS 3808-2	2011	21-Jun	28-Jun	5-Jul	3	Obsv
ORUS 3412-1	2012	27-Jun	4-Jul	7-Jul	2	Rep
ORUS 3381-3	2011	1-Jul	5-Jul	12-Jul	3	Obsv
Niwot (PF)	**2013**	**25-Aug**	**29-Aug**	**15-Sep**	**2**	**Obsv**
ORUS 3409-1 (PF)	2011	31-Aug	9-Sep	25-Sep	3	Obsv
ORUS 3413-1 (PF)	2011	31-Aug	16-Sep	25-Sep	3	Obsv

A FINAL Report to the Oregon Raspberry &Blackberry Commission 2015-2016

TITLE: Do Targeted Calcium Applications to Fruit Increase Fruit Firmness and Shelf-life in Raspberry and Blackberry?

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Objectives:

(1) Determine whether "foliar" applications of calcium (Ca) to developing fruit increase fruit Ca, fruit firmness, and shelf-life.
(2) Evaluate different formulations of liquid Ca products for their effectiveness at increasing fruit Ca
(3) Assess whether increased fruit Ca will improve fresh market quality in raspberry and blackberry

Procedures:

Seven treatments were chosen to compare the effects of a variety of Ca formulations on fruit uptake of Ca and impacts on fruit quality and shelf-life (Table 1). Product rates were chosen to achieve the same rate of actual calcium applied per acre (except for "Ca-Cl high") while staying within label rates. In order to understand effects of Ca on early and late fruiting season varieties, two cultivars each of raspberry ('Tulameen' and 'Vintage') and blackberry ('Obsidian' and 'Triple Crown') were chosen. All fields were located at Unger Farms and managed according to standard commercial practices. For each cultivar, there were 4 reps each for a total of 28 plots. 'Tulameen', 'Vintage', and 'Obsidian' plots were 30 ft long while 'Triple Crown' plots were 20 ft long. Ca was applied using backpack sprayers at a rate of 80 gal/acre for 'Tulameen' and 'Obsidian' and 50 gal/acre for 'Vintage' and 'Triple Crown'.

Table 1: Calcium treatments

Treatment number and "name"	Calcium formulation	Product name	Rate of Ca applied	Rate of Ca (%)*	Label recommendation
1. "control"	Water-control	water	0	0/0	n/a (only water applied)
2. "Ca-Cl Low"	$CaCl_2$	Phyta-Cal QC™ (8% Ca)	4.8oz Ca/A (136g/A)	0.05/0.08	2-4 quarts/acre
3. "Ca-Cl High"	$CaCl_2$	Phyta-Cal QC™ (8% Ca)	9.6oz Ca/A (272g/A)	0.09/0.15	2-4 quarts/acre
4. "Ca-B"	$CaCl_2$	Phyta-Set QC™ (6% Ca; 1% B)	4.8oz Ca/A (136g/A)	0.05/0.08	2-4 quarts/acre
5. "Ca-chelate"	$CaCO_3$ (chelated with citric acid)	Biomin Calcium (5% Ca)	4.8oz Ca/A (136g/A)	0.05/0.08	1-3 quarts/acre
6. "Ca-Silicate"	Ca_2O_4Si	Mainstay Calcium SI (10% Ca)	4.8oz Ca/A (136g/A)	0.05/0.08	1/2 -1quart (in 10-50gal water/acre) 1.25-2.25 quarts/acre (in 50+ gal water/acre)
7. "Ca-acetate"	$C_4H_6CaO_4$ (Ca acetate)	Cultivace Growth CaAce (5% Ca)	4.8oz Ca/A (136g/A)	0.05/0.08	1-3 quarts/acre

*Values represent % Ca applied at 80gal/acre ('Tulameen' and 'Obsidian', lower concentration) and 50 gal/acre ('Vintage' and 'Triple Crown', higher concentration).

Fruit harvest occurred 1-2 weeks after the final application.Fruit in each treatment plot was picked at a commercial stage of ripeness. Data collected included berry weight, rating of fruit appearance, rating of flavor after rinsing, firmness, skin toughness (Wagner penetrometer), and percent soluble solids (Brix). Harvested fruit was placed in commercial clamshells and evaluated for treatment effects on percent decay, weight loss, and nesting during storage (evaluated at approximately 5 and 10 days post-harvest). Temperature was generally maintained between 34 and 37°F for the duration of storage, but conditions fluctuated due to opening and closing of the cooler door. No humidity or atmospheric control was available. Fruit and leaves were sampled at harvest to determine calcium concentration. Leaf samples were rinsed with deionized water before shipping to Brookside Labs (New Bremen, OH) for analysis of macro- and micronutrients as well as % moisture (fruit only) while fruit samples were not washed to prevent excessive decay during shipping.

Results to date:

Targeted calcium applications did not impact leaf or fruit Ca in any raspberry or blackberry cultivar that was tested (Table 2). There was no visual impact or changes in flavor due to Ca treatments. The few changes that were detected in fruit quality during storage were not consistent by treatment or cultivar, and in fact the control (sprayed with water) frequently had greater firmness and skin toughness than some of the Ca sprayed treatments. There were no differences in visual ratings of decay and nesting during storage. In raspberry, interactions were found between cultivar and days of storage for percent moisture loss, skin toughness, firmness, and Brix (Figure 1). 'Vintage' fruit may have showed a greater % moisture loss because clamshells were not filled completely due to lack of available ripe fruit at harvest, thus leaving more airspace in each clamshell. This also may have impacted firmness and skin toughness.In blackberry, Brix was only affected by cultivar, while percent moisture loss was affected by both cultivar and days of storage. Skin toughness and firmness showed interactions between the two factors (Figure 2). It is interesting to note that while 'Triple Crown' had higher skin toughness than 'Obsidian', it was less firm at harvest and throughout storage.Nutrient removal in fruit was calculated based on lab analysis of % moisture and nutrient concentration of samples (Table 3).

Table 2: Fruit and leaf Ca (%) in raspberry and blackberry for all treatments (n.s. indicates not significant at $p<0.05$). Harvest and leaf sampling date is shown below the cultivar name.

	Tulameen 26-Jun		Vintage 3-Aug		Obsidian 22-Jun		Triple Crown 24-Jul	
Treatment	Fruit	Leaf	Fruit	Leaf	Fruit	Leaf	Fruit	Leaf
CaCl Low	0.14	1.63	0.19	1.77	0.16	0.53	0.32	1.28
CaCl High	0.14	1.78	0.22	1.80	0.15	0.51	0.27	1.39
Ca-B	0.14	1.73	0.23	1.77	0.15	0.52	0.28	1.20
Ca Chelate	0.14	1.69	0.23	1.83	0.16	0.52	0.32	1.36
Ca Silicate	0.14	1.70	0.21	1.88	0.15	0.47	0.31	1.32
Ca acetate	0.17	1.52	0.25	1.85	0.16	0.49	0.30	1.25
Control	0.13	1.73	0.20	1.72	0.16	0.49	0.30	1.26
p-value	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.

Figure 1: Raspberry fruit quality at harvest (day 0), 5, and 10 days of storage.

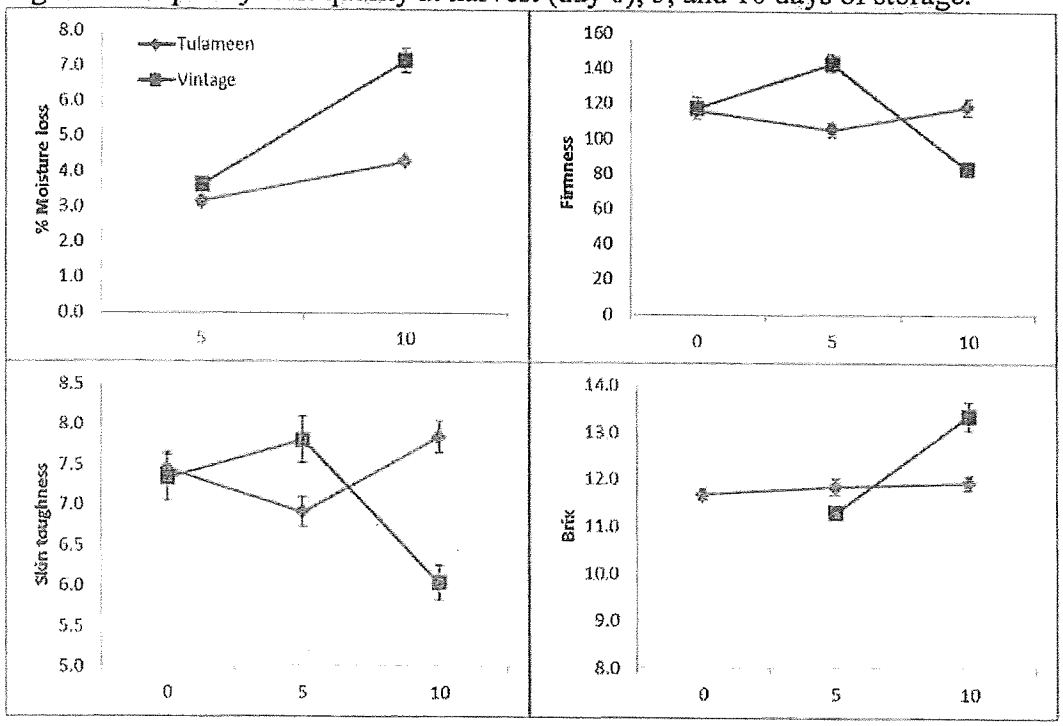

Figure 2: Blackberry fruit quality at harvest (day 0), 5, and 10 days of storage.

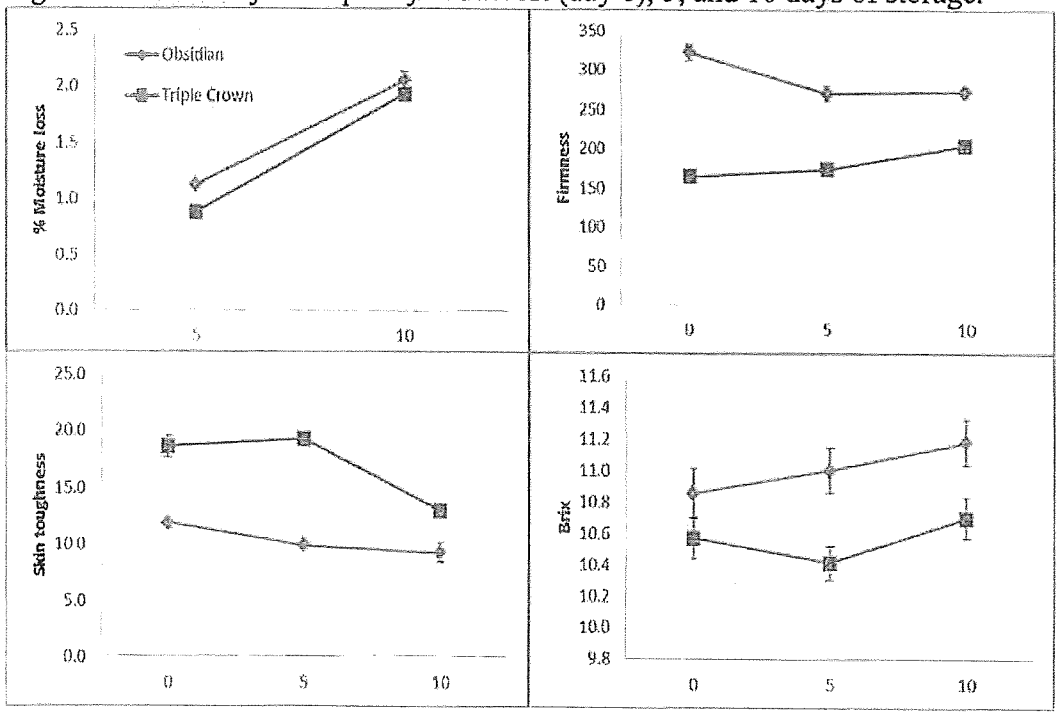

Table 3: Nutrient removal in raspberry and blackberry per ton of fresh fruit harvested.

Lbs nutrient removed per ton of fruit harvested

	N	P	Mg	K	Ca	S
Tulameen	2.85	0.63	0.34	2.50	0.45	0.22
Vintage	4.79	0.74	0.42	3.26	0.61	0.22
Obsidian	3.72	0.58	0.40	3.05	0.44	0.24
Triple Crown	2.85	0.54	0.45	2.37	0.94	0.26

Oz nutrient removed per ton of fruit harvested

	B	Fe	Mn	Cu	Zn	Al
Tulameen	0.05	0.11	0.11	0.02	0.09	0.55
Vintage	0.07	0.26	0.33	0.02	0.12	0.31
Obsidian	0.06	0.15	0.20	0.03	0.08	0.22
Triple Crown	0.06	0.12	0.37	0.03	0.07	0.29

Conclusions

Targeted calcium applications at the current label rates (0.03-0.16% Ca, depending on product) were not effective at increasing fruit or leaf Ca or altering fruit quality at harvest and after storage. Aspects of fruit quality and shelf-life did not always change consistently, but rather were dependent on cultivar. As Ca applications have been found to be effective in crops such as apples and cherries, we hope to continue working on foliar Ca applications testing a dosage response in select crops to determine if higher concentrations are necessary to achieve higher leaf and fruit Ca and resulting changes in fruit quality.

RESEARCH REPORT
TO THE
OREGON RASPBERRY AND BLACKBERRY COMMISSION
AND THE
AGRICULTURAL RESEARCH FOUNDATION
2014-2015

Title: Evaluation of processing quality of advanced caneberry breeding selections

Investigator: Brian Yorgey, Senior Faculty Research Assistant
Food Science & Technology, OSU

Cooperators: Chad Finn, USDA/ARS, Center for Small Fruits Research
Pat Moore, Washington State University

Objectives:
1. Evaluate advanced blackberry and raspberry breeding selections from NWREC and USDA for objective attributes related to processing potential
2. Process samples of advanced selections, selected field crosses, and standard varieties for display to and evaluation by breeders and the industry

Project Duration: July 1, 2014, through June 30, 2015

ORBC Funding for 2014-2015: $ 5476

Results:

Caneberry varieties and selections from plots at the North Willamette Research and Extension Center were sent to the OSU Food Science Pilot Plant for analysis and processing from June 17 to September 9, 2014. During the 2014 season the following numbers of genotypes were processed and analyzed:

Blackberries – 5 processing cultivars, 22 ORUS processing selections, 8 fresh market cultivars, 14 ORUS fresh market selections, 3 selections from various other breeding programs

Red raspberries – 5 processing cultivars, 9 ORUS processing selections, 8 WSU processing selections, 1 purple fruited cultivar, 1 purple fruited selection, 5 primocane/fall fruiting cultivars, 17 ORUS primocane/fall fruiting selections, 2 NY primocane/fall fruiting selections

Black raspberries - 1 cultivar, 34 ORUS selections, 1 primocane cultivar, 2 ORUS primocane selections

Chemistry data (°brix, pH, and TA) are shown in Tables 1 through 6. Included are data for individual harvest dates and weighted data for each genotype over the entire harvest period for blackberries, red raspberries and black raspberries.

Samples were displayed at the Research Evaluation at OSU in December, 2014, at the ORBC Commission Research meeting two days later (hey! also December, 2014), and at the Northwest Food Processors Association meeting in January, 2015.

Table 4: 2014 Red Raspberry Chemistry - Weighted Means

Variety/Selection	Field Year	Wt'd °brix	wt'd pH	Wt'd TA g citric/kg
Crimson Giant	2012	11.84	3.13	14.73
Heritage	2012	15.56	3.20	19.71
	2013	14.84	2.96	21.34
Lewis	2012	10.82	2.97	15.67
Meeker	2011	11.66	3.29	13.09
	2012	13.10	3.15	13.69
Squamish	2012	10.25	3.11	13.00
Ukee	2011	12.13	3.14	14.43
ORUS 3705-2	2012	12.59	2.95	16.71
ORUS 3959-3	2011	9.74	3.26	11.81
ORUS 4086-2	2013	13.75	3.06	16.91
ORUS 4089-2	2012	10.58	3.15	19.80
ORUS 4097-1	2011	15.08	3.05	17.07
ORUS 4097-5	2011	12.97	3.06	17.84
ORUS 4234-2	2012	10.03	3.01	20.62
ORUS 4283-1	2012	12.25	3.14	15.34
ORUS 4283-2	2012	10.46	3.14	14.02
ORUS 4284-1	2012	10.16	3.29	15.24
ORUS 4284-2	2012	9.19	2.86	20.66
ORUS 4289-1	2012	16.06	3.42	15.56
ORUS 4289-3	2012	15.37	3.36	16.31
ORUS 4289-4	2012	15.86	3.25	16.27
ORUS 4291-1	2012	13.07	3.24	19.97
ORUS 4388-3	2013	13.43	3.03	17.82
ORUS 4486-1	2013	14.98	3.24	17.44
ORUS 4487-1	2013	15.00	3.27	13.17
ORUS 4494-1	2013	13.49	3.45	13.55
ORUS 4494-2	2013	12.82	-	16.44
WSU 1499	2012	10.78	3.19	16.40
WSU 1660	2011	11.02	3.28	12.03
WSU 1750	2011	12.92	2.99	15.92
WSU 1792	2011	9.92	2.94	17.28
WSU 1912	2011	10.45	3.02	20.81
WSU 1948	2011	12.02	3.07	18.18
WSU 1964	2012	12.65	3.14	14.55
WSU 2011	2012	11.46	2.91	16.03