December 2016

2016-2017

(FY 2015-2016)

Research Progress Reports

for the

OREGON RASPBERRY AND BLACKBERRY COMMISSION

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Progress Report to the Oregon Raspberry & Blackberry Commission

TITLE: Development of Biologically-based RNAi insecticide to control Spotted Wing Drosophila

Year Initiated: 2015 **Current Year:** 2016 **Terminating Year**: 2018

Summary of Funding (2015-2016)

Funding Breakdown	Requested	Funded
OBC	$10,000	$10,000
WBC	$10,000	$0
ORBC	$10,000	$10,000
WRRC	$10,000	$0
Total budget	**$40,000**	**$20,000**

Principle Investigators: Man-Yeon Choi, USDA-ARS Horticultural Crops Research Laboratory, Corvallis, OR, Phone office 541-738-4026, e-mail mychoi@ars.usda.gov

Collaborator: Dr. Jana Lee – Research Entomologist, Dr. Robert R. Martin – Research Plant Pathologist (Virologist), USDA-ARS Horticultural Crops Research Laboratory, Corvallis, OR,

Relationship to Commission Research Priorities: Prevention and Management of Spotted Wing Drosophila and other insect pests

Objectives:
1. Select thirty genes in SWD from neurohormones and receptors involved in critical physiological functions during larval development and in the adult, and other genes involved in essential cellular activity (Yr. 1)
2. Identify target genes from SWD, and design dsRNA sequences of these genes and green fluorescence protein (GFP) as a control gene (Yr. 1 &2).
3. Inject RNAi into adult flies and monitor RNAi impacts (*i.e.* fecundity or mortality) on SWD (Yr.2 &3).
4. Feed RNAi selected into larvae and/or adults, and monitor RNAi impacts on SWD (Yr. 3 & 4).

Specific Objectives – **Year 1**
1. Select thirty genes in SWD from neurohormones and receptors involved in critical physiological functions during larval development and in the adult, and other genes involved in essential cellular activity.

2. Identify target genes from SWD, and design dsRNA sequences of these genes and green fluorescence protein (GFP) as a control gene.

Materials and Developed Methods - Year 1

Selection and identification of candidate genes for SWD RNAi targets - A feasible approach for RNAi target gene screening is to search previous targets or systems observed already from same or similar insect groups. Based on our RNAi experience, knowledge and previous RNAi reports, we will select 11 potential candidates including neuropeptide hormones, receptors and housekeeping genes for SWD RNAi target(s). We employed a BLAST search with the published *D. suzukii* genome (http://spottedwingflybase.oregonstate.edu) and a PCR-based strategy to identify homologous genes in SWD.

Design and Synthesis dsRNA (= RNAi material) - Using routine molecular biology skills and software, specific primers set with 5'-T7 promoter appended (TAATACGACT CACTATAGGG)

Primers will be designed to amplify partial lengths between 200- 400 nucleotides of the each target gene found in the SWD genome data. Amplified fragments will then be cloned into an appropriate vector for sequencing. Once confirmed the sequence DNA fragments were serve as the templates for dsRNA synthesis using a dsRNA synthesis kit. The negative dsRNA control (dsGFP) will also be constructed by the same method described above for SWD specific targets.

Result and Discussion – Year 1

We identified DNA sequences for 11 candidate genes, designed and synthesized 11 dsRNAs (Table 1 & Figs. 1& 2).

Table 1. SWD RNAi candidates from three different groups and GFP, and nucleotide lengths of dsRNAs.

Select RNAi candidate genes → Identify actual genes from SWD → Design DNA templates →

Construct dsRNA (RNAi material) → RNAi bioassay in SWD → Evaluate RNAi impacts on SWD

Figure 1. Outline of the screening process of RNAi targets to SWD

RNAi candidates	DNA template for RNAi synthesis	Gene group
SWD ID1	296 nucleotides	Neurohormone
SWD ID2	195 nucleotides	Neurohormone
SWD ID3	399 nucleotides	Hormone receptor
SWD ID4	244 nucleotides	Housekeeping
SWD ID5	253 nucleotides	Housekeeping
SWD ID6	255 nucleotides	Housekeeping
SWD ID7	253 nucleotides	Housekeeping
SWD ID8	250 nucleotides	Housekeeping
SWD ID9	251 nucleotides	Housekeeping
SWD ID10	254 nucleotides	Housekeeping
SWD ID11	254 nucleotides	Housekeeping
Green fluorescence protein (GFP)	350 nucleotides	To be used for control gene – unrelated in SWD

We found some genes identified in this study were very different from those sequences published on the SWD genome data, indicating errors in the annotated genome or an incomplete SWD genome that needs to be confirmed for these target genes. The length of dsRNA for SWD ID2 was designed as a short fragment because the size corresponds roughly to full sequence (~200 base pairs). SWDID3 is a receptor for a neuropeptide hormone functioning in egg development in the female SWD.

Eight housekeeping genes as constitutive genes are expressed in all cell types at a level that does not fluctuate with the cell cycle. Functional examples of housekeeping genes for RNAi targets are related in the muscle physiology, detoxification, ATP metabolism, protein sorting and transporting, and cell membrane structure in cells. These genes have been selected for RNAi candidates to develop RNAi-based control for insect pests.

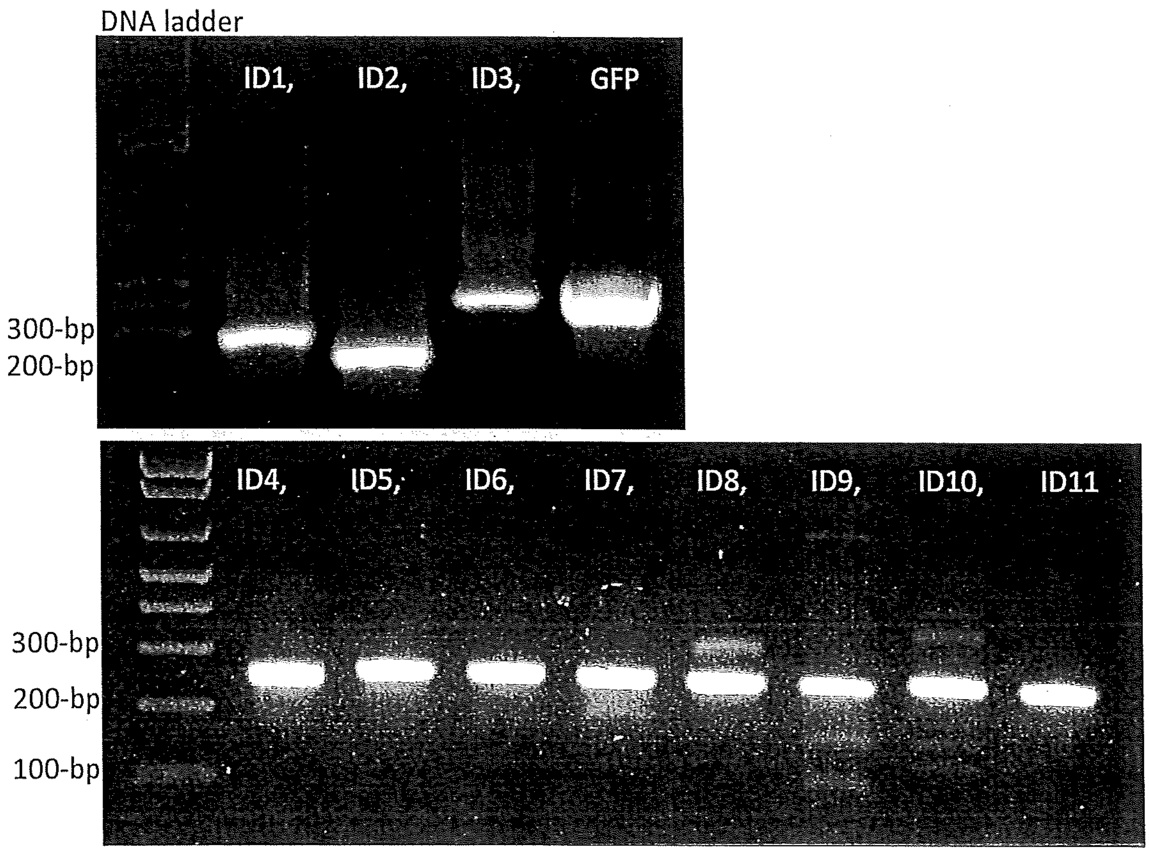

Figure 1. Photos of synthesized dsRNAs of SWD ID1-3 & GFP (upper) and ID4-11 (lower) corresponded to DNA templates in Table 1.

If funding is continued for next year we will evaluate RNAi impacts of these targets on SWD by a SWD specific microinjection established, and continue to identify more candidates in SWD.

Microinjection tool: Recently, PI's lab has successfully established a microinjection system using a Nanoliter 2010^{TM} injector fitted with custom-pulled borosilicate needles, and a homemade vacuumed tube to hold fly alive (Fig 2). The system and skill is particularly important to inject a nano-liter volume (50 nL = 0.02 uL) into small insects such as SWD without or a minimum damage physically on the fly. After injected with a sham or water only almost SWD adults (>

90%) were not affected and survived for two weeks monitored that they were monitored. Although individual RNAi injection into SWD is not a practical approach, it is the best and fastest method to screen RNAi impact on pheno-and genotypic effects in the initial step because dsRNA injected into hemocoel (= blood vessel) will be directly delivered in the target cells.

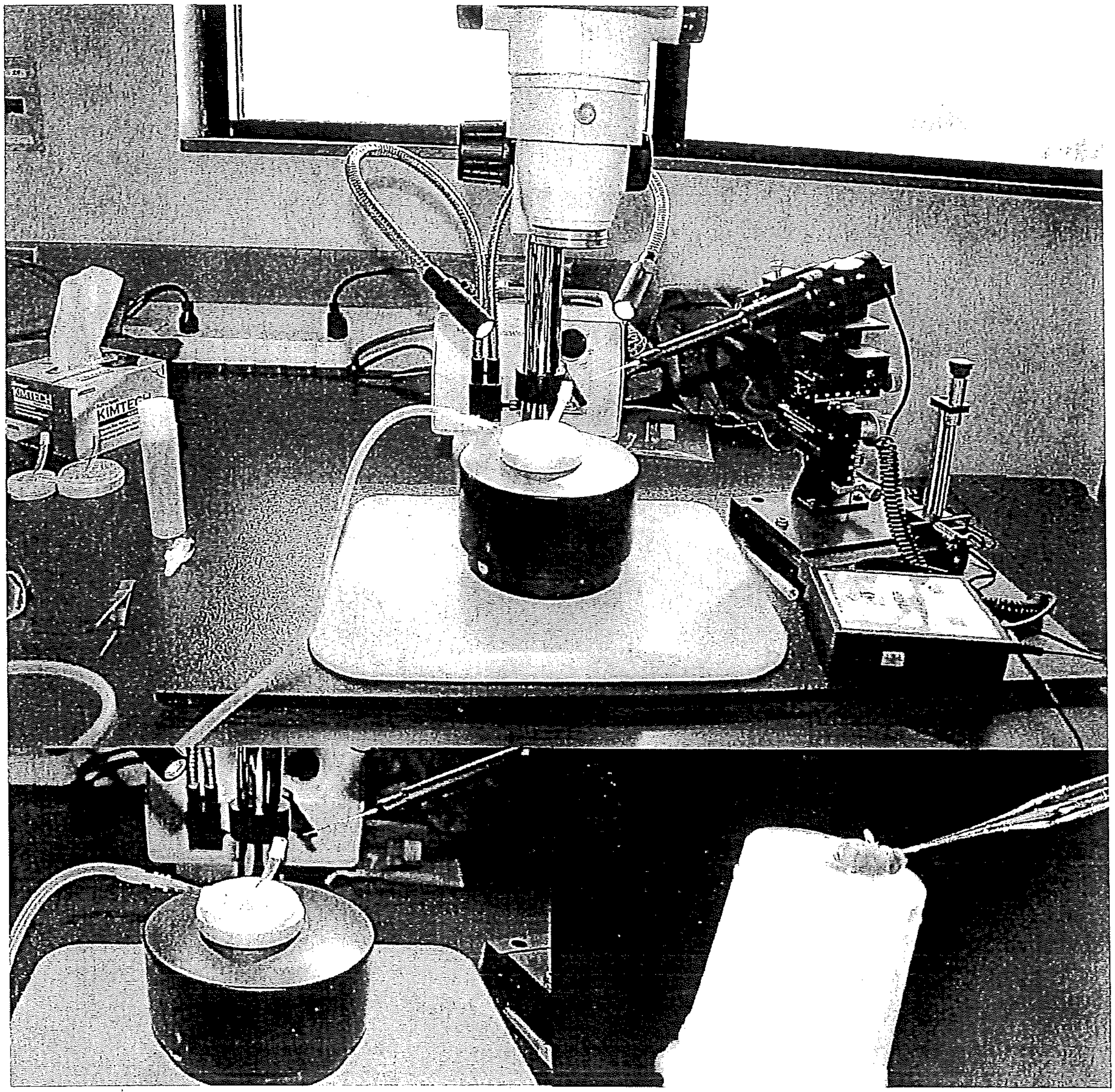

Figure 2. Photos of microinjection system (upper) equipped with a stereomicroscope, micromanipulator and a vacuumed tubed plate (lower left), and SWD adult injected by a capillary glass needle (lower right).

Continuing…

We successfully completed selection and identification of 11 potential RNAi targets, cloning, sequencing, and constructed dsRNA as RNAi material. Currently we are testing phenotypic impact(s) such as mortality effect on SWD adults.

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: 2016-2017

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 - 2016:*
The residue and efficacy data we generated and submitted to EPA for review allowed the registration of the following products in caneberries:

(1) AgriMek SC (abamectin). Agri-Mek can be used for control of adults and nymphs of the twospotted spidermite. Agri-Mek is in IRAC #6, which no other caneberry insecticide or miticide is in, so it will be a good rotation partner with other registered miticides that are in a difference resistance class. The PHI is seven days; REI is 12 hours. Being toxic to aquatic life, the label contains restriction that specifies a 25-ft buffer to bodies of water. Also, use of a spreader or penetrant is required.

(2) Luna Tranquility (fluopyram + pyramethalnil). Luna is a new fungicide from Bayer mainly for control of Botrytis fruit rot. It will also control powdery mildew, Septoria cane and leaf spot, and other diseases. Is in FRAC Groups #7 and #9, which is the same group as components of Pristine and Switch, so careful planning for rotation of fungicides is needed for resistance management. PHI is 0-days; REI is 12 hours.

(3) Prowl H_2O (pendimethalin). Prowl is a soil-active herbicide that will provide good preemergent control of broadleaf and grass weeds. It is in Herbicide Rotation Guide #3, as are Kerb and Surflan. Caneberries appear only on the Prowl H_2O supplemental label for caneberries, and not on the Prowl 3.3 EC label, which is being phased out. PHI is 30-days; REI is 24 hours.

(4) Goal 2XL (oxyfluorfen). Goal 2XL has been used for caneburning for many years under a Section 24c (state) registration. Dow AgroScience has now added these uses (bearing raspberries and blackberries, and AY-production blackberries) to their main, Section 3 label. The 24c labels still exist but will expire on 12/31/17. Caneberries do not appear on the Goal Tender label.

V. ***Caneberry Field Trials Completed in 2016:***

(1) Phosphorous Acid/Potassium Phosphite. In 2016, we conducted three magnitude of residue field trials in raspberry and blackberry for potassium phosphite. Products, such as Phosphite, Fungi-Phyte, 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). Even though the EU is currently not a major 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. The data we provided will help the EU and other countries set a new, more reasonable MRL for potassium phosphite in caneberries.

(2) Saflufenacil (Treevix). With funding from IR-4 and BASF, we completed a 2-year performance and crop safety study in raspberry looking at Treevix herbicide for caneburning and general weed control. Although residue data have already been collected, BASF wanted additional efficacy and crop safety data to be certain their product has a good fit in caneberry production. Our results indicate that Treevix will be useful as a caneburning material and, if used pre-budbreak, can be used for control of broadleaf and grass weeds. This product is NOT yet registered for use in caneberry.

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 2016 workshop in Orlando, Florida, and presented the pest management needs of the Oregon caneberry industry.

IR-4 Residue Trials Slated for 2017:

Pydiflumetofen/FTH-545 (Miravis?). We are not yet certain what the official trade name will be for this active ingredient. Pydiflumetofen is a new fungicide from Syngenta not currently registered on any food crops in the USA. Results from field trials in blueberries show excellent efficacy for control of Botrytis fruit rot and other diseases. Efficacy field trials will be conducted in raspberry and blackberry in 2017. Pydiflumetofen will likely be combined with another active ingredient when Syngenta markets the product.

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
2016

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.

Accomplishments

Major project goals: The overall goal of this proposal was to develop and make available genomic tools for the improvement of black raspberry and apply these tools for crop improvement using wild germplasm. These resources will significantly aid in the integration of novel traits from wild germplasm into elite cultivars and are necessary tools for molecular breeding of black raspberries and related species (e.g., red raspberry, blackberry) and to address the needs of the industry for improved cultivars. Objectives were presented as solutions to address problems in production and breeding that were identified by the industry and the USDA-ARS Small Fruits Crop Germplasm Committee. Conversations with black raspberry growers and processors over the last decade revealed disease and short planting longevity as their top production concerns. The USDA-ARS Northwest Center for Small Fruits Research (an academic/commercial industry partnership) and the Oregon Raspberry and Blackberry Commission have identified cultivar improvement as a number one research priority for the commercial raspberry industry.

Obj. 1: Transcriptome sequencing and high-throughput genomic sequencing: We completed the sequencing and assembly of the genome of a black raspberry individual using the facilities at Oregon State University, Corvallis, OR and The Donald Danforth Center, St. Louis, MO. We also obtained transcriptome sequence information from a variety of plant tissue types to better understand the genes that are expressed in each tissue. We used the expressed gene data to identify gene locations on our genome sequence. The genome of black raspberry (*Rubus occidentalis*) accepted and published in The Plant Journal on line May 12, 2016.

Obj. 2: Developing molecular markers from EST and genomic sequences: We mined the genome sequence for Simple Sequence Repeat (SSR) markers not previously available in black raspberry. We completed the high-throughput sequencing of our two mapping populations and a third population to identify specific differences within a single population and among the three populations.We used this information to develop targeted SSR and genome-wide SNP molecular markers and have placed these markers on a genetic linkage map. We are in the process of constructing a linkage map for our second mapping population of 192 progeny.

Obj. 3: Studying genotype by environment interaction on specific traits of interest in crosses involving diverse wild black raspberry germplasm: Interest in black raspberry production has expanded far beyond upstate New York and the Ohio River Valley where production was once concentrated; however, the industry today is reliant on cultivars developed for this region. The extent to which they are adapted to other production regions is not well understood. Studying the performance of seedling populations segregating for adaptation and other important traits in four production regions, Oregon, New York, Ohio, and North Carolina will provide valuable information on relative performance for these traits and effectiveness of selection for them in very different locations with strong small fruits industries and an interest in improved black raspberry cultivars. We successfully completed three years of data collection to conduct this analysis. Preliminary results using a subset of data indicate that an individual's performance is influenced by the environment in some cases. This analysis will be completed this year.

Obj. 4: Using molecular markers for mapping specific traits of interest in crosses involving diverse wild black raspberry germplasm: We constructed a genetic linkage map for one mapping population. We are in the process of developing the linkage map for the second mapping population. Genetic linkage maps provide a framework of how the chromosomes of black raspberry are assembled and which regions are inherited together and will be used for identifying the regions of the genome involved in the expression of traits of interest. Next we plan to map loci involved in disease and insect resistance, vigor, phenology, fruit chemistry properties, and quality traits across locations as well as specific to each production region. The resulting linkage maps and QTL association will be used for the development of marker-based tests for important traits.

Obj. 5: Evaluate transferability of SSR markers developed in black raspberry to red raspberry: The completion of the first genetic linkage map for black raspberry will provide us with the means to address this objective as we are prioritizing evaluating transferability of markers mapped in black raspberry to red raspberry to allow comparative mapping in both crops. To date, 37 SSR markers are polymorphic in both species and 14 of these markers are located on the linkage map for ORUS 4305 with 1 to 4 markers per linkage group. These and other markers are useful as anchor markers for comparing maps between red and black raspberry and other Rose Family crops.

Obj. 6: Better understanding of consumer preferences and factors promoting black raspberry market expansion: We managed a replicated planting of advanced black raspberry selections for use in sensory evaluation. Fruit harvested from all fruiting plants commenced on 28 June and continued to 10 July. Fresh fruit harvested from these plots were submitted to an 11-member trained sensory panel for quantitative descriptive analysis (QDA) of appearance, aroma, flavor and texture characteristics. QDA panelists were exposed to 3 or 4 entries per test; each genotype was evaluated twice. There were significant differences among genotype means for many fruit characteristics. Oregon-grown fruit of the same selections and standards were machine-harvested and processed into puree by the Oregon State University (OSU) Department of Food Science and Technology. Purees were randomly assigned to two groups of four purees. Groups were subjected to consumer preference analysis at the OSU Sensory Science Laboratory on August 6th and 7th and on September 17th and 18th using 109-member and 115-member consumer panels, respectively. Purees will be analyzed by the QDA panel in mid-Oct. 2014. We are also exploring messaging techniques to improve black raspberry market share. Survey instruments and protocols to ascertain purchasing incentives of larger buyers (processors, retail grocery chains, etc.) have also been developed. We have also explored several analytical techniques for extracting and evaluating flavor compounds present in these fruit and have developed an analytical library of over 30 flavor compound standards. This information will provide us with consumer acceptance targets when selecting germplasm for breeding. Additional work is on-going at the Ohio State University.

A survey instrument entitled "Opportunities and Challenges Facing Black Raspberry Producers" was developed to delineate current production and marketing strategies and to outline important grower needs/concerns for future expansion of acreage. This instrument was presented at the 2014 Oregon Raspberry and Blackberry Commission (ORBC) Annual Growers Meeting, December 17 at the Wellspring Conference Center, in Woodburn, Oregon and at the North American Raspberry & Blackberry Association (NARBA) Conference, February 24-27, 2015 in Fayetteville, Arkansas. An on-line version was made available and was promoted by ORBC, NARBA and the Ohio Produce Growers & Marketers Association (OPGMA). The survey revealed that most black raspberry producers (68%) farm less than 100 acres and 32% of respondents reported to grow less than 5 acres of this crop and realized gross receipts of less than $50,000 annually. They tend to grow a mixture of berry crops. They sell through farm stands, farmers markets, pick your own, wholesale and retail. Responding growers indicated that production costs, product perishability and shipping constraints, disease and insect problems, consumer unfamiliarity with the product (often confused with blackberries), and the lack of cultivar diversity to be major impediments to industry growth. Varietal characteristics most highly desired by producers included excellent pest resistance and fruit quality characteristics, thornlessness, season extension capacity and the primocane fruiting habit.

Obj. 7: Delivering research results and training in molecular breeding to the industry, breeders, and students through a multifaceted outreach and extension program: Over the course of the project we have presented our research at more than 20 different conferences and field days and have nine peer-reviewed publications. We hired and trained high school students and trained volunteers in North Carolina and Oregon in field and molecular components of the project. Research was also highlighted on several social media sites. We conducted training in germplasm assesment and characterization, molecular breeding, and applied use of molecular tools in breeding at the 2015 American Society for Horticultural Science Annual Conference in New Orleans, LA.

Publications:

<u>Peer-reviewed Publications (by date):</u>

Dossett M, Bassil NV, Lewers KS, Finn CE. **2012**. Genetic diversity in wild and cultivated black raspberry (*Rubus occidentalis* L.) evaluated by simple sequence repeat markers. Gen. Res. Crop Evol. 59:1849-1865.

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

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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.

Dossett M, Bushakra JM, Gilmore BS, Koch CA, Kempler C, Finn CE, Bassil NV. **2015**. Development and transferability of black and red raspberry microsatellite markers from short-read sequences. J. Amer. Soc. Hort. Sci. 140:243-252.

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. 128:1631-1646.

Weber CA, Galvani CD. **2015**. Field performance of black raspberry cultivars in Western New York. J. Amer. Pomol. Soc. 69:109-115.

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

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Lee J. **2016**. Further research on the biological activities and the safety of raspberry ketone are needed. NFS Journal 2:15-18

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Dossett M, Bassil NV, Finn CE. **2012**. Fingerprinting of black raspberry cultivars shows discrepancies in identification. Acta Hortic. 946:49-53.
Dossett M, Lee J, and Finn CE. **2012**. Anthocyanin content of wild black raspberry germplasm. Acta Hortic. 946:43-47.
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, and Perkins-Veazie P. **2014**. Genetic and Developing Genomic Resources in Black Raspberry. Acta Hortic. 1048:19-24.
Lee J, Dossett M, and Finn CE. **2014**. Anthocyanin rich black raspberries can be made even better. Acta Hortic. 1017:127-133.
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Bassil N, Gilmore B, Hummer K, Dossett M, Mockler T, Filichkin S, Peterson M, Finn C, Lee J, Fernandez G, Perkins-Veazie P, Weber C, Agunga R, Rhodes E, Scheerens JC, Lewers K, Graham J, Fernández-Fernández F, Yun SJ. **2014**. Genetic and Developing Genomic Resources in Black Raspberry. Acta Hortic. 1048:19-23.
Bradish CM, Fernandez GE, Bushakra JM, Perkins-Veazie P, Dossett M, Bassil NV, Finn CE. **2016**. Evaluation of vigor and winter hardiness of black raspberry breeding populations (*Rubus occidentalis*) grown in the southeastern US. Acta Hortic. 1133:129-134.
Bushakra JM, Bassil NV, Weiland JE, Finn CE, Vining KJ, Filichkin S, Dossett M, Bryant DW, Mockler TC. **2016**. Comparative RNA-seq for the investigation of tolerance to Verticillium wilt in black raspberry. Acta Hortic. 1133:103-114.
Perkins-Veazie P, Ma G, Fernandez GE, Bradish CM, Bushakra JM, Bassil NV, Weber CA, Scheerens JC, Robbins L, Finn CE, Dossett M. **2016**. Black raspberry fruit composition over two years from seedling populations grown at four US geographic locations. Acta Hortic. 1133:335-338.

Abstracts

Bushakra J, Bassil N, Dossett M, Gilmore B, Mockler T, Bryant D, Filichkin S, Weiland J, Peterson M, Bradish C, Fernandez G, Lewers K, Graham J, Finn C. **2013**. Black raspberry genomic resource development. International Plant & Animal Genome XXI.
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Bradish CM, Fernandez GE, Bushakra JM, Perkins-Veazie P, Dossett M, Bassil NV, Finn CE. **2014**. North Carolina's role in a nationwide effort to improve black raspberry. HortScience Annual Meeting Supplement 49:S56-S57 (abstract).
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Bushakra JM, Bradish CM, Weber CA, Scheerens JC, Dossett M, Peterson M, Fernandez G, Lee J, Bassil N, Finn CE. **2014**. Toward understanding genotype x environment interactions in black raspberry. HortScience Annual Meeting Supplement 49:S298 (abstract).
Perkins-Veazie P, Fernandez G, Bradish CM, Ma G, Scheerens JC, Weber CA, Finn CE, Bassil N, Bushakra JM. **2014**. Black raspberry fruit composition from seedling populations planted at multiple locations. HortScience Annual Meeting Supplement 49:S248 (abstract).
Bushakra J, Dossett M, Lee JC, Lee J, Bassil NV, Finn CE. **2015**. Molecular evaluation of aphid-

resistant black raspberry germplasm for improved durability in black and red raspberry [abstract]. American Society of Horticulture Science Meeting. 2015 American Society for Horticultural Science Annual Conference.

Bushakra J, Bassil NV, Bryant D, Mockler T, Dossett M, Gilmore BS, Peterson ME, Bradish C, Fernandez G, Lee J, Finn CE. **2015**. Black raspberry genomic and genetic resource development to enable cultivar improvement [abstract]. Plant and Animal Genome XXIII Conference.

Bushakra J, Bryant D, Dossett M, Vining K, VanBuren R, Gilmore BS, Filichkin S, Weiland JE, Peterson ME, Bradish CM, Fernandez G, Lewers KS, Graham J, Lee J, Mockler T, Bassil NV, Finn CE. **2015**. Developing black raspberry genetic and genomic resources [abstract]. International *Rubus* and *Ribes* Symposium

Additional Publications (PDs in bold font):

Lee, J. 2015. *Rubus* myths vs. reality. http://www.black-raspberries.com (Factsheet/Other)

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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 (*Rubus occidentalis* 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 (*Rubus occidentalis* 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 (Rubus occidentalis 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 (*Rubus occidentalis* 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 (*Rubus occidentalis* 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 (*Rubus occidentalis* 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. 7th Rosaceae 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 2016

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: USDA/ARS Northwest Center for Small Fruits Research
Amount Awarded $32,419 for 2016-2017 for both raspberry and strawberry breeding

USDA/ARS Northwest Center for Small Fruits Research
Amount Awarded $34,144 for 2016-2017 for "Enhanced Tools for Improving Root Rot Resistance in Red Raspberry"

Washington Red Raspberry Commission
Amount Awarded $63,000 for 2016 "Development of New Raspberry Cultivars for the Pacific Northwest"

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:
Grower Trials. Four selections were planted in grower trials in 2014. All four selections were productive, machine harvested well, with good fruit quality. One selection appears very promising, machine harvests well, productive, firm, producing fruit at the same time as 'Willamette'. This selection will be evaluated in 2017 and may be considered for release.

Crosses/seedlings/selections. In 2016, there was a strong emphasis to improve root rot resistance by crossing selections that had good machine harvestability with cultivars and selections that are highly root rot resistant. Fifty-one of the sixty crosses for cultivar development had at least one parent that was root rot resistant. The seedling field planted in 2014 was in an area with a high level of root rot. Thirty selections were made, with six selections from the cross of WSU 1914 and Cascade Harvest. WSU 1914 has Boyne (highly root rot resistant) as a parent.

Machine Harvesting Trials. A new machine harvesting trial was planted in Lynden with 77 WSU selections, 6 ORUS selections, 5 BC selections and 'Cascade Harvest', 'Meeker' and 'Willamette' for reference. This planting will be harvested in 2018 and 2019.

The machine harvesting planting established in 2013 was evaluated in 2015-16 seasons. Harvest data for each harvest in the 2013 planting were collected in 2015, but only subjectively evaluated in 2016. The 20 plots with the highest yields in 2015 are given in Figure 1. WSU 2069 had the highest yield and WSU 2068 and WSU 1962 were in the top seven for yield. The 2014 planting was evaluated subjectively on five dates in 2016 and harvest data collected for each harvest.). Forty-three WSU selections and standard cultivars were machine harvested along with the BC and ORUS selections in this planting. Cascade Harvest had the second highest yield and WSU 2188 and WSU 2166 were in the top 10 for yield (Figure 2).

Selection Trial Puyallup. Cascade Harvest had the highest yield in both the 2013 selection trial at Puyallup and the 2014 planting (Tables 1 and 2). Other high yielding selections in the 2013 planting were WSU 2075, WSU 2069, WSU 2068 and WSU 1914. WSU 2188 had a good yield in the 2014 planting. WSU 2166 had very low yield in the first year of harvest as a result of producing few canes. This fall there is a normal amount of canes, hopefully the 2017 yield will be higher.

Publications

Machine Harvesting Field Day Lynden, WA June 23, 2016

Lanning, K.K., P.P. Moore, K.E. Keller, R.R. Martin. 2016. First report of a resistance-breaking strain of Raspberry bushy dwarf virus in red raspberry (Rubus idaeus) in North America. Plant Disease 100:868.

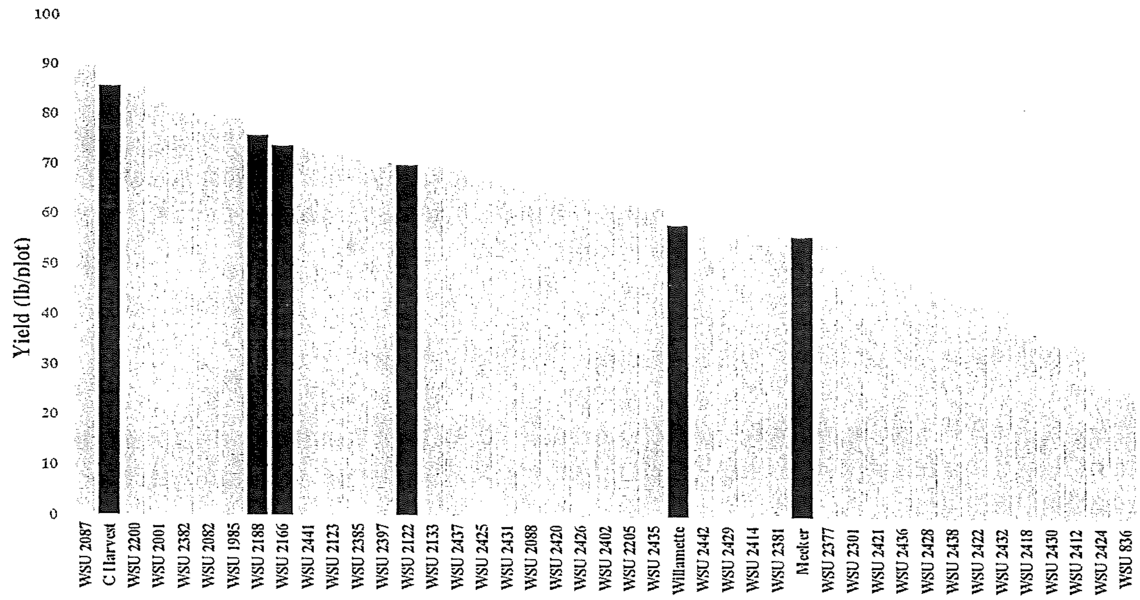
Summary

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.

Figure 1

2016 Machine Harvest yield (lb/plot) in 2014 planted trial, Willey's Lake



Figure

2015 Machine Harvest yield Bedlington planting (of top 20 yielding clones). Planted 2013

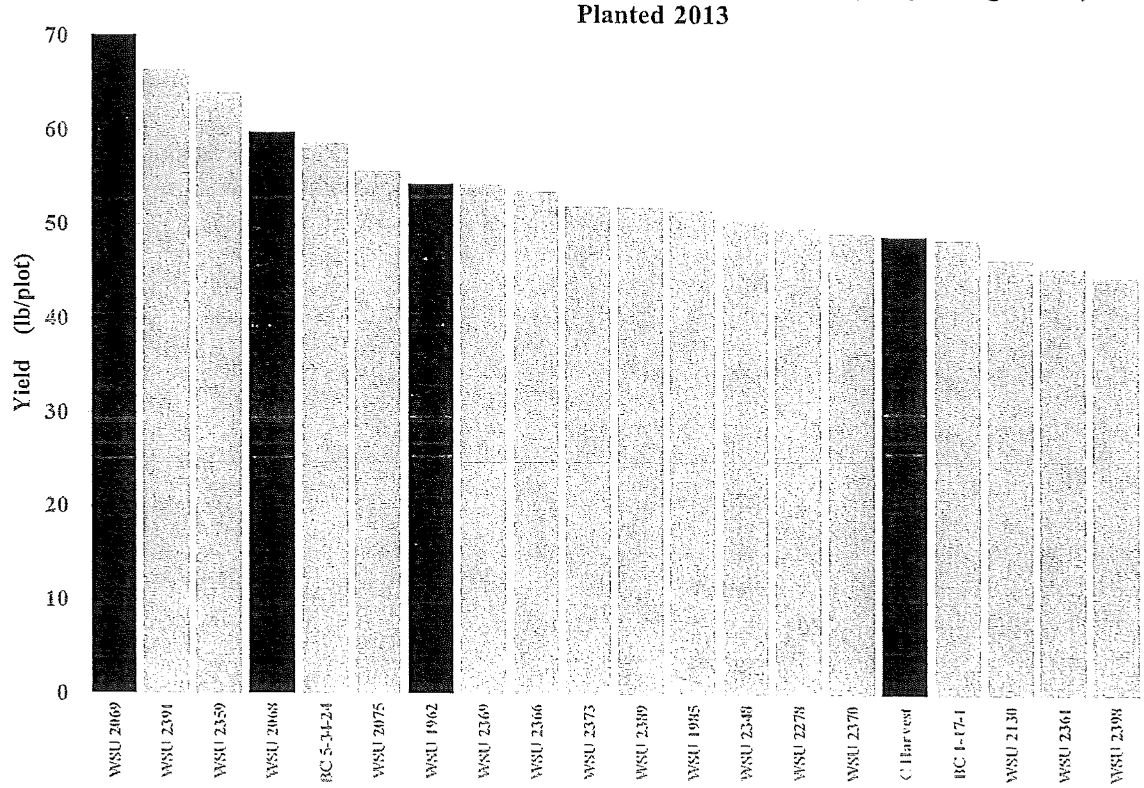


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Table 1. 2015 and 2016 harvest of 2013 planted raspberries, Puyallup, WA

	Yield (t/a)			Fruit weight (g)		Culls (%)		Fruit firmness (g)		Midpoint of harvest	
	2016	2015	Total	2016	2015	2016	2015	2016	2015	2016	2015
C Harvest	10.3 a-c	7.8 a	18.1 a	4.09 ab	3.21 a	6.31 b	11.2 a	80 ab	192 ab	6/23 bc	6/28 cd
WSU 2075	12.2 a	5.7 a	17.9 a	3.02 b	2.02 ef	2.53 b	2.7 d	68 a-d	127 f	6/21 cd	6/22 e
WSU 2069	11.7 ab	5.8 a	17.4 a	4.00 ab	2.86 a-c	5.52 b	5.5 b-d	85 ab	163 b-d	6/18 ef	6/25 dc
WSU 2068	11.3 ab	6.1 a	17.4 a	5.41 a	2.94 ab	5.29 b	6.2 b-d	89 a	140 d-f	6/18 ef	6/23 e
Meeker	10.8 a-c	5.8 a	16.6 a	3.40 b	2.38 c-e	13.57 a	9.6 ab	81 ab	157 c-e	6/27 a	7/1 a-c
WSU 1914	10.0 a-d	5.4 a	15.3 a	3.81 ab	3.14 a	6.43 b	4.6 cd	67 a-d	141 d-f	6/28 a	6/30 bc
Willamette	9.7 a-d	4.7 ab	14.4 a	3.38 b	2.34 d-f	4.17 b	4.0 cd	67 a-d	131 ef	6/17 f	6/22 e
WSU 2010	9.7 a-d	4.7 ab	14.4 a	2.97 b	1.85 f	2.68 b	4.9 cd	64 b-d	137 d-f	6/20 de	6/24 dc
WSU 1985	8.4 a-e	5.1 ab	13.5 ab	3.91 ab	2.39 c-e	4.89 b	7.2 a-c	80 a-c	214 a	6/26 ab	7/3 ab
WSU 1962	7.9 b-e	5.0 ab	13.0 ab	3.35 b	2.37 c-e	5.84 b	7.3 a-c	57 cd	173 bc	6/27 a	7/5 a
WSU 2022	5.9 de	5.7 a	11.7 ab	3.48 b	2.97 ab	3.58 b	7.9 a-c	69 a-d	159 c-e	6/20 de	6/25 dc
WSU 1958	6.8 c-e	4.8 ab	11.6 ab	2.76 b	2.12 d-f	6.92 b	7.2 a-c	56 d	96 g	6/18 ef	6/23 e
WSU 1908	5.5 e	2.3 b	7.8 b	3.01 b	2.59 b-d	4.01 b	4.9 cd	49 d	82 g	6/19 d-f	6/23 e
Average	9.3	5.3	14.5	3.6	2.55	5.5	6.4	70	147	6/22	6/26

Table 2. 2016 harvest of 2014 planted raspberries, Puyallup, WA

	Yield (t/a)	Yield g/cane	Fruit weight (g)	Culls (%)	Fruit firmness (g)	Midpoint harvest
C Harvest	11.0 a	533 a	4.16 ab	9.79 a-c	90 a-c	6/23 d-f
WSU 2188	8.1 ab	493 ab	4.41 a	7.85 bc	102 a	6/27 a-d
Willamette	7.8 a-c	349 c	3.06 d-f	7.21 bc	74 b-e	6/19 fg
WSU 2001	7.8 a-c	537 a	3.86 a-c	14.33 a	87 a-d	6/30 a
WSU 2122	6.9 a-c	384 bc	3.64 bc	11.95 ab	88 a-d	6/26 b-e
Meeker	6.8 a-c	337 c	3.10 de	11.44 ab	74 c-e	6/28 ab
WSU 2200	6.8 a-c	336 c	2.49 f	6.40 bc	59 e	6/22 ef
WSU 1985	6.7 a-c	388 bc	3.43 b-d	9.16 a-c	64 de	6/27 a-c
WSU 2205	6.2 bc	322 c	3.16 de	4.25 c	74 b-e	6/17 g
WSU 0836	5.4 bc	315 c	2.92 ef	12.42 ab	63 de	6/17 g
WSU 2133	4.4 bc	438 a-c	2.93 ef	6.28 bc	60 e	6/23 c-f
WSU 2082	4.0 bc	393 bc	4.27 a	9.41 a-c	100 ab	6/23 c-f
WSU 2166	3.7 c	409 a-c	4.30 a	4.37 c	101 a	6/19 fg
Average	6.6	403	3.5	8.8	79.9	6/23

Progress Report to the Oregon Raspberry & Blackberry Commission

November 27, 2016

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 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
- Improving the quality and breadth of information available on advanced selections,
- 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 2013-2016

- Established grower cooperator network and have successive trial blackberry plantings in the ground.
- 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 overall budget for determining annual costs for maintaining an ongoing program.

Selections/Cultivars being evaluated onfarm to date 2013-2016

Blackberries

- **ORUS 2635-1 (Erect-thorny)** Still being evaluated. Primarily to see if upright growth habit could make it more economic to prune and tie. Most likely not acceptable for main processing uses.
- **ORUS 3172-1** Ripens two weeks later than Marion. Discarded. Fruit is too soft for machine harvesting.
- **ORUS 3447-1 (Columbia Star)** Excellent fruit quality. Planted acreage quickly increasing.
- **ORUS 3447-2 (Columbia Giant)** Very large fruit. Is quickly finding a fresh market niche. Possible that we could trial it in large trials to see if it could be useful for processing uses.
- **ORUS 2707-1 (Marion timing)** Discarded. Fruit too soft for machine harvesting.
- **ORUS 1324-1 (Newberry)** Niche market potential. Thorniness, fruit color and fruit flavor profile make it unacceptable for present processing uses.
- **ORUS 1939-4 (Thorny-Fresh Market)** Potential Advantage for Oregon industry: Has good fresh market potential uses in California and elsewhere. Could provide royalty income to support breeding program without directly competing with our major markets.
- **ORUS 1793-1 (Thorny-Fresh Market)** Potential Advantage for Oregon industry: Has good fresh market potential uses in California and elsewhere. Could provide royalty income to support breeding program without directly competing with our major markets.
- **ORUS 2816-4 (Thornless-Fresh Market)** Very late-three weeks after Marion. Fresh market potential.
- **ORUS 2635-1 (Thorny-High yielding)** While thorny it still produces 50-70% more than Marion. Good for fresh. Might be worth trialing for processing even though thorny.

Black Raspberries (Will get first fruit evaluations in 2017)

- **ORUS 3735-3** Potential for larger fruit and higher yields than Munger. Plants used for trials had crumbly fruit—likely propagation problem. Will replant in 2017 with new planting material.
- **ORUS 3013-1** In some early trials had double the yields of Munger. Will get new fruit this season.
- **ORUS 3217-1** In some early trials had double the yields of Munger. Will get new fruit this season.
- **ORUS 3409-1** May have verticillium resistance. Probable fresh market niche. Fruits on primocanes and floricanes.

The Northwest Berry Foundation
5261 North Princeton Street, Portland OR
97203-5263
503-285-0908~info@nwberries.org
www.nwberryfoundation.org

Small Fruit Update Progress Report

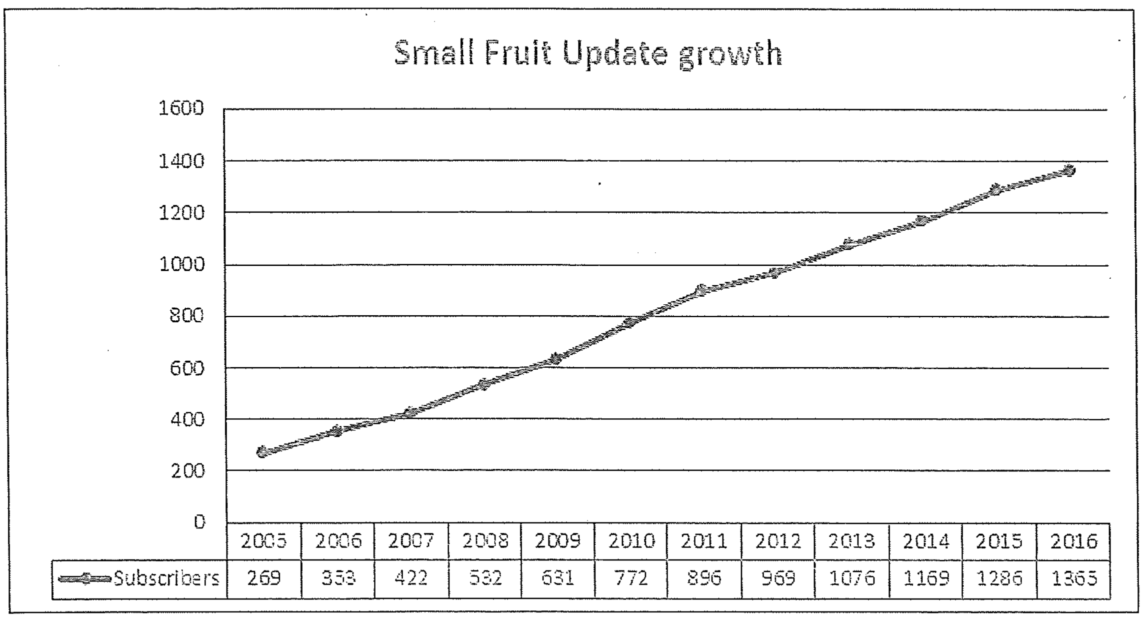
As of November 28, 2016

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 by 79 addresses (from 1286 addresses 2015, to 1365 addresses in 2016). As several recipients regularly pass it on to others, we estimate the total number receiving the Update to be well over 1,400 people.

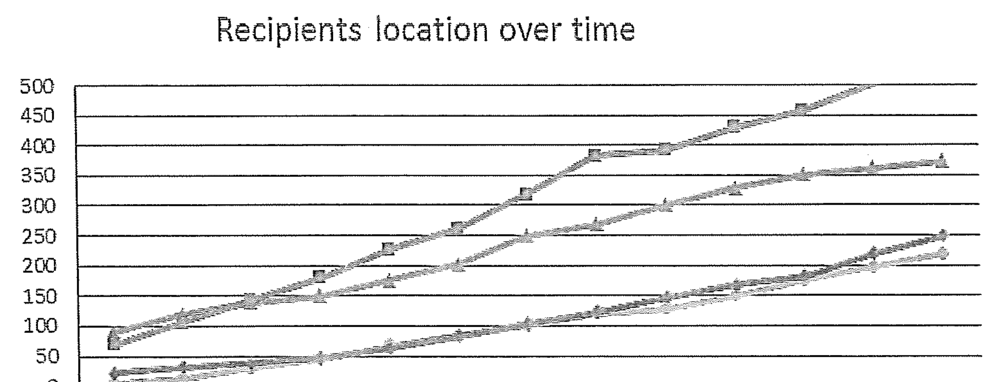


	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Subscribers	269	353	422	532	631	772	896	969	1076	1169	1286	1365

2016 Profile of the Small Fruit Update

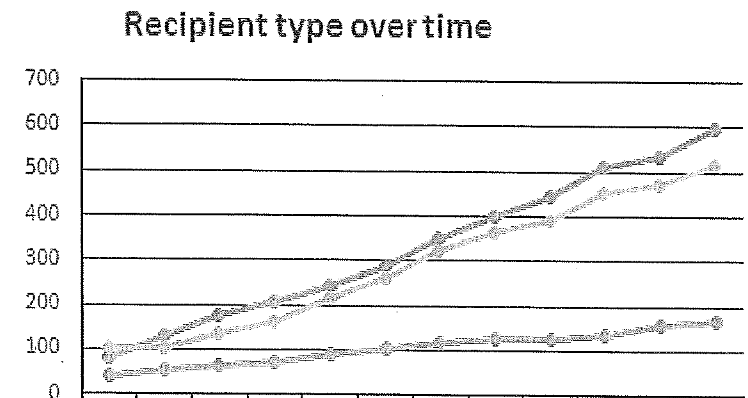
The following charts illustrate the profile of the Small Fruit Update recipients in our database as of the date of this report.

We make every effort to provide you with accurate information. We don't mandate those who sign up for the Update to give us any information beyond their email 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 36 unsubscribes). Some drop out because of a job change, but there are always a few dropped simply 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	2016
Washington	91	119	140	150	175	203	249	269	301	329	352	363	373
Oregon	69	106	143	180	227	261	318	383	392	430	458	501	528
Out of Area	4	12	31	45	67	84	101	121	129	150	176	197	219
BC	22	32	39	47	63	83	104	123	147	167	182	220	250

In 2016, there has been a subscriber increase of 30 recipients in BC, 27 in Oregon and 10 in Washington. The remaining recipients are located throughout the U.S., Canada, and the rest of the world. That segment increased by 30 subscribers. We screen new subscribers from potentially competitive markets until such time that the funding entities decide that is not necessary.



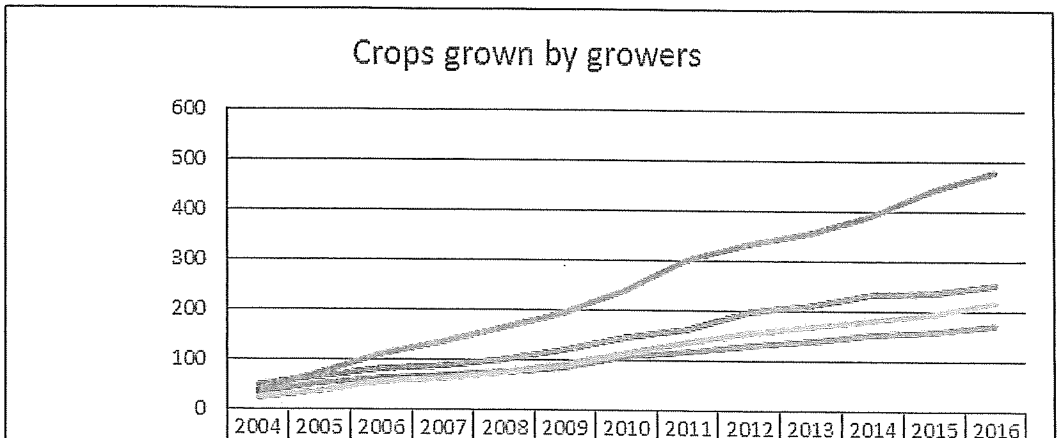
	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Growers	83	130	175	205	244	289	349	399	443	513	536	596
Researchers	42	53	63	74	92	103	118	125	127	134	158	166
Industy	104	104	135	163	217	262	325	362	391	455	474	516

The "Growers" category had a major jump of 45 individuals in subscribers going from 596 in 2015 to 641 in 2016.

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 declined by 1individual. This may reflect a natural pause after the growth in researchers who subscribed in 2014 and 2015.

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 declined by 3 individuals.

Our signup form (http://www.nwberryfoundation.org) 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	2016
Strawberry	35	52	64	70	75	85	108	117	131	141	152	161	172
Raspberry	49	65	82	90	103	121	147	163	198	210	233	237	255
Blackberry	23	39	56	62	76	91	116	139	158	171	183	196	217
Blueberry	40	73	113	139	167	197	242	303	333	358	392	444	480

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 2016, the number of recipients identifying themselves as blackberry growers increased 11%, strawberry growers increased 7%, and blueberry growers increased 8%, while raspberry growers increased by 8%.

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. There has been a 734% increase in subscribed recipients since 2004, when the first email messages were sent to subscribers.
All this is due to your continued sponsorship.

PROGRESS REPORT TO THE OREGON RASPBERRY AND BLACKBERRY COMMISSION

2015-2016 Fiscal Year

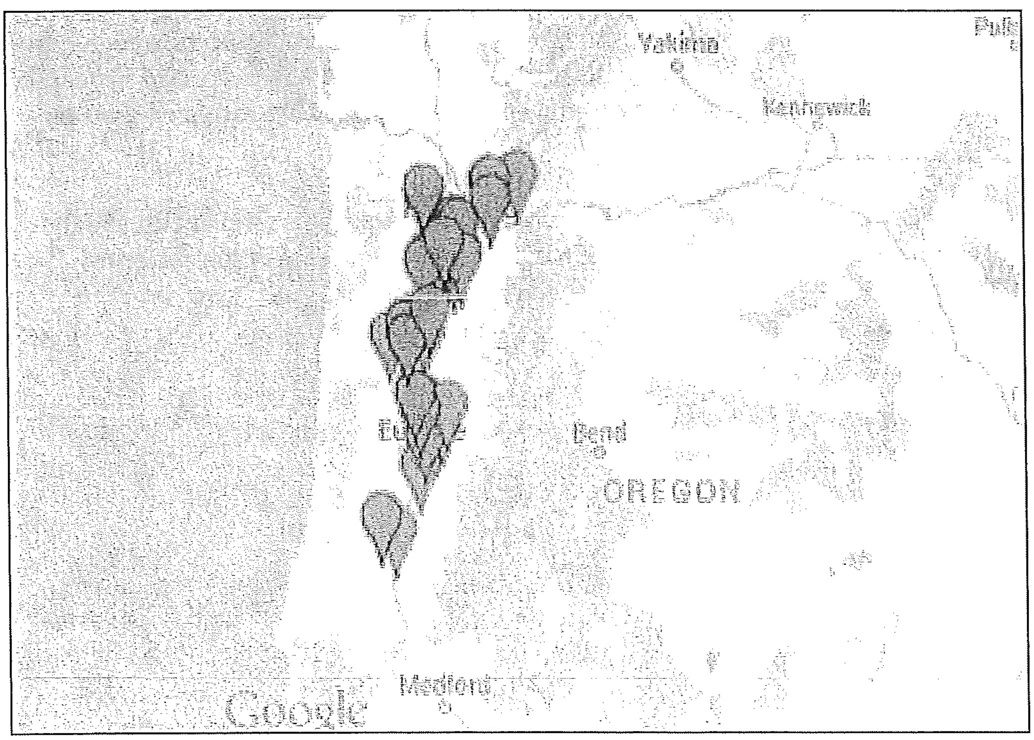
Project Leaders: Lisa A. Jones and Jay W. Pscheidt, Dept. of Botany & Plant Pathology,

Oregon State University, Corvallis, OR, 97331-2903

Title: *Botrytis* Species Affecting Raspberries and Blackberries in Oregon

Botrytis samples were collected from blackberry fruit and raspberry fruit and canes during July, 2014 through October 2015, throughout the caneberry growing regions of Oregon to determine if species other than *B. cinerea* are responsible for fruit rots and cane infections. Over 700 samples were collected from 44 farms. Farms of all sizes and growing practices, conventional to organic, were included in this survey.

Figure 1. *Botrytis* sample sites



Samples were surface sterilized, *Botrytis* was isolated from the fruit and canes and DNA was extracted for species identification. The housekeeping gene, glyceraldehyde 3-phosphate dehydrogenase (G3PDH), was sequenced for all isolates to determine if the isolate was *B. cinerea* or another *Botrytis sp.* For isolates requiring additional genetic analysis two more housekeeping genes RNA polymerase II (RPB2), and the heat shock protein 60 (HSP60), were sequenced to determine identity.

Little *Botrytis* diversity at the species level was found on isolates collected from caneberries in Oregon, 99.5 % of isolates were identified as *B. cinerea.* Four isolates, 3 on raspberries from a location near

Portland and one from a blackberry near Springfield were genetically distinct from *B. cinerea* but genetically similar to each other. DNA sequence analysis of the G3PDH, RPB2, and HSP60 genes did not closely align with any known species of *Botrytis* suggesting that these isolates represent an undescribed *Botrytis* species. All four isolates of these isolates were sent to Dr. Tobin Peever, Department of Plant Pathology, at Washington State University in Pullman, WA, for fungicide sensitivity testing. All isolates were found to be sensitive to fenhexamid (group 17), fludioxonil (group 12), iprodione (group 2), boscalid (group 7) and cyprodinil (group 9).

Currently, the undescribed *Botrytis* sp. found in this study does not pose an added threat to caneberry production due to its low frequency and fungicide sensitivities. Further analysis of this undescribed *Botrytis sp.* will be conducted in collaboration with plant pathologists at WSU in Puyallup, WA and the USDA-ARS in Corvallis, OR.

Progress Report to the Agricultural Research Foundation
2016

Title: Cooperative breeding program - Caneberries

Principal investigators:
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Lassen Canyon Nursery
North American Plant Co.
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, and strawberry 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 2014-16 'Black Diamond' accounted for 37% of plants sold in the PNW, 'Columbia Star' was at 24% and 'Marion' was at 2.7%. 'Columbia Giant', a very large fruited blackberry was released in 2015 and 'Columbia Sunrise', the earliest ripening thornless blackberry, was released this year. They will be working their way into the marketplace over the next few years along with ORUS 3453-2 that we plan to release in 2017. Towards an improved floricane red raspberry, the high quality and high yielding 'Coho' was released but it 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'. We have several selections in machine harvest trials in northern Washington and of these two look promising in the early going. The relatively recent primocane fruiting release 'Vintage' is performing well for some growers and ORUS 4090-1 was released this year as 'Kokanee'. 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 2016, we evaluated about 6,000 blackberry and red and black raspberry and black raspberry seedlings. We made 36 red raspberry (15 floricane, 21 primocane), **60 black raspberry!!** (53 for processing, 7 fresh), and 44 blackberry (20 trailing, 18 erect/semi-erect, and 6 primocane fruiters) selections. Below are the highlights of the genotypes at various stages of evaluation.

<u>**Blackberry**</u>

Cultivar Releases

<u>**Blackberry**</u>

Cultivar Releases

'Columbia Sunrise' released and patent application filed in 2016

'Columbia Sunrise' is thornless and very early ripening, 10 d before 'Black Diamond' and 14 d sooner than 'Marion'. The fruit size is larger than 'Marion' or 'Black Diamond' while its yield is comparable to 'Marion' and less than 'Black Diamond'. Fruit quality as a fresh or processed fruit is outstanding. 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. Has done well with growers.

'Columbia Giant' released and patent application filed in 2015

A sibling of 'Columbia Star', 'Columbia Giant' produces a very large berry (12-13 g) that has excellent quality. The yields are larger than 'Marion'. 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. Need names, patent data or plant propagation.

- **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% e*astern 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 3453-2** is a half sib of 'Columbia Star' that is thornless, high yielding, with outstanding fruit quality. Consistently perceived as being sweeter than 'Columbia Star' fresh Very large, double blossoms are also very ornamental. Good cold hardiness in Washington.
- **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.

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 at excellent quality and high yields but thorny
- 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 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 4057-3. Thornless that produces high yields of high quality fruit 7-10 d ahead of 'Black Diamond' and ahead of Metolius/Obsidian in some seasons.
- ORUS 4066-2, thorny, with a grandparent that is *R. caucasicus*, had excellent yields and fruit quality and ripened earlier than 'Chester Thornless'.
- ORUS 4222-1 is thornless and very high yielding, comparable to 'Black Diamond', with fruit size comparable to 'Marion'. Excellent quality for processing
- ORUS 4278-2 is about a week ahead of 'Chester Thornless' and ORUS 4273-2 about 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 4370-1 is an early ripening (10d<Triple Crown) thornless with 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 two years.

2012 Trailing Planting (Tables BLK1 and BLK8)

- Very exciting planting with several interesting selections.
- ORUS 3448-2 will be released as 'Columbia Sunrise' (see above).
- ORUS 4057-3 is thornless with excellent yields of large fruit. Slated for grower trial, the plant is thornless and the fruit ripen earlier than 'Black Diamond'. A tendency to purple fruit is a concern.
- ORUS 4222-1, while 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 BLK2 and BLK8)

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

2014 Trailing Planting (Tables BLK3 and BLK8)

- ORUS 3453-2 continues to be intriguing. It has very high quality, large fruit with yields comparable to 'Black Diamond' and 'Columbia Star'. It has extremely large, attractive, light pink, double blossoms in the spring as well. It has potential as a commercial fruit and ornamental cultivar.

2012, 2013, and 2014 Semi-erect trials (Tables BLK4, BLK5, BLK6 and BLK8)

- ORUS 4273-2 is about two weeks ahead of 'Chester Thornless. It has a *Rubus georgicus* grandparent. While thorny, the fruit tastes good, are firm, and comparable to, or larger than 'Chester Thornless' in size. While thorny, it is Tt for Merton Thornlessness.
- 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, which is 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 two years.
- ORUS 2816-4, which is in grower trial, continues its steady performance. While its yields are not as big as Chester or Triple Crown, it is 2.5 weeks earlier than Chester and 2 weeks ahead of Triple Crown with very good fruit quality.

- 'Von' had excellent fruit quality early in the season, and ripened about 2 weeks ahead of Triple Crown and Chester Thornless.
- None of the new selections planted in 2014 were impressive in their first year
- 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

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

- 'Prime-Ark® Freedom' and 'Prime-Ark® Traveler' had moderate crops, with 'PA Traveler' seeming to consistently have a larger crop. PA Freedom bears gigantic fruit.
- The ORUS 4545 group of selections are looking very promising for yield. They are thorny (Tt), have medium not large fruit with good, not great fruit quality, similar to the PAs. They begin to ripen with 'Prime-Ark® 45' but have a larger potential crop if under tunnels. At the last harvest date, ORUS 4545-2 and ORUS 4545-1 were estimated to still have 20 and 60%, respectively of their crop unripe on the plant whereas 'PA 45' had less than 15%.

Blackberry phenotyping RosBREED completed (Yin, M. Clark, Bassil, Zurn, J.R. Clark, Finn)

Populations were established in both locations and phenotyped for numerous vegetative and fruiting traits. Melinda Yin has taken the lead on this. The populations will be genotyped in 2017 in the Bassil lab.

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 Sunrise' and ORUS 3453-2, slated for release, were scored as similar to and much better than 'Marion' for cold hardiness in comparable years in Lynden.

Red Raspberry

Named

- 'Kokanee' (ORUS 4090-1) is primocane fruiting with very large fruit, excellent fruit quality and yields comparable to or better than 'Heritage'. Shipping quality is excellent. Since as late as 'Heritage' may need tunnels in Oregon to have sufficient yield. It is root rot susceptible but not horribly so. Did very well in commercial fresh market trial in Mexican/Spanish fresh market production systems.

Being propagated for Grower Trial

- ORUS 4373-1, Floricane processed. Good yield. Good fruit quality. Root rot resistant at Puyallup
- ORUS 4607-2, Floricane processed. Promising in MH Trial at Enfield.
- ORUS 4465-3, Floricane processed. Promising in NWREC and Trials at Machine harvest trial at Maberry's. Vigorous plant.
- ORUS 4289-4, Primocane, fresh/processed. Extremely sweet, outstanding raspberry flavor. Good yield but small fruited and a bit light colored. Easily machine harvested. Group would like to trial in Cal/Mexico
- ORUS 4487-1, Primocane, fresh. Very early! 10d < Heritage
- ORUS 4291-1, Primocane, fresh. Very early! 18-21 d < Heritage
- ORUS 4716-1, Primocane fresh. Group would like to trial in Cal/Mexico. Initial yield and quality look good
- ORUS 4725-1, Primocane fresh. Group would like to trial in Cal/Mexico. Initial yield and quality look good

2013 Floricane Fruiting Trial (Tables RY1 and RY7)

- Similar yields for all.
- 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. Will plant in grower trial.

2014 Floricane Fruiting Trial (Tables RY2 and RY7)

- 'Lewis' performed well as usual at our station with among the highest yields and largest fruit. Unfortunately seems to have problems off the station!
- WSU 1980 and WSU 2166 were the top sections in our trial for yield and had very nice fruit size Both appear to pick very easily but have "frosty" fruit that can have a bicolor tendencies.
- ORUS 4462-2, ORUS 4482-3, ORUS 4465-3 and ORUS 3713-1 were promising for fruit quality but had yields only comparable to 'Meeker'. ORUS 4462-2 will be put into machine harvest trial and ORUS 4465-3 and ORUS 3713-1 are already in machine harvest trial (Table RY3). In the first year, ORUS 4465-3 looked promising but still early.

WRRC supported machine harvest trial planted in 2015 (Table RY3)

- A few selections look interesting. "Interesting" could be the kiss of death but in this case it is exciting. These selections are in the first year and they have yields and fruit firmness comparable to Meeker. That is a great start as the target is yields and firmness comparable to Wakefield but we hope these will continue to look good next year.
- ORUS 4465-3 and ORUS 3713-1 were promising in our Oregon trials and ORUS 4465-3 was acceptable in a 1st year evaluation in Washington
- ORUS 4607-2 and ORUS 4603-1 (out of Saanich) were interesting in the first year of trial; they had good fruit quality and Meeker sized yield.

2013 Primocane Fruiting Trial (Tables RY4 and RY8)

- Unfortunately, two of the reps for this trial are right over an unknown hot spot for root rot and everything suffered.

- ORUS 4487-1 had decent sized fruit and was about 10 d 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 RY8)

- While the yield for ORUS 4493-1 was impressive, we don't trust it. We proofed the data but will withhold the judgement until next year. Notes were not stunning.

2015 Primocane Fruiting Trial (Tables RY6 and RY8)

- 'Kokanee' performed well and has very good fruit size.
- ORUS 4716-1 and ORUS 4725-1 had good yields and outstanding fruit quality, especially for firmness. They will be propagated for rep trial and grower trial. As soon as possible due to their potential.
- ORUS 4719-1 is very promising and will be put to rep trial, but it may be too soft and hard to pick.

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' and as good as 'Cascade Bounty': ORUS 4373-1, ORUS 4499-1, ORUS 4619-1
- Probably not as good as 'Cascade Bounty', similar to 'Cascade Harvest' and better than 'Meeker': ORUS 3539-1, ORUS 3718-2, ORUS 3722-2, Vintage, Kokanee
- Probably comparable to 'Meeker': ORUS 3237-2, ORUS 3705-2, ORUS 3718-1 and ORUS 3702-3, ORUS 4090-2, ORUS 4283-1, ORUS 4289-1
- Probably comparable to or worse than 'Meeker': ORUS 3735-3 (Blk Rasp), ORUS 3234-1, ORUS 4462-2, ORUS 4465-2, ORUS 3038-1 (Blk Rasp)

Black Raspberry

Developing the Genomic Infrastructure for Breeding Improved Black Raspberries (Bushakra, Bassil, Dossett, Ju. Lee, Weber, Scheerens, Fernandez, Weiland, Ja. Lee, Finn) Project number 2072-21220-002-04R

Major project goals: The overall goal of this proposal was to develop and make available genomic tools for the improvement of black raspberry and apply these tools for crop improvement using wild germplasm. These resources will significantly aid in the integration of novel traits from wild germplasm into elite cultivars and are necessary tools for molecular breeding of black raspberries and related species (e.g., red raspberry, blackberry) and to address the needs of the industry for improved cultivars. Objectives were presented as solutions to address problems in production and breeding that were identified by the industry and the USDA-ARS Small Fruits Crop Germplasm Committee. Conversations with black raspberry growers and processors over the last decade revealed disease and short planting longevity as their top production concerns. The USDA-ARS Northwest Center for Small Fruits Research (an academic/commercial industry partnership) and the Oregon Raspberry and Blackberry Commission have identified cultivar improvement as a number one research priority for the commercial raspberry industry.
Outcomes: A high-quality annotated genome sequence of black raspberry and transcriptome sequences from diverse plant tissues were developed and made public.
Impact: Will serve as the reference genome for *Rubus* crops (red and black raspberry, blackberry). The reference genome with gene annotations from the transcriptome sequencing provides researchers with the ability to compare genomic regions and genes of interest across other members of Rosaceae and outside of the family. These comparisons provide opportunities to expand knowledge of how genes function in plants.

Outcomes: Construction of genetic linkage maps and development of transferable markers.
Impact: Maps with markers in common provide information on the chromosome arrangement among different species and can assist with developing markers that can be used to identify regions of the genome responsible for the expression of specific traits of interest.

Outcome: Loci linked to aphid resistance alleles were identified and mapped. A marker that can distinguish susceptible from resistant individuals and two markers that can distinguish the Maine source from the Ontario and Michigan sources have been identified. Work is continuing to refine the markers for ease of use.
Impact: Development of markers for aphid resistance enable the efficient selection of progeny that are less prone to infection with devastating aphid-borne viruses as well as help determine the best strategies for combining these alleles for increased resistance durability.

Outcomes: Increased the genetic diversity of germplasm to use in black raspberry breeding and improved our understanding of genotype by environment interactions.
Impact: A larger pool of diverse germplasm provides breeders with variability from which to draw to meet the needs of black raspberry growers and consumers. Understanding how the genotypes interact with the environment provides breeders with options to develop cultivars adapted for specific growing areas or for wider distribution.

Outcome: Established standardized phenotyping protocols.
Impact: A database of phenotypic values on several hundred individuals of black raspberry is documented and will be formatted for use through the Genome Database for Rosaceae information repository for all Rosaceae crops. As information on trait/locus associations arise, this information will be added to the database. The standardized methods for phenotyping can be used by other researchers in other *Rubus* crops to add to the database.

Outcome: Quantitative trait locus analysis and mapping.
Impact: Data collection on field and fruiting traits has been completed. Analysis of the data is taking place. Results will provide insight on which areas of the genome are involved in the expression of certain traits and which traits are influenced primarily by the environment.

Outcomes: Concerns and needs of black raspberry industry characterized through a grower survey.
Impact: The concerns and expectations of black raspberry growers throughout North America are better understood so that they can be addressed further targeted research.

Outcomes: Fruit flavor attributes profiled and consumer preferences determined.
Impact: Links between consumer preference and the flavor profile of the black raspberry selections will inform breeders on what attributes to aim for or to avoid. The additional focus on meeting consumer expectations will help breeders develop cultivars that will meet the needs of the market.

Grower Trial

- Major setback on ORUS 3735-3 as every plant that came from the nursery was crumbly in 2015 and it was not due to RBDV; suspect a mutation in propagation. We have started over with plants from original stock.
- 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. May have root rot problem.
- ORUS 3409-1 is a primocane fruiting black raspberry that is somewhat similar to 'Niwot' but seems to be more reliably productive.

2012 Planted Trials (Tables BLKRY1 and BLKRY5).

- This field suffered from being in a hot spot for root rot. Nothing stood out as significantly better than 'Munger' although some indication that ORUS 3412-1 may have better root rot resistance.

2013 Planted Trials (Tables BLKRY2 and BLKRY5).

- In rep, the only one worth harvesting was ORUS 4306-1 which had yield similar to 'Munger' but with better quality. We will watch it.
- ORUS 4396-1, ORUS 4310-1 (MI aphid res), and ORUS 4401-1have vigorous plants, good fruit quality and may have higher yields than 'Munger' and will be planted in rep trial.

2014 Planted Trials (Tables BLKRY3 and BLKRY5)

- The best planting we have ever had of blackcaps and it was all machine harvested!!! While none may be better than 'Munger' for yield that is typical in the 1st year.
- Very excited but need more data!
- ORUS 3381-3 has yields, season, and fruit size similar to 'MacBlack'

Table BLK1. Fruit size and yield in 2014-16 for trailing blackberry genotypes at OSU-NWREC. Planted in 2012.

Genotype	Thorny or Thornless[y]	Berry size (g) 2014-16	Yield (tons·a^{-1}) 2014	2015	2016	2014-16
2014		5.8 a				6.53 b
2015		5.7 a				4.03 c
2016		6.2 a				9.22 a
Replicated						
ORUS 4057-3	Thls	7.7 a	7.25 a	5.50 a	10.97 a	7.91 a
ORUS 4222-1	Thls	4.7 d	7.56 a	3.02 b	12.15 a	7.58 a
Black Diamond	**Thls**	**5.5 c**	**8.03 a**	**3.66 b**	**10.86 a**	**7.52 a**
Marion	**Thny**	**5.1 cd**	**4.95 a**	**4.38 ab**	**5.85 b**	**5.06 b**
Columbia Sunrise (ORUS 3448-2)	**Thls**	**6.5 b**	**4.85 a**	**3.59 b**	**6.26 b**	**4.90 b**
Nonreplicated						
ORUS 4239-1	Thls	7.1	5.60	3.71	4.43	4.58
ORUS 4200-1	Thls	5.3	4.93	3.42	5.75	4.70

[z] Mean separation within columns by LSD, p≤0.05. [y] Thl=Thornless; Thny=Thorny

Table BLK2. Fruit size and yield in 2015-16 for trailing blackberry genotypes at OSU-NWREC[z]. Planted in 2013.

Genotype	Thorny or Thornless[y]	Type[x]	Berry size (g) 2015-16	Yield (tons·a^{-1}) 2015	2016	2015-16
2015			6.0 b			3.33 a
2016			6.7 a			4.91 a
Replicate						
ORUS 4344-2	Thls	Tr	7.4 a	3.87 a	5.28 a	4.57 a
Columbia Star	**Thls**	**Tr**	**6.5 b**	**3.33 a**	**5.73 a**	**4.53 a**
Marion	**Thny**	**Tr**	**5.1 d**	**3.87 a**	**4.82 a**	**4.35 a**
Black Diamond	**Thls**	**Tr**	**6.0 c**	**2.55 a**	**6.07 a**	**4.31 a**
ORUS 4235-2	Thls	Tr	7.5 a	3.60 a	4.83 a	4.21 a
ORUS 3172-1	Thls	Tr	5.7 c	2.55 a	2.73 b	2.74 b
Nonreplicated						
ORUS 4344-3	Thls	Hyb	6.0	2.94	5.46	4.20
ORUS 3453-2	Thls	Tr	6.1	2.51	4.72	3.62

[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 2016 for trailing blackberry genotypes at OSU-NWREC. Planted in 2014

Thornless Genotype	Berry or thorny[y]	Yield size (g)[z]	(tons·a^{-1})
Replicated			
ORUS 3453-2	Thls	6.8 a	7.40 a
Columbia Star	**Thls**	**6.1 a**	**7.24 a**
Black Diamond	**Thls**	**6.1 a**	**6.73 a**
Marion	**Thorny**	**5.8 a**	**4.50 b**
ORUS 4424-1	Thls	6.3 a	4.29 b
ORUS 4344-2	Thls	7.0 a	3.87 a
Nonreplicated			
ORUS 4430-1	Thls	7.0	8.39
ORUS 3636-1	Thorny	5.7	4.22
ORUS 4426-1	Thls	3.1	3.94

[z] Mean separation within columns by LSD, p≤0.05.
[y] Thl=Thornless; Thny=Thorny; Tr=Trailing;.

Table BLK4. Fruit size and yield in 2014-2016 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] 2014-16	Yield(tons·a^{-1}) 2014	2015	2016	2014-16
Replicated							
2014			6.4 b				9.89 a
2015			6.1 b				8.80 a
2016			7.4 a				9.57 a
Chester Thls	**Thls**	**SE**	**6.4 a**	**12.57 a**	**11.63 a**	**12.86 a**	**12.35 a**
ORUS 4278-2	Thny	SE	6.9 a	7.21 a	5.97 b	6.29 a	6.49 b
Nonreplicated							
ORUS 4273-2	Thny	SEHyb(1/4georg)	5.1	22.73	8.84	8.45	13.34
ORUS 4066-2	Thny	SEHyb (1/8cauc)	8.1	10.75	10.57	11.90	11.07
ORUS 4266-1	Thny	SEHyb(1/4georg)	5.9	-	9.73	7.90	8.81
Osage	**Thls**	**Er**	**6.4**	**3.80**	**7.45**	**8.86**	**6.70**
ORUS 4266-2	Thny	SEHyb(1/4georg)	5.9	-	5.01	5.34	5.18

[z] Mean separation within columns by 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 BLK5. Fruit size and yield in 2015-2016 for semi-erect blackberry genotypes in replicated trial at OSU-NWREC[z]. Planted in 2013.

Genotype	Thorny or Thornless[y]	Type[y]	Berry size (g)[z]	Yield(tons·a^{-1}) 2014	2015	2014-15
Replicated						
2015			7.1 a			8.34 a
2016			7.1 a			8.91 a
Triple Crown	**Thls**	**SE**	**7.5**	**10.98 a**	**10.45 a**	**10.29 a**
Chester Thornless	**Thls**	**SE**	**6.0**	**8.06 b**	**8.77 a**	**9.65 a**
ORUS 4370-1	Thls	Hyb	8.5	7.93 b	9.53 a	9.10 a
ORUS 2816-4	Thls	Hyb	6.4	6.38 b	6.90 b	6.93 b
Nonreplicated						
Von	**Thls**	**SE**	**6.9**	**10.89**	**7.35**	**9.12**
ORUS 4370-2	Thls	Hyb	6.9	1.25	3.46	2.35

[z] Mean separation within columns by 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 2016 for thornless semi-erect blackberry genotypes in trial at OSU-NWREC planted in 2014.

Genotype	Type[z]	Berry size (g)	Yield(tons·a^{-1})
Nonreplicated			
Chester Thornless	**SE**	**6.0**	**8.43**
Triple Crown	**SE**	**8.9**	**7.27**
ORUS 4453-2	HybSE	7.3	4.91
ORUS 4453-1	HybSE	8.3	4.64
ORUS 2867-3	HybSE	8.0	4.56
ORUS 2867-2	HybSE	4.5	3.03
ORUS 4430-2	HybSE	8.2	1.09

[z] SE= Semi-erect; HybSE= 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. All are thorny except Prime-Ark® Freedom and Prime-Ark® Traveler.

Genotype	Berry size (g)[z]	Yield(tons·a^{-1}) 2014	2015	2016	Mean	Est. % yield on plant 10-10-16
2012 planted						
Prime-Ark® Traveler	6.6	3.32	2.81	3.63	3.25	10
Prime-Ark® Freedom	13.1	1.82	1.98	3.46	2.42	0
2013 Planted						
ORUS 4355-2	4.5	0.56	0.64	1.45	0.88	20
ORUS 4355-3	5.6	0.55	0.32	1.62	0.83	20
2014 Planted						
ORUS 4545-2	4.8		2.58	5.48	4.03	20
Prime-Ark® 45	**5.7**		**1.28**	**3.60**	**2.44**	**15**
ORUS 4545-1	6.1		2.79	1.94	2.37	60
ORUS 4545-3	4.3		2.11	1.41	1.76	10
ORUS 4546-1	5.5		1.69	1.89	1.79	10

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

Genotype	Type	Year planted	Harvest season 5%	50%	95%	No. yrs. in mean	Rep/ Obsv
ORUS 4425-1	Tr	2014	7-Jun	7-Jun	21-Jun	1	Obsv
ORUS 3636-1	Tr	2014	7-Jun	14-Jun	21-Jun	1	Obsv
Columbia Sunrise (ORUS 3448-2)	**Tr**	**2012**	**11-Jun**	**18-Jun**	**2-Jul**	**3**	**Rep**
ORUS 3453-2	Tr	2013	15-Jun	19-Jun	6-Jul	2	Obsv
Columbia Star	**Tr**	**2014**	**7-Jun**	**21-Jun**	**28-Jun**	**1**	**Rep**
ORUS 4426-1	Tr	2014	7-Jun	21-Jun	28-Jun	1	Obsv
Marion	**Tr**	**2014**	**14-Jun**	**21-Jun**	**6-Jul**	**1**	**Rep**
ORUS 4424-1	Tr	2014	14-Jun	21-Jun	6-Jul	1	Rep
ORUS 4430-1	Tr	2014	14-Jun	21-Jun	6-Jul	1	Obsv
ORUS 3453-2	Tr	2014	30-Jun	21-Jun	6-Jul	1	Rep
Columbia Star	**Tr**	**2013**	**15-Jun**	**22-Jun**	**2-Jul**	**2**	**Rep**
ORUS 4057-3	Tr	2012	16-Jun	23-Jun	3-Jul	3	Rep
Black Diamond	**Tr**	**2013**	**15-Jun**	**25-Jun**	**13-Jul**	**2**	**Rep**
Marion	**Tr**	**2013**	**19-Jun**	**25-Jun**	**10-Jul**	**2**	**Rep**
Black Diamond	**Tr**	**2014**	**7-Jun**	**28-Jun**	**12-Jul**	**1**	**Rep**
ORUS 4430-2	SE	2014	28-Jun	28-Jun	12-Jul	1	Obsv
ORUS 4235-2	Tr	2013	15-Jun	29-Jun	10-Jul	2	Rep
ORUS 4344-3	Tr	2013	19-Jun	29-Jun	10-Jul	2	Obsv
Black Diamond	**Tr**	**2012**	**18-Jun**	**29-Jun**	**3-Jul**	**3**	**Rep**
ORUS 4222-1	Tr	2012	21-Jun	2-Jul	6-Jul	3	Rep
Marion	**Tr**	**2012**	**23-Jun**	**2-Jul**	**12-Jul**	**3**	**Rep**
ORUS 4453-2	SE	2014	28-Jun	6-Jul	14-Jul	1	Obsv
ORUS 4266-2	SEHyb(1/4georg)	2012	29-Jun	6-Jul	23-Jul	2	Obsv
ORUS 3172-1	Tr	2013	29-Jun	6-Jul	13-Jul	2	Rep
ORUS 4344-2	Tr	2013	25-Jun	10-Jul	27-Jul	2	Rep
ORUS 4453-1	SE	2014	28-Jun	12-Jul	2-Aug	1	Obsv
ORUS 4266-1	SEHyb(1/4georg)	2012	2-Jul	13-Jul	27-Jul	2	Obsv
Von	**SE**	**2013**	**6-Jul**	**13-Jul**	**3-Aug**	**2**	**Obsv**
ORUS 2816-4	SE	2013	14-Jul	13-Jul	3-Aug	2	Rep
ORUS 2867-2	SE	2014	6-Jul	14-Jul	9-Aug	1	Obsv
ORUS 4239-1	Tr	2012	9-Jul	16-Jul	30-Jul	3	Obsv
ORUS 4370-1	SE	2013	6-Jul	16-Jul	6-Aug	2	Rep
ORUS 4273-2	SEHyb(1/4georg)	2012	25-Jun	18-Jul	1-Aug	3	Obsv
ORUS 4370-2	SE	2013	10-Jul	20-Jul	27-Jul	2	Obsv
ORUS 4200-1	Tr	2012	8-Jul	21-Jul	6-Aug	3	Obsv
ORUS 2867-3	SE	2014	12-Jul	26-Jul	16-Aug	1	Obsv
Triple Crown	**SE**	**2013**	**13-Jul**	**27-Jul**	**6-Aug**	**2**	**Rep**
ORUS 4066-2	SEHyb (1/8cauc)	2012	11-Jul	27-Jul	10-Aug	3	Obsv
ORUS 4278-2	SE	2012	16-Jul	27-Jul	13-Aug	3	Rep
Chester Thornless	**SE**	**2013**	**13-Jul**	**30-Jul**	**17-Aug**	**2**	**Rep**
Triple Crown	**SE**	**2014**	**12-Jul**	**2-Aug**	**9-Aug**	**1**	**Obsv**
Chester Thornless	**SE**	**2014**	**12-Jul**	**2-Aug**	**23-Aug**	**1**	**Obsv**
Chester Thornless	**SE**	**2012**	**18-Jul**	**3-Aug**	**24-Aug**	**3**	**Rep**
Prime-Ark® Freedom	**PF**	**2012**	**20-Aug**	**27-Aug**	**19-Sep**	**3**	**Obsv**
Prime-Ark® Traveler	**PF**	**2012**	**24-Aug**	**3-Sep**	**24-Sep**	**3**	**Obsv**

ORUS 4545-2	PF	2014	24-Aug	4-Sep	25-Sep	2	Obsv
ORUS 4545-1	PF	2014	24-Aug	10-Sep	28-Sep	2	Obsv
Prime-Ark® 45	**PF**	**2014**	**24-Aug**	**14-Sep**	**1-Oct**	**2**	**Obsv**
ORUS 4545-3	PF	2014	27-Aug	14-Sep	25-Sep	2	Obsv
ORUS 4546-1	PF	2014	17-Aug	14-Sep	28-Sep	2	Obsv
ORUS 4355-2	PF	2013	7-Sep	17-Sep	26-Sep	3	Obsv
ORUS 4355-3	PF	2013	7-Sep	22-Sep	29-Sep	3	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 10/10/2016.

Table RY1. Mean yield and berry size in 2015-16 for floricane fruiting raspberry genotypes at OSU-NWREC planted in 2013.

Genotype	Berry size (g) 2015-16[z]	Yield (tons·a^{-1}) 2015	2016	2015-16
2015	2.8 a			2.84 a
2016	3.6 b			2.65 a
Replicated				
Meeker	**2.7 b**	**2.01 a**	**3.29 a**	**2.65 a**
ORUS 4371-4	3.6 a	2.81 a	2.41 a	2.61 a
ORUS 4373-1	3.3 a	2.03 a	2.24 a	2.13 a
Nonreplicated				
ORUS 4465-1	3.6	2.13	3.60	2.86
WSU 1914	3.1	2.87	2.37	2.62
WSU 2010	2.2	2.90	1.77	2.33
ORUS 4371-3	2.8	2.14	2.04	2.09

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

Table RY2. Mean yield and berry size in 2016 for floricane fruiting red raspberry genotypes in replicated and observation trials at OSU-NWREC planted in 2014.

Genotype	Berry size (g)[z]	Yield ($tons \cdot a^{-1}$)
Replicated		
WSU 1980	5.2 ab	4.89 a
Lewis	**4.8 ab**	**4.83 a**
WSU 2166	5.3 a	4.11 ab
ORUS 4462-2	4.6 bc	4.09 ab
ORUS 4482-3	4.8 ab	3.74 ab
Meeker	**3.3 e**	**3.71 ab**
ORUS 4465-3	4.0 cd	3.56 ab
ORUS 3713-1	3.6 de	3.21 ab
WSU 2188	5.1 ab	3.15 ab
WSU 2122	3.7 de	2.75 b
Nonreplicated		
WSU 1956	4.3	4.82
ORUS 4473-3	3.6	4.28
ORUS 4465-2	3.7	3.83
WSU 1985	4.0	3.78
WSU 2068	3.7	3.78
ORUS 3767-3	3.0	3.60
ORUS 4463-1	4.4	3.34
WSU 2001	3.9	3.32
WSU 2075	2.8	3.24
WSU 2200	2.6	2.78
WSU 2010	2.5	2.76
ORUS 3959-3	5.4	2.74
WSU 2133	2.6	2.45
WSU 2205	3.0	2.23
ORUS 4473-2	3.4	2.21
ORUS 4462-1	3.3	2.17
WSU 2130	2.9	2.11

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

Table RY3. Performance of ORUS selections in machine harvest trials in Lynden, Washington. Planted in 2015.

Grower	Selection	Yield *(pounds/plot)*	Yield as % of Meeker	Brix	Firm	Harvest First	Harvest Last	Comments
Enfield	**Wake®field**	**84.3**	**135**	**12.6**	**43.9**	**15-Jun**	**3-Aug**	-
Enfield	ORUS 4607-2	75.3	121	13.0	26.6	7-Jun	19-Jul	Firm enough. Often noted for lots of moldy berries & lots of green berries/stems showing up on belt
Enfield	**Meeker**	**62.3**	**100**	**11.3**	**30.4**	**7-Jun**	**26-Jul**	-
Enfield	ORUS 4603-1	56.9	91	10.6	31.3	7-Jun	19-Jul	Often noted for lots of moldy berries and lots of green berries/stems showing up on the belt
Enfield	ORUS 4600-3	53.0	85	11.6	36.6	11-Jun	19-Jul	Often noted for lots of moldy berries and lots of green berries/stems showing up on the belt
Enfield	ORUS 4600-1	41.7	67	11.1	40.6	11-Jun	19-Jul	Few comments about moldy berries
Enfield	ORUS 4462-1	39.5	64	10.8	46.4	11-Jun	19-Jul	Lots of comments about berries crumbling on the belt
Enfield	**Cascade Harvest**	**31.8**	**62**	**10.7**	**29.8**	**7-Jun**	**26-Jul**	-
Maberry	**Cascade Harvest**	**85.7**	**153**	-	-	**13-Jun**	**25-Jul**	-
Maberry	**Willamette**	**58.5**	**104**	-	-	**13-Jun**	**25-Jul**	-
Maberry	**Meeker**	**56.2**	**100**	-	-	**13-Jun**	**25-Jul**	-
Maberry	ORUS 4465-3	53.9	96	-	-	13-Jun	25-Jul	Nice frt, good color *
Maberry	ORUS 4283-1	49.5	88	-	-	13-Jun	25-Jul	Gs. Dark mod Soft *
Maberry	ORUS 3722-1	48.4	86	-	-	13-Jun	25-Jul	-
Maberry	ORUS 3713-1	39.8	71	-	-	13-Jun	25-Jul	Lrg, few frt
Maberry	ORUS 3767-3	21.9	39	-	-	13-Jun	25-Jul	Broken, mold, greens
Maberry	ORUS 3234-1	11.5	20	-	-	13-Jun	25-Jul	-

Table RY4. Mean yield and berry size in 2014-2016 for primocane fruiting raspberry genotypes at OSU-NWREC planted in 2013.

	Berry size (g)	Yield (tons·acre^{-1})			
	2014-16	2014	2015	2016	2014-16
Replicated					
2014	2.2 b				1.70 a
2015	1.7 c				1.10 b
2016	2.8 a				1.42 ab
ORUS 4487-1	2.2 b	2.88 a	1.50 a	1.40 a	1.93 a
Heritage	**1.9 c**	**2.03 b**	**1.24 ab**	**1.75 a**	**1.68 a**
Vintage	**2.5 a**	**1.13 c**	**0.75 c**	**1.07 a**	**1.11 b**
ORUS 4090-2	2.4 a	0.77 d	0.90 bc	1.09 a	0.92 b
Non replicated					
ORUS 4086-1	2.3		0.26	3.84	2.05
ORUS 4486-1	2.0	3.01	1.05	1.58	1.88
ORUS 4388-2	2.7	1.67	1.11	2.70	1.83
TulaMagic	2.8	1.49	0.27	3.04	1.60
ORUS 4086-2	2.3	1.66	0.22	1.45	1.11

Table RY5. Mean yield and berry size in 2015-16 for primocane fruiting red raspberry genotypes at OSU-NWREC planted in 2014.

	Berry size (g)	Yield (tons·a^{-1})		
	2015-16	2015	2016	2015-16
Nonreplicated				
ORUS 4493-1	3.0	2.06	7.61	4.84
Heritage	**2.0**	**1.62**	**3.72**	**2.67**
ORUS 4599-3	4.7	0.19	3.66	1.93
Vintage	**2.9**	**1.04**	**2.55**	**1.79**
Kokanee (ORUS 4090-1)	**3.5**	**0.68**	**2.73**	**1.71**
ORUS 4487-4	3.0	1.17	2.20	1.69
ORUS 4090-2	3.2	1.80	1.39	1.60

Table RY6. Mean yield and berry size in 2016 for primocane fruiting red raspberry genotypes at OSU-NWREC planted in 2015.

Genotype	Berry size (g)	Yield (tons·a^{-1})
Replicated		
Kokanee	**3.0 a**	**3.16 a**
Heritage	**2.1 b**	**1.96 b**
Vintage	**3.3 a**	**1.77 b**
Non replicated		
ORUS 4719-1	4.4	4.66
ORUS 4622-2	3.8	3.93
ORUS 4716-1	3.4	3.09
ORUS 4725-1	3.9	2.79
ORUS 4291-1	3.0	1.96
BP1 (=Amira)	4.3	1.32

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

Table RY7. Ripening season for floricane fruiting red raspberry genotypes at OSU-NWREC. Planted in 2013 or 2014 and harvested 2015 and/or 2016.

Year	Harvest season		No. years	Rep/		
Genotype	planted	5%	50%	95%	in mean	Obsv
ORUS 3767-3	2014	31-May	14-Jun	28-Jun	1	Obsv.
ORUS 4465-2	2014	31-May	14-Jun	28-Jun	1	Obsv.
WSU 2075	2014	31-May	14-Jun	28-Jun	1	Obsv.
WSU 2200	2014	31-May	14-Jun	28-Jun	1	Obsv.
WSU 2205	2014	31-May	14-Jun	28-Jun	1	Obsv.
ORUS 4473-2	2014	7-Jun	14-Jun	28-Jun	1	Obsv.
WSU 2068	2014	7-Jun	14-Jun	28-Jun	1	Obsv.
WSU 2130	2014	7-Jun	14-Jun	28-Jun	1	Obsv.
WSU 2166	2014	7-Jun	14-Jun	28-Jun	1	Rep
ORUS 4462-1	2014	7-Jun	14-Jun	5-Jul	1	Obsv.
WSU 2133	2014	7-Jun	14-Jun	5-Jul	1	Obsv.
ORUS 3722-1	2013	4-Jun	18-Jun	25-Jun	2	Rep
ORUS 3702-3	2013	4-Jun	18-Jun	29-Jun	2	Rep
WSU 2010	2013	4-Jun	18-Jun	29-Jun	2	Obsv.
ORUS 4465-1	2013	8-Jun	18-Jun	25-Jun	2	Obsv.
ORUS 4371-3	2013	8-Jun	18-Jun	29-Jun	2	Obsv.
WSU 1914	2013	11-Jun	18-Jun	2-Jul	2	Obsv.
WSU 2010	2014	7-Jun	21-Jun	28-Jun	1	Obsv.
Meeker	**2014**	**7-Jun**	**21-Jun**	**5-Jul**	**1**	**Rep**
ORUS 3713-1	2014	7-Jun	21-Jun	5-Jul	1	Rep
ORUS 4465-3	2014	7-Jun	21-Jun	5-Jul	1	Rep
ORUS 4473-3	2014	7-Jun	21-Jun	5-Jul	1	Obsv.
WSU 1985	2014	7-Jun	21-Jun	5-Jul	1	Obsv.
WSU 2122	2014	7-Jun	21-Jun	12-Jul	1	Rep
ORUS 3959-3	2014	14-Jun	21-Jun	5-Jul	1	Obsv.
WSU 2188	2014	14-Jun	21-Jun	5-Jul	1	Rep
Meeker	**2013**	**8-Jun**	**22-Jun**	**2-Jul**	**2**	**Rep**
ORUS 4371-4	2013	8-Jun	22-Jun	10-Jul	2	Rep
ORUS 4380-3	2013	15-Jun	22-Jun	29-Jun	2	Obsv.
ORUS 4462-2	2014	14-Jun	24-Jun	12-Jul	1	Rep
ORUS 4373-1	2013	8-Jun	25-Jun	10-Jul	2	Rep
ORUS 4463-1	2014	12-Jun	28-Jun	12-Jul	1	Obsv.
Lewis	**2014**	**14-Jun**	**28-Jun**	**12-Jun**	**1**	**Rep**
ORUS 4482-3	2014	14-Jun	28-Jun	12-Jul	1	Rep
WSU 1956	2014	14-Jun	28-Jun	19-Jul	1	Obsv.
WSU 1980	2014	14-Jun	28-Jun	19-Jul	1	Rep
WSU 2029	2013	2-Jul	13-Jul	24-Jul	2	Obsv.

Table RY8. Ripening season for primocane fruiting red raspberry genotypes at OSU-NWREC. Planted in 2012, 2013, or 2014 and harvested 2013-16.

Genotype	Year planted	Harvest season 5%	50%	95%	No. years in mean	Rep/ Obsv
ORUS 4493-1	2014	20-Jul	27-Jul	24-Aug	2	Obsv.
ORUS 4291-1	2015	26-Jul	2-Aug	16-Aug	1	Obsv.
BP-1	2015	26-Jul	9-Aug	16-Aug	1	Obsv.
ORUS 4725-1	2015	26-Jul	9-Aug	16-Aug	1	Obsv.
ORUS 4719-1	2015	2-Aug	9-Aug	30-Aug	1	Obsv.
ORUS 4599-3	2014	6-Aug	13-Aug	20-Aug	2	Obsv.
ORUS 4090-2	2013	1-Aug	15-Aug	5-Sep	3	Rep
ORUS 4086-2	2013	3-Aug	15-Aug	10-Sep	3	Rep
ORUS 4622-2	2015	2-Aug	16-Aug	30-Aug	1	Obsv.
Vintage	**2015**	**2-Aug**	**16-Aug**	**30-Aug**	**1**	**Rep**
ORUS 4716-1	2015	9-Aug	16-Aug	30-Aug	1	Obsv.
ORUS 4486-1	2013	8-Aug	20-Aug	5-Sep	3	Obsv.
Kokanee	**2015**	**9-Aug**	**23-Aug**	**13-Sep**	**1**	**Rep**
Heritage	**2015**	**16-Aug**	**23-Aug**	**30-Aug**	**1**	**Rep**
Vintage	**2014**	**3-Aug**	**24-Aug**	**14-Sep**	**2**	**Rep**
Heritage	**2013**	**10-Aug**	**24-Aug**	**7-Sep**	**3**	**Rep**
ORUS 4388-2	2013	13-Aug	27-Aug	10-Sep	3	Obsv.
Heritage	**2014**	**10-Aug**	**27-Aug**	**14-Sep**	**2**	**Rep**
ORUS 4086-1	2013	13-Aug	27-Aug	7-Sep	2	Obsv.
TulaMagic (Frutafri)	2013	22-Aug	5-Sep	12-Sep	3	Obsv.
Kokanee	**2014**	**20-Aug**	**7-Sep**	**21-Sep**	**2**	**Obsv.**
ORUS 4487-4	2014	24-Aug	10-Sep	21-Sep	2	Obsv.

Table BLKRY1. Mean yield and berry size in 2014-2016 for black raspberry genotypes at OSU-NWREC planted replicated trial in 2012. Hand harvested in 2014-15. Harvested with Littau Harvester (Stayton, OR) in 2016.

	Berry size (g)	Yield (tons·acre^{-1})
2014	1.6 a	2.22 a
2015	1.3 b	1.28 b
2016	1.7 a	1.71 ab
Munger	**1.5 a**	**2.05 a**
ORUS 3219-2	1.5 a	1.81 a
ORUS 3412-1	1.5 a	1.35a

Mean separation within columns by LSD, p≤0.05.

BLKRY2. Yield, berry size and harvest season in 2015-16 for black raspberry genotypes planted in replicated (3, 3-plant plots) or single, 3-plant observation plots in 2013 at the OSU-NWREC. Hand harvested in 2015. Harvested with Littau Harvester (Stayton, OR) in 2016.

Genotype	Berry size (g)	Yield (tons·a-^{1})
Replicated		
2015	1.1 a	2.07 a
2016	1.5 b	2.06 a
Munger	**1.4 a**	**2.07 a**
ORUS 4306-1	1.2 a	2.05 a
Nonreplicated		
ORUS 4396-1	1.7	2.84
ORUS 4310-1	1.0	2.52
ORUS 4401-1	1.3	2.47
ORUS 4310-2	1.0	2.36
ORUS 4311-1	1.1	2.11
ORUS 4396-2	1.5	2.11
ORUS 4395-1	1.4	2.10

Mean separation within columns by LSD, p≤0.05.

Table BLKRY3. Yield and berry size in 2016 for black raspberry genotypes planted in replicated trial and single observation plots in 2014 at the OSU-NWREC. Harvested with Littau Harvester (Stayton, OR).

Genotype	Berry size (g)		Yield (tons·a^{-1})	
Replicated				
ORUS 4412-2	1.9	a	4.56	a
Munger	**1.5**	**b-d**	**4.40**	**a**
ORUS 4410-1	1.6	ab	4.39	a
ORUS 4499-1	1.6	bc	3.94	ab
ORUS 4154-1	1.7	ab	3.81	ab
ORUS 4399-1	1.8	ab	3.41	bc
ORUS 4395-1	1.8	ab	3.34	bc
ORUS 3835-1	1.3	cd	3.08	b-d
ORUS 3381-3	1.8	ab	3.06	b-d
ORUS 3902-2	1.3	de	3.03	b-d
ORUS 3896-1	1.2	de	3.03	b-d
ORUS 3891-1	1.3	de	3.01	cd
ORUS 4073-1	1.0	e	2.34	de
ORUS 3839-1	0.8	f	1.77	e
ORUS 4124-1	1.7	ab	1.51	e
Nonreplicated				
ORUS 4411-3	1.5		5.79	
ORUS 4412-1	1.7		5.17	
ORUS 4411-2	1.4		4.71	
ORUS 4412-4	2.1		4.66	
ORUS 4499-3	1.4		3.81	
ORUS 4498-2	2.0		3.47	
MacBlack	**1.8**		**3.16**	
ORUS 4411-1	1.3		3.13	
ORUS 4409-2	1.1		3.06	
ORUS 3808-2	1.4		2.76	
ORUS 4497-1	2.5		2.74	
ORUS 4412-3	1.8		2.41	
ORUS 3843-1	0.8		1.84	

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

Table BLKRY5. Ripening season for black raspberry genotypes at OSU-NWREC. Planted in 2012-14 and harvested 2014-16.

Genotype	Year planted	Harvest season 5%	50%	95%	No. years in mean	Rep/ Obsv
ORUS 3843-1	2014	3-Jun	13-Jun	21-Jun	1	Obsv
ORUS 4499-3	2014	3-Jun	13-Jun	21-Jun	1	Obsv
ORUS 4411-1	2014	3-Jun	17-Jun	21-Jun	1	Obsv
ORUS 4073-1	2014	3-Jun	17-Jun	24-Jun	1	Rep
ORUS 3891-1	2014	13-Jun	17-Jun	21-Jun	1	Rep
ORUS 4411-2	2014	13-Jun	17-Jun	21-Jun	1	Obsv
ORUS 4411-3	2014	13-Jun	17-Jun	21-Jun	1	Obsv
ORUS 4412-1	2014	13-Jun	17-Jun	21-Jun	1	Obsv
ORUS 4498-2	2014	13-Jun	17-Jun	21-Jun	1	Obsv
Munger	**2014**	**13-Jun**	**17-Jun**	**24-Jun**	**1**	**Rep**
ORUS 3835-1	2014	13-Jun	17-Jun	24-Jun	1	Rep
ORUS 3896-1	2014	13-Jun	17-Jun	24-Jun	1	Rep
ORUS 3902-2	2014	13-Jun	17-Jun	24-Jun	1	Rep
ORUS 4154-1	2014	13-Jun	17-Jun	24-Jun	1	Rep
ORUS 4395-1	2014	13-Jun	17-Jun	24-Jun	1	Rep
ORUS 4399-1	2014	13-Jun	17-Jun	24-Jun	1	Rep
ORUS 4409-2	2014	13-Jun	17-Jun	24-Jun	1	Obsv
ORUS 4410-1	2014	13-Jun	17-Jun	24-Jun	1	Rep
ORUS 4412-2	2014	13-Jun	17-Jun	24-Jun	1	Rep
ORUS 4412-3	2014	13-Jun	17-Jun	24-Jun	1	Obsv
ORUS 4412-4	2014	13-Jun	17-Jun	24-Jun	1	Obsv
ORUS 4497-1	2014	13-Jun	17-Jun	24-Jun	1	Obsv
ORUS 4499-1	2014	13-Jun	17-Jun	24-Jun	1	Rep
ORUS 3839-1	2014	17-Jun	17-Jun	24-Jun	1	Rep
Munger	**2012**	**16-Jun**	**18-Jun**	**28-Jun**	**3**	**Rep**
ORUS 3808-2	2014	13-Jun	21-Jun	24-Jun	1	Obsv
ORUS 4124-1	2014	13-Jun	21-Jun	24-Jun	1	Rep
ORUS 4153-3	2012	16-Jun	23-Jun	23-Jun	2	Obsv
Munger	**2013**	**16-Jun**	**23-Jun**	**30-Jun**	**2**	**Rep**
ORUS 4306-1	2013	16-Jun	23-Jun	30-Jun	2	Rep
ORUS 4310-2	2013	16-Jun	23-Jun	30-Jun	2	Obsv
ORUS 4311-1	2013	16-Jun	23-Jun	30-Jun	2	Obsv
ORUS 4395-1	2013	16-Jun	23-Jun	30-Jun	2	Obsv
ORUS 4401-1	2013	16-Jun	23-Jun	30-Jun	2	Obsv
ORUS 4302-1	2013	16-Jun	23-Jun	7-Jul	2	Obsv
ORUS 4310-1	2013	16-Jun	23-Jun	7-Jul	2	Obsv
ORUS 4396-1	2013	16-Jun	23-Jun	7-Jul	2	Obsv
ORUS 4396-2	2013	16-Jun	23-Jun	7-Jul	2	Obsv
ORUS 4398-1	2013	16-Jun	23-Jun	7-Jul	2	Obsv
ORUS 4399-1	2013	16-Jun	23-Jun	7-Jul	2	Obsv
ORUS 3038-1	2012	18-Jun	23-Jun	2-Jul	3	Obsv
ORUS 3219-2	2012	18-Jun	25-Jun	2-Jul	3	Rep
ORUS 3381-3	2014	17-Jun	28-Jun	7-Jul	1	Rep
Mac Black	**2014**	**21-Jun**	**28-Jun**	**12-Jul**	**1**	**Obsv**
ORUS 3412-1	2012	25-Jun	2-Jul	7-Jul	3	Rep

Progress Report to the Agricultural Research Foundation, 2015-16

Title: Root distribution in blackberry plants and impacts for management

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Luis Valenzuela, Post Doc Research Associate
David Bryla, Horticulturist, USDA-ARS, HCRU

Collaborators: Amanda Vance, Faculty Research Assistant, Horticulture/NWREC
Patrick Jones, Faculty Research Assistant, Horticulture/NWRE

Rationale:

While most of our blackberry growers use irrigation, there are some growers (particularly those in the Russian grower community) who do not irrigate. However, we have shown that insufficient irrigation during the fruit harvest in July leads to substantial plant water stress reducing yield and fruit quality (Bryla and Strik, 2008). While "dry farming" is not common in blackberry, irrigation is often reduced or discontinued after fruit harvest (towards the end of July) even though the crop's water demands are still high (Bryla and Strik, 2008). The thinking is that, in addition to saving water and reducing energy costs, limiting postharvest irrigation induces drought stress which helps the plants harden off, reducing the potential for freeze damage over the winter. Blackberry is indeed very sensitive to winter cold damage, especially 'Marion'. Also, limiting postharvest irrigation reduces weed presence, and prevents the leaching of soil nutrients.

We received funding from the industry and the NIFA-OREI (Federal) to study the impact of weed management and postharvest irrigation on yield and quality of 'Marion' and 'Black Diamond' blackberry (see "Progress" below). After the cold temperatures of December 2013, we noted that plants that were irrigated after harvest had more cold damage (bud break rating of 2.50 on a scale of "1" {normal bud break} to "5" {<5% bud break}) than those that were not irrigated after harvest (rating of 1.87) – thus confirming growers' thoughts. Our results over two years (2013-14) showed that there was no effect of postharvest irrigation (with or without) on yield – this was surprising since so much of the primocane growth, necessary for next year's crop, occurs after fruit harvest. In addition, we found that the presence of weeds greatly reduced yield (see below). A production system where irrigation is withheld after fruit harvest might then have benefits for improving cold hardiness, saving irrigation water (no irrigation postharvest saves ~ 67,000 gallons/acre), reducing weed pressure, nutrient leaching, and costs without a negative impact on yield.

Key questions we all have are: 1) What impact does postharvest deficit irrigation have on root distribution and growth? 2) Where are the "feeder" roots located and what impact does fertigation have on their location though the soil profile? And 3) Do these important cultivars differ in root location and rooting depth? It is important to understand root growth and root distribution in order to understand how to best irrigate and fertilize these crops. Also, root depth would have important implications in a drought year – is it riskier to use postharvest deficit irrigation in a shallow-rooted cultivar if it has been a dry spring?

Our goal was to use an existing test planting where we have compared deficit irrigation to normal irrigation in two cultivars to explore the impacts of cultivar and irrigation on root distribution.

Objectives:

- Evaluate root distribution of blackberry plants between plants in a row and from the plant crown into the aisle – location and depth
- Assess the effect of cultivar and with or without postharvest irrigation on root location and depth

Background information:

We received funding from the industry, and the NIFA-OREI (Federal) to study the impact of weed management and postharvest irrigation on yield and quality of 'Marion' and 'Black Diamond' blackberry. The presence of weeds greatly reduced yield (Figure 1) but there was no effect of postharvest irrigation (with or without) on yield after two years (data not shown).

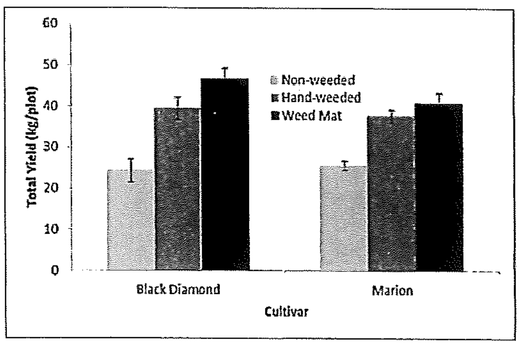


Figure 1. *Effect of blackberry cultivar and weed management treatment on cumulative yield per plant from 2012–2013 (first and second fruiting years). (mean ± SE)*

Our preliminary findings using root observational "tubes" indicated that there was no difference between cultivars in new root growth from the soil surface to a foot deep, but plants receiving irrigation postharvest had more new root growth than those that did not (data not shown). Plants must thus compensate for this at deeper rooting depths since there was no effect on yield. We found that soil water content differed between the cultivars at a soil depth of 24–59 inches, which was likely due to differences in root presence or distribution, but we wanted to confirm this.

Methods used:

This study was conducted in a mature, established trial at OSU's North Willamette Research and Extension Center. In this trial, we had replicated 'Marion' and 'Black Diamond' plots that had been subjected to two irrigation treatments (with or without postharvest irrigation) for three consecutive years (2012-14). The planting was established in 2010, was grown as "off year" (primocanes only) in 2011 and was machine-harvested in 2012-2014 (every-year production).

Treatments:

<u>Cultivar</u>: 'Marion' and 'Black Diamond'

Irrigation: with or without postharvest irrigation (2012-14)

'Marion' and 'Black Diamond' plots either received irrigation, as needed, based on plant and soil water status from postharvest (approximately the end of July to the onset of rain in October) of each year or did not receive any supplemental irrigation during this period of time. Plants thus either received postharvest irrigation or did not, for three consecutive years (2012-14).

Data collected:

Trenches were dug (dimensions of approximately 6 feet deep and 2.5 feet wide), using a back-hoet. Trenches were dug beside treatment plots (6 inches from the plants) perpendicular to the row to observe root growth between plants in the row and parallel to the row to better observe root growth toward the aisle.

The sides of the trench (on plant side) were then carefully "teased" with a spatula to expose the roots. A grid composed of 32 rectangles (12" X 8.7") was placed on the trench wall using string to provide reference points. Digital photographs were then taken using a flatbed scanner. Computer software programs are being used to evaluate the scanned images to provide root counts. The root distribution is thus being "mapped" per published methods (Dauer et al., 2009).

Back-hoe being operated by Amanda Vance; trench; grids

References cited:

Bryla, D. and B. Strik. 2008. Do primocanes and floricanes compete for soil water in blackberry? Acta Hort. 777:477-482

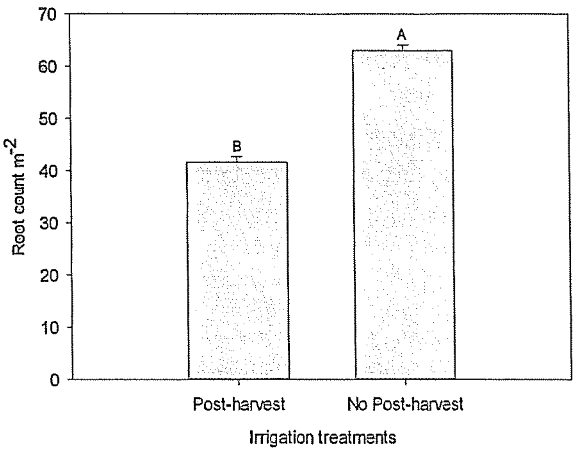
Dauer, J.M., J.M. Withington, J. Oleksyn, J. Chorover, O.A. Chadwick, P.B. Reich, and D.M.Eissenstat. 2009. A scanner-based approach t soil profile-wall mapping of root distribution. Dendrobiology 62:35-40.

Harkins, R.H., B.C. Strik, and D.R. Bryla. 2013. Weed management practices for organic production of trailing blackberry: I. Plant growth and early fruit production. HortScience 48:1139-1144.

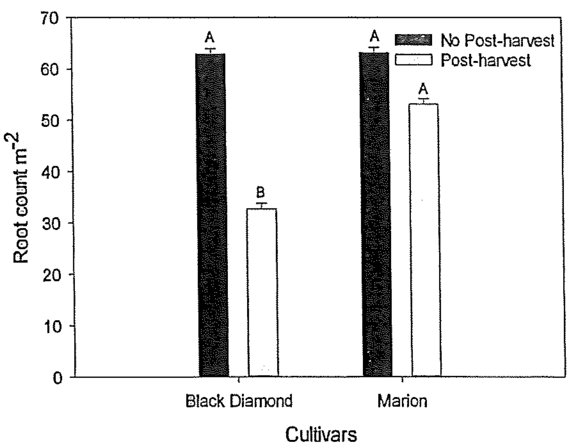
Progress:

This is a very labor-intensive project, requiring careful analysis of many scanned images. While the trenching was done in late winter 2015, considerable time is needed to analyze the images and interpret the data. We report on the results to date and will make definitive conclusions once all of the images have been analyzed.

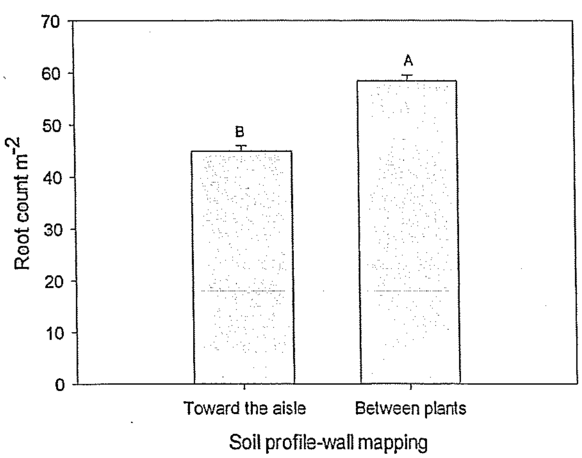
Irrigation effects:



- Plants with no post-harvest irrigation produced more roots. Plants tend to produce more roots to look for water.

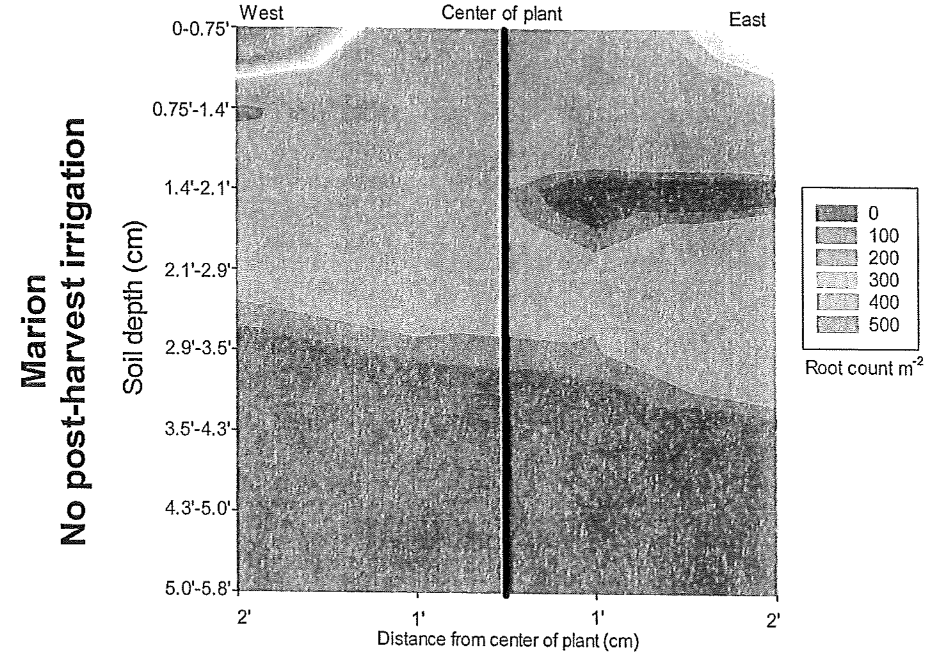


- Marion root counts were similar among the two irrigation treatments suggesting higher adaptability to dry soil conditions. Overall Marion root counts were higher than Black Diamond.
- Black Diamond showed a significant difference between irrigation treatments suggesting greater susceptibility to lack of soil moisture.

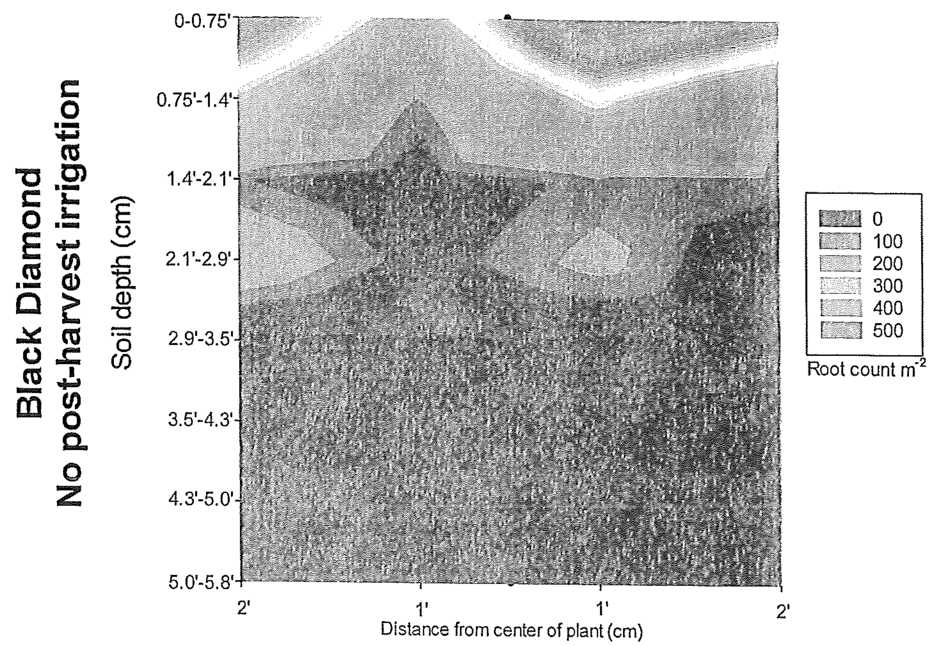


- Root counts were higher between plants than toward the aisle. This is probably influenced by the close proximity to the drip irrigation line.

Root growth between plants: Perpendicular mapping at 6" from the center of the plant
scanned side facing west

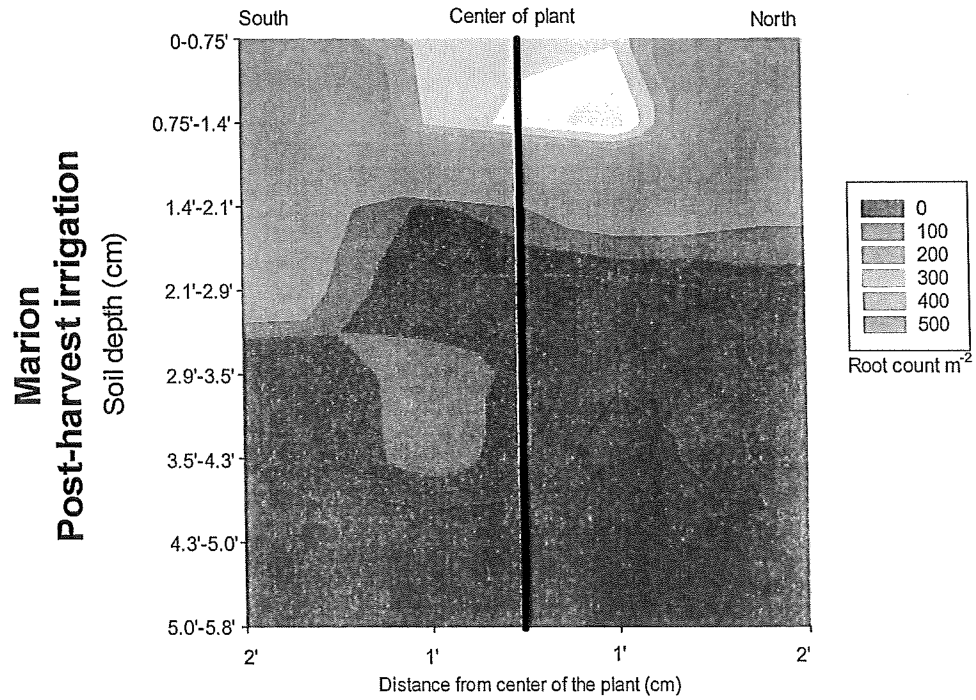


Root growth between plants: Perpendicular mapping at 6" from the center of the plant
scanned side facing west

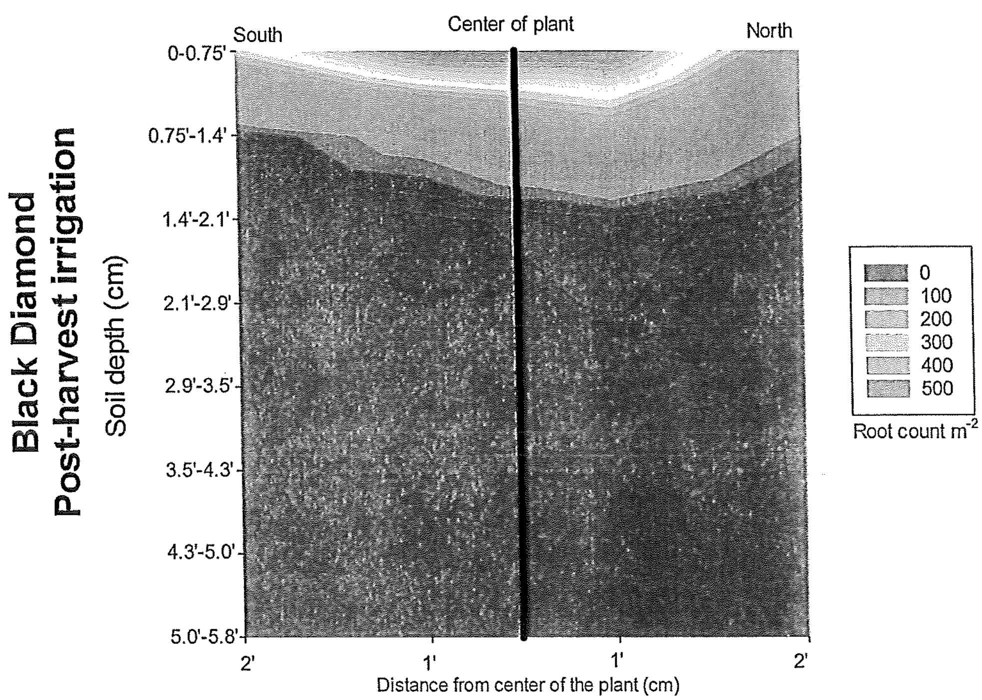


Interpretation: Marion showed higher root counts deeper in the soil compared to Black Diamond.

Root growth between plants: Perpendicular mapping at 6" from the center of the plant scanned side facing west

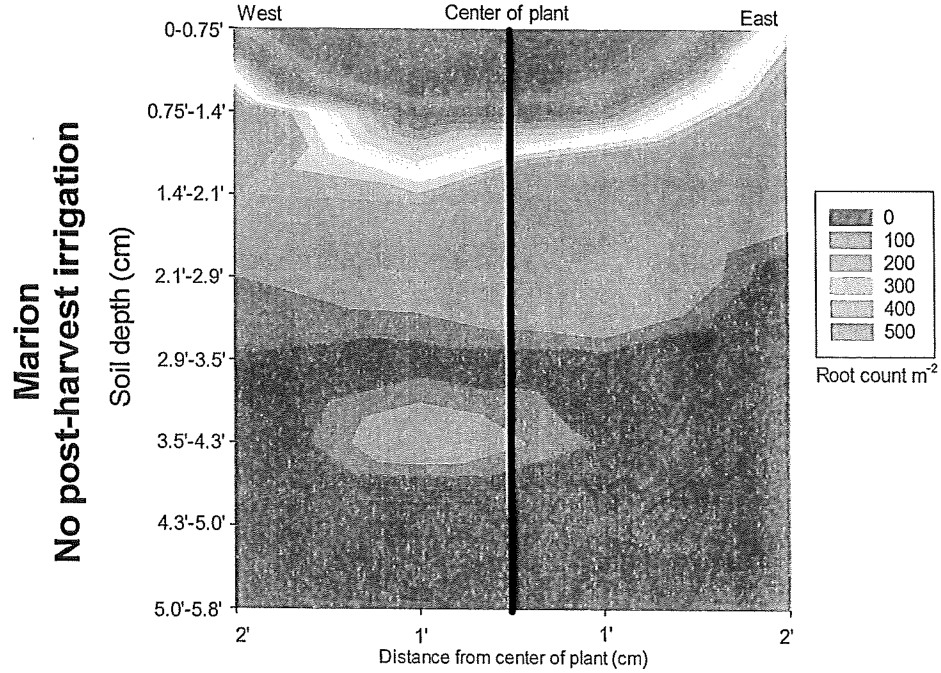


Root growth between plants: Perpendicular mapping at 6" from the center of the plant scanned side facing west

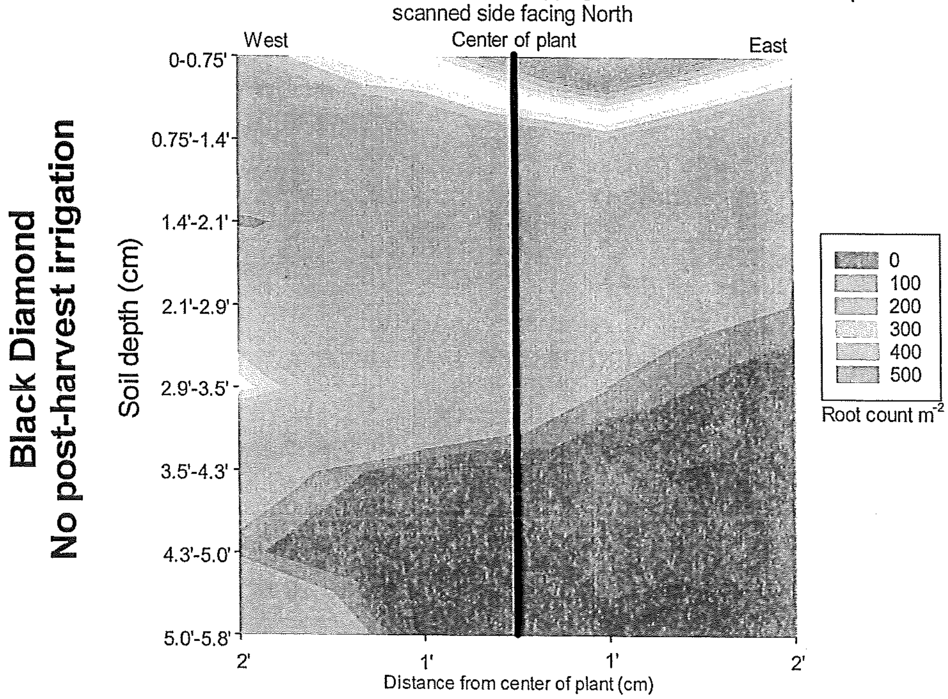


Interpretation: With continuous soil moisture provided by post-harvest irrigation the root systems of both Blackberry cultivars remained distributed close to the soil surface.

Root growth toward the aisle: Transverse mapping at 6" from the center of the plant scanned side facing North

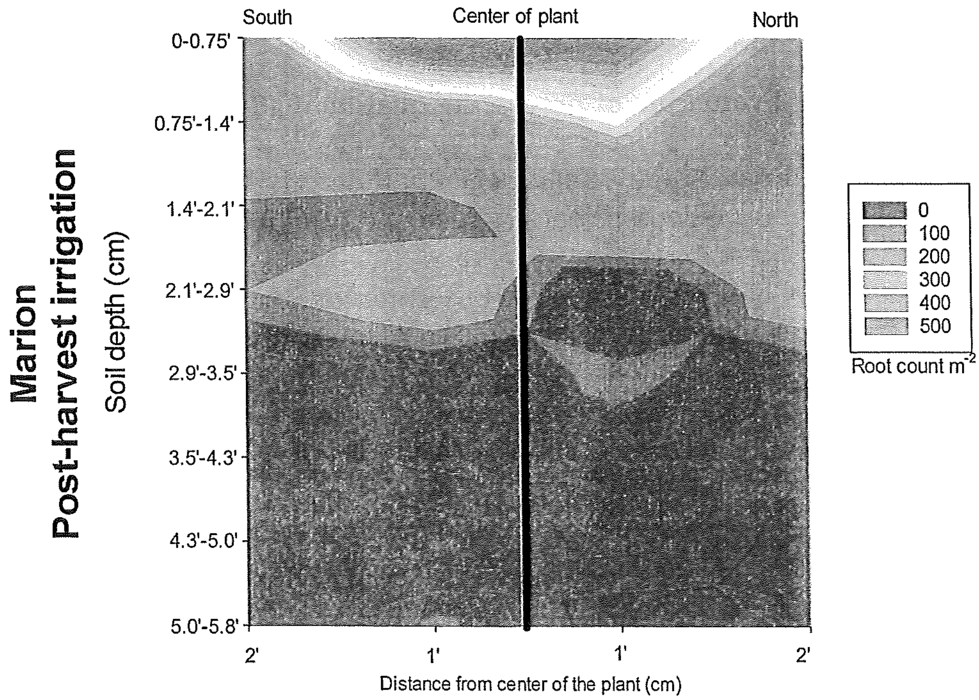


Root growth toward the aisle: Transverse mapping at 6" from the center of the plant scanned side facing North

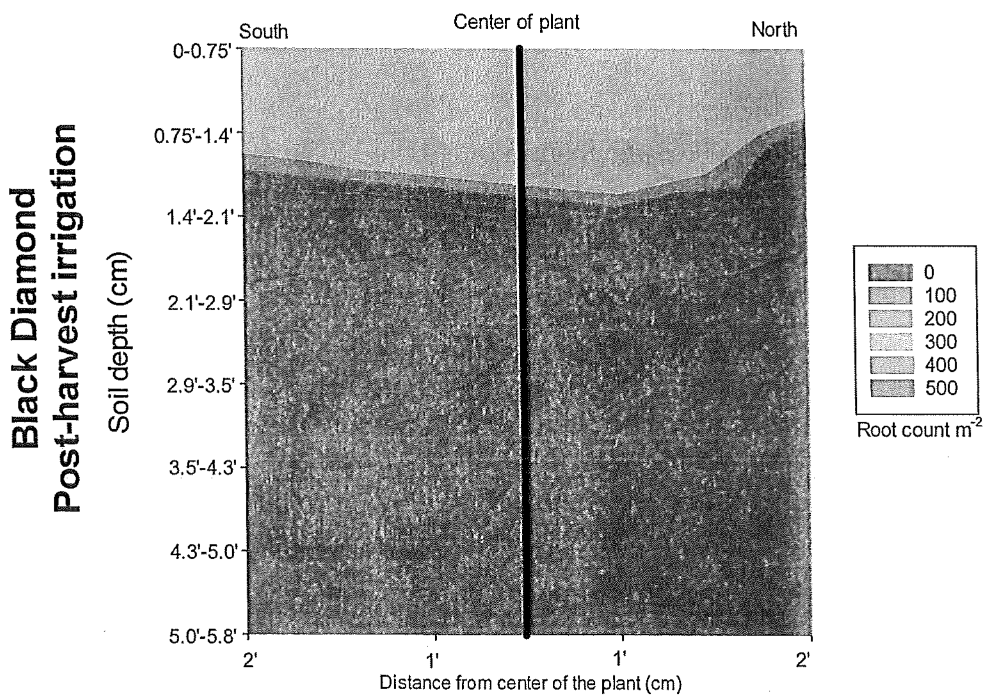


Interpretation: The transverse side was the one with more root counts. Black Diamond plants were able to grow roots deeper in the soil compared to Marion suggesting higher capabilities to obtain water from deeper soil layers.

Root growth toward the aisle: Transverse mapping at 6" from the center of the plant scanned side facing North



Root growth toward the aisle: Transverse mapping at 6" from the center of the plant scanned side facing North



Interpretation: With post-harvest irrigation and continuous soil moisture in the upper soil layers roots distributed mainly on the upper soil layers.

RESEARCH REPORT
TO THE
OREGON RASPBERRY AND BLACKBERRY COMMISSION
AND THE
AGRICULTURAL RESEARCH FOUNDATION 2015-2016

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, 2015, through June 30, 2016

ORBC Funding for 2015-2016: $ 6802

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 9 to September 8, 2015. During the 2015 season the following numbers of genotypes were processed and analyzed:

Blackberries – 6 processing cultivars, 21 ORUS processing selections, 9 fresh market cultivars, 17 ORUS fresh market selections
Red raspberries – 3 processing cultivars, 13 ORUS processing selections, 8 WSU processing selections, 1 BC processing selection, 3 primocane/fall fruiting cultivars, 11 ORUS primocane/fall fruiting selections, 2 NY primocane/fall fruiting selections
Black raspberries - 1 cultivar, 29 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, 2015, at the ORBC Commission Research meeting two days later (hey! also December, 2015), and at the Northwest Food Processors Association meeting in January, 2016.

Table 1: 2015 Blackberry Chemistry - by Harvest Date

Variety/Selection	Field Year	Harvest Date	°brix	pH	TA (g citric/kg)
Black Diamond	2011	6/23/15	13.35	3.24	13.06
		6/30/15	13.16	3.41	11.21
	2012	6/16/15	12.85	3.31	12.73
		6/30/15	12.77	3.43	10.78
	2013	6/16/15	13.91	3.33	12.15
		6/23/15	13.00	3.35	11.17
		6/30/15	13.07	3.43	10.47
Chester Thornless	2012	7/14/15	14.23	3.25	9.97
	2013	7/14/15	13.44	3.49	10.67
		7/21/15	12.56	3.25	13.27
Columbia Giant	2011	6/16/15	11.21	3.01	24.27
		6/23/15	11.72	3.09	17.95
		6/30/15	12.84	3.11	16.86
		7/7/15	14.32	3.34	15.77
Columbia Star	2013	6/16/15	13.47	3.08	16.23
		6/23/15	13.01	3.15	13.12
		6/30/15	15.73	3.28	13.78
Marion	2011	6/23/15	14.19	2.99	17.63
		6/30/15	14.21	3.16	15.29
	2012	6/30/15	14.60	3.38	12.16
	2013	6/23/15	15.02	3.16	15.56
		6/30/15	14.59	3.19	13.91
Metolius	demo	6/16/15	11.53	3.55	11.37
Navaho	2011	7/7/15	15.30	3.33	10.99
		7/14/15	15.50	3.47	8.55
Obsidian	demo	6/16/15	10.86	3.29	13.25
Osage	2012	7/7/15	12.34	3.95	6.51
		7/14/15	11.73	3.60	8.59
Triple Crown	2013	7/14/15	15.66	3.54	7.98
		7/21/15	14.73	3.35	11.99
Von	2013	7/14/15	13.27	3.68	6.32
ORUS 1793-1	Demo	6/16/15	10.31	3.16	15.59
ORUS 2707-1	2013	6/16/15	11.48	3.22	12.86
		6/23/15	11.05	3.26	10.06
		6/30/15	11.31	3.28	12.36
ORUS 2785-2	demo	6/16/15	13.41	3.12	24.50
ORUS 2816-4	2013	7/7/15	15.83	3.45	9.77
		7/14/15	14.09	3.50	8.49
ORUS 2855-1	demo	6/16/15	13.72	3.55	11.89
ORUS 3172-1	2013	6/30/15	13.98	3.03	19.23
		7/7/15	13.58	3.16	17.49

Variety/Selection	Field Year	Harvest Date	°brix	pH	TA (g citric/kg)
		7/14/15	13.59	3.16	15.55
ORUS 3448-2	2012	6/9/15	-	3.28	11.01
		6/16/15	15.16	3.53	8.74
		6/23/15	17.14	3.72	6.09
ORUS 3453-2	2013	6/23/15	15.37	3.26	12.47
ORUS 4017-2	2011	6/23/15	18.29	3.20	12.77
		6/30/15	17.31	3.27	12.08
		7/7/15	20.90	3.43	12.86
ORUS 4024-3	2011	6/30/15	14.46	3.20	17.56
		7/7/15	16.15	3.40	13.75
		7/14/15	19.30	3.76	9.14
ORUS 4057-2	2012	6/16/15	10.78	3.15	20.25
		6/23/15	12.64	3.29	13.70
ORUS 4057-3	2012	6/16/15	13.96	3.40	14.34
		6/23/15	12.07	3.29	11.81
		6/30/15	12.31	3.46	11.03
ORUS 4060-2	2011	7/14/15	14.53	3.61	9.64
ORUS 4066-2	2012	7/7/15	16.07	3.44	10.05
		7/14/15	14.30	3.43	8.37
		7/21/15	13.55	3.23	11.09
ORUS 4200-1	2012	7/21/15	15.75	3.28	18.13
ORUS 4207-2	2012	6/23/15	15.23	3.33	12.16
		7/7/15	17.87	3.51	11.18
		7/14/15	16.12	3.43	11.82
ORUS 4222-1	2012	6/23/15	16.32	3.54	10.41
		6/30/15	14.50	3.46	11.42
ORUS 4235-1	2013	6/16/15	14.89	3.55	10.38
ORUS 4235-2	2013	6/16/15	14.03	3.08	16.67
		6/30/15	14.68	3.30	12.21
ORUS 4239-1	2012	7/28/15	13.47	3.89	6.88
ORUS 4248-1	2012	7/7/15	13.61	3.59	6.48
ORUS 4259-1	2012	7/14/15	13.18	3.94	6.74
ORUS 4266-1	2012	7/7/15	13.06	3.51	9.62
		7/14/15	13.21	3.44	9.06
ORUS 4266-2	2012	7/7/15	16.09	4.13	5.08
		7/14/15	17.46	4.38	3.90
ORUS 4273-2	2012	7/7/15	12.69	3.72	8.13
		7/14/15	13.21	3.71	6.90
ORUS 4278-2	2012	7/14/15	14.59	3.60	7.07
ORUS 4324-1	2013	6/16/15	13.14	3.15	20.46
		6/23/15	12.85	2.95	18.39
ORUS 4325-1	2013	6/23/15	16.60	3.49	8.66
ORUS 4329-2	2013	6/30/15	13.87	3.16	13.86

Variety/Selection	Field Year	Harvest Date	°brix	pH	TA (g citric/kg)
		7/7/15	14.28	3.48	11.30
ORUS 4344-1	2013	7/14/15	16.31	3.56	10.43
		7/28/15	14.84	3.39	10.70
ORUS 4344-2	2013	6/30/15	14.45	3.46	10.61
		7/7/15	14.97	3.44	12.66
		7/14/15	14.43	3.51	10.50
ORUS 4344-3	2013	6/30/15	13.32	3.55	7.73
		7/7/15	13.97	3.52	8.80
ORUS 4356-1	2013	6/30/15	12.67	3.47	9.64
		7/14/15	13.30	3.68	7.79
ORUS 4358-3	2013	7/7/15	10.73	3.36	10.00
ORUS 4362-1	2013	6/30/15	16.02	3.43	9.72
ORUS 4370-1	2013	7/7/15	14.55	3.56	8.88
		7/14/15	13.68	3.69	7.05
ORUS 4370-2	2013	7/14/15	15.15	3.90	5.52

Table 2: 2015 Blackberry Chemistry - Weighted Means

Variety/Selection	Field Year	Wt'd °brix	Wt'd pH	Wt'd TA (g citric/L)
Black Diamond	2011	13.23	3.34	11.89
	2012	12.80	3.37	11.70
	2013	13.20	3.37	11.13
Chester Thornless	2012	14.23	3.25	9.97
	2013	12.89	3.33	12.30
Columbia Giant	2011	12.40	3.12	18.09
Columbia Star	2013	13.68	3.16	13.95
Marion	2011	14.20	3.11	15.89
	2012	14.60	3.38	12.16
	2013	14.80	3.17	14.73
Metolius	demo	11.53	3.55	11.37
Navaho	2011	15.43	3.41	9.50
Obsidian	demo	10.86	3.29	13.25
Osage	2012	12.15	3.84	7.14
Triple Crown	2013	15.06	3.41	10.56
Von	2013	13.27	3.68	6.32
ORUS 1793-1	Demo	10.31	3.16	15.59
ORUS 2707-1	2013	11.23	3.27	11.60
ORUS 2785-2	demo	13.41	3.12	24.50
ORUS 2816-4	2013	14.77	3.48	8.98
ORUS 2855-1	demo	13.72	3.55	11.89
ORUS 3172-1	2013	13.70	3.12	17.44
ORUS 3448-2	2012	15.99	3.58	7.95
ORUS 3453-2	2013	15.37	3.26	12.47
ORUS 4017-2	2011	19.00	3.32	12.56
ORUS 4024-3	2011	15.46	3.32	15.61
ORUS 4057-2	2012	11.54	3.21	17.58
ORUS 4057-3	2012	12.76	3.37	12.47
ORUS 4060-2	2011	14.53	3.61	9.64
ORUS 4066-2	2012	15.29	3.42	9.58
ORUS 4200-1	2012	15.75	3.28	18.13
ORUS 4207-2	2012	15.99	3.39	11.88
ORUS 4222-1	2012	15.52	3.50	10.86
ORUS 4235-1	2013	14.89	3.55	10.38
ORUS 4235-2	2013	14.54	3.25	13.20
ORUS 4239-1	2012	13.47	3.89	6.88
ORUS 4248-1	2012	13.61	3.59	6.48
ORUS 4259-1	2012	13.18	3.94	6.74
ORUS 4266-1	2012	13.13	3.47	9.36
ORUS 4266-2	2012	16.58	4.21	4.66
ORUS 4273-2	2012	12.90	3.72	7.64

Variety/Selection	Field Year	Wt'd °brix	Wt'd pH	Wt'd TA (g citric/L)
ORUS 4278-2	2012	14.59	3.60	7.07
ORUS 4324-1	2013	12.97	3.04	19.28
ORUS 4325-1	2013	16.60	3.49	8.66
ORUS 4329-2	2013	14.10	3.34	12.39
ORUS 4344-1	2013	15.80	3.50	10.52
ORUS 4344-2	2013	14.57	3.48	11.06
ORUS 4344-3	2013	13.62	3.53	8.22
ORUS 4356-1	2013	13.04	3.59	8.55
ORUS 4358-3	2013	10.73	3.36	10.00
ORUS 4362-1	2013	16.02	3.43	9.72
ORUS 4370-1	2013	13.96	3.65	7.63
ORUS 4370-2	2013	15.15	3.90	5.52

Table 3: 2015 Red Raspberry Chemistry - by Harvest Date

Variety/Selection	Year	Harvest Date	°brix	pH	TA (g citric/L)
Lewis	2012	6/23/15	13.69	3.05	18.13
		6/30/15	13.09	3.18	15.51
		7/7/15	14.63	3.47	12.72
		7/21/15	16.56	3.45	13.87
Meeker	2012	6/16/15	13.09	3.40	13.47
		6/23/15	14.06	3.25	14.73
		6/30/15	14.92	3.35	13.87
		7/7/15	18.11	3.69	11.32
	2013	6/16/15	14.87	3.35	13.27
		6/23/15	15.20	3.20	13.21
		6/30/15	15.25	3.51	12.24
Squamish	2012	6/9/15	-	3.12	18.45
		6/16/15	11.80	3.29	13.16
		6/23/15	11.92	3.12	14.54
Tula Magic	2013	6/23/15	13.63	3.08	-
ORUS 3702-3	2013	6/16/15	12.81	3.23	16.54
		6/23/15	13.84	2.97	16.16
		6/30/15	13.22	3.15	15.29
ORUS 3722-1	2013	6/16/15	12.46	3.52	10.13
		6/23/15	12.60	3.54	8.98
ORUS 4084-2	2012	6/23/15	13.32	3.13	21.99
ORUS 4283-2	2012	6/16/15	12.62	3.58	11.78
		6/23/15	13.44	3.45	11.36
ORUS 4284-1	2012	6/16/15	11.48	3.16	17.20
		6/23/15	12.21	3.23	18.09
		6/30/15	12.71	3.34	15.69
ORUS 4289-4	2012	7/7/15	13.25	3.45	15.37
ORUS 4291-1	2012	7/21/15	12.28	3.22	18.92
ORUS 4371-3	2013	6/23/15	15.72	3.59	9.60
ORUS 4371-4	2013	6/23/15	13.82	2.89	17.96
		6/30/15	14.29	3.42	14.16
		7/7/15	17.25	3.57	11.91
ORUS 4371-5	2013	6/23/15	14.99	2.95	15.49
ORUS 4373-1	2013	6/23/15	15.42	3.37	13.67
		6/30/15	13.83	3.39	12.35
		7/7/15	15.27	3.71	9.97
ORUS 4380-1	2013	6/30/15	13.30	3.22	15.07
ORUS 4380-3	2013	6/23/15	12.65	2.97	21.60
		6/30/15	11.03	3.03	19.51
		7/7/15	13.92	3.29	16.71
ORUS 4465-1	2013	6/23/15	11.86	3.04	19.20

Variety/Selection	Year	Harvest Date	°brix	pH	TA (g citric/L)
BC 97-30-20	2013	6/23/15	14.52	2.99	16.62
WSU 1914	2013	6/23/15	12.96	2.88	24.60
WSU 1964	2012	6/16/15	14.72	3.22	15.67
		6/23/15	14.13	3.14	14.40
		6/30/15	16.49	3.52	12.99
WSU 1996	2013	7/7/15	16.07	3.14	21.87
WSU 2010	2013	6/16/15	13.48	3.35	12.38
		6/23/15	15.00	3.41	11.46
WSU 2011	2012	6/16/15	14.35	3.09	17.55
		6/23/15	14.75	3.01	17.93
		7/7/15	19.13	3.35	14.13
WSU 2029	2013	7/14/15	11.57	3.27	11.46
		7/21/15	13.63	3.16	13.34
WSU 2060	2013	6/16/15	13.76	3.21	-
WSU 2068	2013	6/23/15	14.52	2.95	14.45
WSU 2075	2013	6/16/15	13.98	3.07	18.46

Table 4: 2015 Red Raspberry Chemistry - Weighted Means

Variety/Selection	Year	Wt'd °brix	Wt'd pH	Wt'd TA (g citric/L)
Lewis	2012	14.14	3.27	15.04
Meeker	2012	14.62	3.35	13.91
	2013	15.17	3.35	12.81
Squamish	2012	11.84	3.21	14.52
Tula Magic	2013	13.63	3.08	-
ORUS 3702-3	2013	13.35	3.10	16.07
ORUS 3722-1	2013	12.53	3.53	9.54
ORUS 4084-2	2012	13.32	3.13	21.99
ORUS 4283-2	2012	13.06	3.51	11.56
ORUS 4284-1	2012	12.17	3.24	17.29
ORUS 4289-4	2012	13.25	3.45	15.37
ORUS 4291-1	2012	12.28	3.22	18.92
ORUS 4371-3	2013	15.72	3.59	9.60
ORUS 4371-4	2013	14.76	3.25	15.11
ORUS 4371-5	2013	14.99	2.95	15.49
ORUS 4373-1	2013	14.76	3.48	12.06
ORUS 4380-1	2013	13.30	3.22	15.07
ORUS 4380-3	2013	12.13	3.07	19.51
ORUS 4465-1	2013	11.86	3.04	19.20
BC 97-30-20	2013	14.52	2.99	16.62
WSU 1914	2013	12.96	2.88	24.60
WSU 1964	2012	15.00	3.27	14.22
WSU 1996	2013	16.07	3.14	21.87
WSU 2010	2013	14.28	3.38	11.90
WSU 2011	2012	15.63	3.12	16.91
WSU 2029	2013	12.47	3.22	12.28
WSU 2060	2013	13.76	3.21	-
WSU 2068	2013	14.52	2.95	14.45
WSU 2075	2013	13.98	3.07	18.46

Table 5: 2015 Black Raspberry Chemistry - by Harvest Date

Variety/Selection	Field Year	Harvest Date	°brix	pH	TA (g citric/kg)
Munger	2011	6/16/15	16.18	3.62	12.29
		6/23/15	17.40	3.83	11.69
	2012	6/16/15	15.33	3.65	11.16
		6/23/15	17.32	3.85	9.58
	2013	6/16/15	16.89	3.78	10.12
		6/23/15	19.22	3.94	8.95
ORUS 3021-1	2011	6/16/15	15.84	3.84	9.20
		6/23/15	17.35	4.12	7.30
ORUS 3023-3	2011	6/16/15	16.27	3.94	7.75
		6/23/15	18.21	4.19	6.23
		6/30/15	18.03	4.13	7.09
ORUS 3038-1	2012	6/16/15	14.86	3.64	9.96
		6/23/15	16.82	3.90	8.52
ORUS 3219-2	2011	6/16/15	13.08	3.65	14.50
		6/23/15	14.35	3.69	11.40
	2012	6/16/15	15.38	3.45	14.81
		6/23/15	16.18	3.76	10.51
ORUS 3381-3	2011	7/7/15	20.11	3.73	10.19
ORUS 3412-1	2012	6/23/15	15.36	3.59	10.93
		6/30/15	14.67	3.67	10.34
		7/7/15	16.55	3.81	8.75
ORUS 3808-2	2011	6/23/15	19.23	3.87	10.00
ORUS 4063-1	2013	6/16/15	15.82	3.88	8.73
ORUS 4074-3	2011	6/16/15	17.56	3.42	15.67
		6/23/15	17.28	3.55	13.25
ORUS 4155-2	2011	6/23/15	16.12	4.01	9.66
ORUS 4156-1	2011	6/16/15	17.78	3.68	11.78
		6/23/15	21.15	3.97	9.60
ORUS 4158-3	2012	6/16/15	14.40	3.59	12.66
ORUS 4159-1	2011	6/16/15	14.46	3.58	11.38
		6/23/15	17.65	3.92	9.76
ORUS 4159-2	2011	6/16/15	15.01	3.63	11.81
		6/23/15	18.85	3.93	9.39
ORUS 4302-1	2013	6/16/15	17.03	3.68	10.54
		6/23/15	17.29	3.78	8.56
ORUS 4306-1	2013	6/23/15	16.90	4.08	6.60
ORUS 4310-1	2013	6/16/15	17.42	3.81	9.90
		6/23/15	17.82	3.73	10.03

Variety/Selection	Field Year	Harvest Date	°brix	pH	TA (g citric/kg)
ORUS 4310-2	2013	6/16/15	16.91	3.81	8.44
		6/23/15	17.51	4.11	6.78
ORUS 4311-1	2013	6/9/15	16.02	3.51	11.92
		6/16/15	16.75	3.92	8.82
		6/23/15	18.77	4.10	6.55
ORUS 4395-1	2013	6/16/15	16.47	3.70	10.88
ORUS 4396-1	2013	6/16/15	14.92	3.67	11.93
		6/23/15	16.26	3.88	9.27
		6/30/15	18.84	3.86	9.30
ORUS 4398-1	2013	6/23/15	16.47	3.82	7.75
ORUS 4399-1	2013	6/16/15	14.89	3.97	7.47
		6/23/15	16.45	4.06	6.41
ORUS 4401-1	2013	6/16/15	16.50	3.98	9.19
		6/23/15	18.63	4.17	7.63
ORUS 4458-2	2011	6/23/15	16.69	3.82	9.79