Northwest Center for Small Fruits Research

2006 Annual Conference

Welcome to the 15th annual conference of the Northwest Center for Small Fruits Research in Kennewick, Washington. We hope you will find this year's program interesting and useful.

Schedule: A detailed schedule has been provided in order to best choose the sessions you would like to participate in throughout the day. Each Technical Working Group will include a section for research reports and a featured presentation.

Research Priorities: During the conference, time is set aside to revisit all research priorities by commodity. After the Technical Working Group meetings, commodity groups will meet separately to review and revise priorities. Please refer to the enclosed schedule for the time and room assignments. Copies of all priorities can be found at the back of this booklet.

Organizational Handbook: The Organizational Handbook has been included in your registration packet. This booklet provides an overview of the NCSFR operations, detailed funding information and a member directory.

Wine Tasting: Prior to this evening's dinner, we will have the opportunity to enjoy sampling a variety of wines from the state.

Keynote Speaker: The keynote speaker for the Annual Conference will be Jim Ballington, North Carolina State University and the Southern Region Small Fruit Consortium.

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BERRY / GRAPE PROCESSING

Quality Evaluation of Berry Selections and Varieties (Small Fruits Initiative - Plant Improvement)

In cooperation with Chad Finn and the USDA-ARS/Oregon State University Small Fruit Breeding Program:

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

Yanyun Zhao, Assistant Professor, Food Science & Technology, OSU

Objectives:
1. Evaluate advanced breeding selections from Chad Finn's breeding program (USDA/ARS/NCSFR) and variety trials for objective attributes related to processing or fresh market potential
2. Process samples of advanced selections, selected field crosses, and standard varieties for display to and evaluation by breeders and the industry
3. Include blueberries, black raspberries, and other berries grown around the region along with strawberries, blackberries and raspberries as has been done in the past
4. Prepare summary of all data in report format for use by breeders and industry members

Our part in this group effort to bring new berry varieties to the growers, processors and consumers of the Northwest is focused on fruit quality evaluation. Berries from the breeding plots at the North Willamette Research and Extension Center plots were picked weekly and brought to the OSU Food Science Department in Corvallis for evaluation from early June through September 2005. Basic chemical data were collected on strawberries, raspberries, blackberries, black raspberries and blueberries for several harvest dates throughout this period. Samples were frozen and were displayed to industry representatives and researchers during the fall, winter and early spring. This information will be used with field data to select the berries which will be included in further breeding trials.

During the 2005/06 season the following numbers of samples were processed and analyzed:

strawberries – 47 selections and varieties
raspberries – 18 selections and varieties
black raspberries – 12 selections and varieties
blackberries – 58 selections and varieties
blueberries – 34 selections and varieties

An industry evaluation of puree of red raspberries from Pat Moore's machine harvesting trials was held in Washington in December, 2005, and in Oregon in February, 2006. A consumer tasting of the same fruit was held at OSU in May, 2006. For Overall Quality both the industry panel and the consumer panel liked BC 96-21R-58, Willamette, and WSU 1503. The industry panel also rated Meeker as best. Both the industry and consumer panel rated WSU 1471, WSU 1452, and WSU 1507 lowest. For Aroma there was no statistically significant difference among samples for either the industry or consumer panels, although for both WSU 1469 and WSU 1507 scored lowest. For Flavor there was a split between panels. The industry panel liked BC 965-21R-58 best, followed by WSU 1468, WSU 1503, and Willamette. The consumer panel liked Meeker and WSU 1503 best. Both panels scored WSU 1452 and WSU 1507 low. The industry panel also did not like WSU 1471. For Color both panels scored Willamette and WSU 1468 highest. The industry panel scored WSU 1507, WSU 1471, and WSU 1502 lowest. The consumer panel scored WSU 1206, WSU 1452, and WSU 1507 lowest.

An industry evaluation of IQF blackberries was held at the Oregon Raspberry and Blackberry Commission research meeting. Two ORUS selections (1442-2 and 1482-2) were compared to Marion and Obsidian. For Overall Quality there was no statistically significant differences among samples, though Marion was scored highest. For Color and for Appearance Obsidian was scored highest. Guess what? For Flavor Marion scored significantly higher than the other samples. For Seediness there was no significant difference among samples.

Effects of Food Processing Technologies on the Nutraceutical Content of Raspberries, Strawberries and Blackberries

Yanyun Zhao, Food Science & Technology, OSU

Mark Daeschel, Food Science & Technology, OSU

This project is to determine antioxidant content, total phenolics, anthocyanins, and ellagic acid in processed berries. The effect of freezing process, frozen storage up to 7 months, and different drying methods (conventional and freeze drying methods) on the nutraceutical compounds of strawberries has been evaluated. Samples were extracted and analyzed for their total phenolic content, anthocyanins, ellagic acid, and antioxidant content. Total phenolic content was measured using Folin-Ciocalteu procedure, anthocyanins by a pH differential method, ellagic acid by reversed-phase HPLC methodology, and antioxidant content was determined using both ferric-reducing antioxidant power (FRAP) assay, Oxygen Radical Absorbance Capacity (ORAC), and a spectrophotometric assay when a stable free radical, 1,1-diphenyl-2-picrylhydrazyl (DPPH) reacts with an antioxidant. Results showed that 3-day cold storage, freezing process and frozen storage up to 7 months did not significantly reduce total antioxidant and phenolic content of strawberries except cold storage reduced phenolic content. Conventional drying caused significantly reduction in antioxidant content in comparison with freeze-drying, while no different effect on the phenolic content.

Improving Fruit Quality and Storage Life of the Hardy Kiwifruit

Yanyun Zhao, Associate Professor, OSU

Mina McDaniel, Professor, Dept. Food Science and Technology, OSU

Bernadine Strik, Professor, Dept. Horticulture, OSU

The influences of harvest maturity (6.0, 8.7, 9.1, and 15.1% average soluble solids content (SSC)) and storage conditions (22±1 ºC and 45% RH, or 2 ºC and 88% RH for three weeks followed by a ripening period at 22±1 ºC and 45% RH) on the physicochemical, sensory, and nutritive qualities of 'Ananasnaya' hardy kiwifruit were investigated in 2004. Results showed that refrigeration significantly ($p<0.05$) reduced titratable acidity and increased SSC of ripened fruit, regardless of harvest maturity, and reduced firmness of fruit harvested at 6.0 and 8.7% SSC. Sensory study using free-choice profiling method revealed that panelists perceived significant ($p<0.05$) differences between refrigerated and room-stored samples in aroma and flavor descriptors as well as differences between harvest maturity treatments. Refrigerated fruit harvested at 6.0 and 8.7% SSC measured highest in total phenolics with over 2 mg gallic acid equivalents/g fresh weight. Antioxidant activity ranged from 1.6-2.3 ascorbic acid equivalents/g fresh weight with no significant difference between treatments. This study demonstrated that quality of ripened hardy kiwifruit can be optimized through identification of ideal harvest date for this Actinidia species and by controlling storage conditions.

The postharvest physiology of fruit was monitored for three consecutive seasons, from 2003 to 2005. Fruit were packaged in low- or high-vent plastic containers and stored under room or refrigerated conditions. Calcium caseinate, chitosan, PrimaFresh™, and Semperfresh™ edible coatings were investigated for their potential to enhance the quality and extend the storage life of the fruit. Packaged fruit were exposed to an ethylene-rich environment in the third season to determine the effect of the coatings on ethylene-induced ripening. Semperfresh™-coated and uncoated fruit were evaluated by a sensory consumer panel using a hedonic scale in the third season. Low-vent packaging significantly ($p<0.05$) reduced weight loss. Refrigerated storage delayed ripening and extended storage life by four weeks. Coatings provided an attractive sheen to the fruit surface and did not impair ethylene-induced ripening. The consumer test indicated that both coated and uncoated fruit were well liked by consumers.

Dietary Anthocyanins and the Prevention of Obesity

R.L. Prior and Xianli Wu, USDA-ARS

A total of 148 male C57BL6 mice were assigned to one of 12 different dietary treatments in the first study. A control diet containing 10% of calories from fat and a high fat diet (45% of calories from fat) were used. Freeze dried powders from whole berries of blueberry, strawberry, marion blackberry and black raspberry were added to the diet at a level of 9.4% of the control diet and 11.5% of the high fat diet. Weight gains and food intakes were measured weekly. Inclusion of the berries in the low fat diet did not alter weight gain, final body weight, body fat or protein (% BW), diet intake (g/d) or energy intake (kcal/d). However, in mice fed the high fat diet, body weight gain, final body weight and body fat (%) were significantly increased and body protein was decreased compared to those mice fed the low fat diet. Furthermore, in those mice fed the high fat diet plus either blueberry, or black raspberry, body weight gains, body fat (% of BW) and epididymal fat tissue weight were significantly greater than the high fat fed controls. Mice fed a high fat diet developed a pre-diabetic condition which was reflected in glucose intolerance in response to an external glucose dose which became worse with time. Strawberry or blueberry feeding did not alter glucose tolerance in either low fat or high fat fed mice. Baseline plasma glucose was decreased in strawberry-fed vs control mice consuming a high fat diet. Based upon the conditions of our first completed experiment, there was no evidence that berry anthocyanins when fed as the whole berry diet, prevented obesity, and to the contrary, may have increased obesity. Additional studies are in progress which may help explain our observations relative to previous published work which demonstrated an anti-obesity effect of anthocyanins.

GENETICS

Fruit Quality Evaluation of Transgenic 'Meeker' and Major Cultivars of Red Raspberry Grown in the Pacific Northwest

Michael Qian, Department of Food Science & Technology, OSU

Raspberry bushy dwarf virus (RBDV) has been a re-emerging problem over the past 15 years throughout raspberry growing regions of the world. Combination of crumble fruit and yield reduction reduces crop value by more than 50%. RBDV is pollen-borne, making chemical control virtually impossible. The RBDV-resistant variety has been developed and the fruit quality was further evaluated to make sure those RBDV-resistant varieties were identical to the wild type 'Meeker'. The fruits from both Oregon and Washington sites were evaluated for two years to determine differences due to transgenic variations and climatic differences between the states and years. Fruit quality indicators such as °Brix, titratable acidity, and sugar and organic acid profiles were compared. A rapid Stir Bar Soprtive extraction-GC-MS technique was developed to analyze aroma-active compounds in raspberry, quantification was achieved using standard curves of aroma compounds and multiple internal standards in selective mass ion mode. More than 30 aroma-active compounds were quantitatively analyzed for all RBDV-resistant and the wild 'Meeker' raspberries grown in both Oregon and Washington states for two years. The chiral compositions of some aroma compounds in these raspberries were also studied.

Evaluation of Hardy Kiwifruit Germplasm

Bernadine Strik[1], Kim Hummer[2], and Chad Finn[3]

[1]Dept. Horticulture, Berry Research Leader, NWREC, OSU

[2]Curator, Research Leader, National Clonal Germplasm Repository – ARS

[3]Research Geneticist, HCRL, ARS

The purpose of this study is to determine the chilling requirement of hardy kiwifruit germplasm to ascertain potential production range in the Pacific Northwest and whether there is a correlation between rate of acclimation, deacclimation, and total chilling requirement on time of bud break, bloom, and harvest in the field.

The following 13 genotypes of kiwifruit are being evaluated in winter 2005-06 and 2006-07: 'Issai' and 'Hayward' (NWREC); 'Ananasnaya', 74-49, and 'Ken's Red' (2 locations: NCGR, Corvallis and NWREC, Aurora); 'Red Princess', *A. arguta var. purpurea*, 127-40, 'Kuchta', 'Geneva-1', 'Jumbo', 'Chang Bai Giant', and 'Chang Bai Mountain-3' (NCGR). Five to seven node cuttings of one-year-old wood are being collected every two weeks from 14 Oct 2005 to 17 Feb. 2006 and 6 Oct. 2006 to Feb-Mar. 2007. Cuttings are being stuck in moist media in the greenhouse and evaluated for percent bud break and days to bud break for up to 30 days. Temperature data are being collected at both locations and chilling units (0-7C) calculated. The chilling requirement (best bud break and fewest days to bud break) for each genotype, will be calculated (in progress). Genotypes are being evaluated in the field for date of budbreak, bloom, and first ripe fruit.

USDA-ARS/Oregon State University Small Fruit Breeding Program for the Pacific Northwest at Oregon State University (Small Fruits Initiative - Plant Improvement)

Bernadine Strik, OSU, NWREC

Chad Finn; USDA-ARS, HCRL

Objectives

1) To develop small fruit cultivars that meet the needs of the Northwest commercial small fruit industry; and 2) to optimize management systems for newly released cultivars. Specific traits of interest in new cultivars are:

Blackberry: thornless, machine harvestable, fruit quality comparable to 'Marion' for processing; extended harvest season, excellent flavor, and shipping quality for fresh market.

Blueberry: for fresh market: high quality, late-ripening, and suited for machine harvest; for processing: suited for machine harvest, high quality fruit, and small fruit for niche markets.

Strawberry: for processing: quality comparable to 'Hood'/'Totem', large fruit to improve harvest efficiency, and plants that are disease tolerant; for local sale and regional fresh marketing: fruit that attractive, have great flavor, and ship well, and plants that are productive with good disease and insect resistance.

Black raspberry: fruit quality comparable to 'Munger', suited to machine harvest, and improved planting longevity than 'Munger'.

Red raspberry: for processing: suited for machine harvest with excellent processing characteristics; for fresh market: summer- and primocane-fruiting cultivars that extend the season, can be shipped, and maintain excellent fruit quality.

Towards these goals, the USDA-ARS makes crosses between parents and evaluates their offspring in Corvallis. Selections from these offspring are then planted at Oregon State University's North Willamette Research and

Extension Center (NWREC) in observation and replicated trials and grown using commercial practices. While many selections are established at NWREC, only those that look promising are hand harvested to determine yield and fruit size. Fruit are shipped to the OSU Department of Food Science for processing to assess processed fruit quality. The plants are also scored for plant health, growth habit, and fruit quality. As appropriate, production methods are evaluated to optimize a genotypes performance and ultimately develop recommendations for commercial cultivation methods. Genotypes that perform well are moved into commercial trials.

In 2006, approximately 167 successful raspberry/blackberry, 130 strawberry and 60 blueberry crosses were made. Dozens of selections were made within each crop. Selections were planted or harvested and evaluated at NWREC; 17 plantings with over 1500 individual plots! Five new blackberry cultivars were released in 2005: 'Black Diamond', 'Black Pearl', 'Nightfall', 'Obsidian' and 'Metolius'; 'Wild Treasure' (ORUS 1843-3) blackberry was slated for release in 2006 but propagation problems have caused a delay in its release. 'Esquimalt' red raspberry was released in 2005 and 'Saanich' and 'Cascade Bounty' will officially be released either in late 2006 or 2007 based in part on performance at NWREC.

In 2005, 'Obsidian' and 'Siskiyou' were compared in a 30" and 60" EY production system. 'Obsidian' produced 7 tons/a at 30" compared to 5.3 tons/a for 'Siskiyou'. Cultivars had from 15 to 18% greater yield at 30" than at 60" spacing. In 2006, these cultivars were compared at 30" and 60" spacing in both every year and alternate year production systems. There were treatment effects on cold hardiness and yield. In addition, the processing cultivars Black Diamond, Black Pearl, and Nightfall were evaluated for yield using machine harvest.

Scientific citations

Kempler, C., H.A. Daubeny, B. Harding, and C.E. Finn. 2005. 'Esquimalt' red raspberry. HortScience 40: 2192-2194.

Finn, C.E., B. Yorgey, B.C. Strik, H.K. Hall, R.R. Martin and M.C. Qian. 2005. 'Black Diamond' trailing thornless blackberry. HortScience 40:2175-2178.

Finn, C.E., B. Yorgey, B.C. Strik, R.R. Martin and M.C. Qian. 2005. 'Black Pearl' trailing thornless blackberry. HortScience 40:2179-2181.

Finn, C.E., B. Yorgey, B.C. Strik, and R.R. Martin. 2005. 'Metolius' trailing blackberry. HortScience 40:2189-2191.

Finn, C.E., B. Yorgey, B.C. Strik, R.R. Martin and M.C. Qian. 2005'Nightfall' trailing thornless blackberry. HortScience 40:2182-2184.

Finn, C.E., B. Yorgey, B.C. Strik, R.R. Martin, and C. Kempler. 2005. 'Obsidian' trailing blackberry. HortScience 40:2185-2188.

Moore, P.P. and C.E. Finn. 200X. 'Cascade Bounty' red raspberry. HortScience (submitted).

Kempler, C., H.A. Daubeny, B. Harding, T. Baumann, and C.E. Finn. 200X. 'Saanich' red raspberry. HortScience. (accepted).

Impact:

Evaluation of advanced selections using commercial methods, including machine harvest, where appropriate, in a location where growers can easily observe material during field days, is of importance to the berry crop industries. Specific measurable outcomes include: 'Obsidian' and 'Metolius' blackberry are suited for early-season fresh market and are being planted by commercial growers. In addition, due to its very high yields of high quality fruit, 'Obsidian' is being planted for certain processing applications. 'Black Pearl', 'Nightfall', and 'Black Diamond' blackberry are for the processed market with the latter cultivar already accounting for over 20% of blackberry plant sales in 2005. The release of the thornless blackberry cultivars for processing is expected to have a large impact in our industry as there can be a problem with thorn contamination in machine-harvested thorny cultivars like 'Marion'. The new blueberry cultivars from Michigan State University, 'Draper', 'Aurora', and 'Liberty', tested in this program, are in very high demand by growers.

Edible-Fruited Honeysuckle, Lonicera caerulea L.: Cultivar Development and Advanced Trial Plots With Cooperators

Maxine Thompson, Professor Emerita, Department of Horticulture, OSU

Danny Barney, Professor, University of Idaho, Sandpoint Research and Extension Center

Major efforts this year at both Corvallis and Sandpoint sites were continued evaluations of 3rd, 4th and 5th year open-pollinated seedlings and propagation of superior selections. First evaluations were made of 2,546 hybrids created from controlled pollinations in 2003. Many of these 2nd year seedlings expressed superior yields (up to 434 g), larger fruit sizes (up to 2.7 g), and erect growth habit . Several were chosen for further observation and propagation for preliminary trial plots All reject plants were removed from the plots.

Twelve of the best selections from the Corvallis plot have been propagated and distributed to 5 collaborators for replicated trial plots in Aurora, OR, Bandon, OR, Sandpoint, ID, Parma, ID and Mt. Vernon, WA. Additional 7 superior selections from the Sandpoint plot are currently being propagatted for advanced trial plots in 2007.

Nutritional analyses for 42 selections are underway in Corvallis. ° Brix ranged from 6.28 to 15.48, titratable acids from 1.29 to 4.02 and °Brix/acids ratio from 2.36 to 10.05. This wide range of variability indicates potential for selecting mild to acid berry types. Analysis of anthocyanins, total phenolics, anti-oxidant capacity, and vitamin C are under way but have not yet been completed. Information on the excellent nutritional content of haskap. berries will aid in promoting this new berry crop.

Domestication of Western Huckleberries

Danny Barney, Professor, and Omar Lopez, M.S. Candidate

University of Idaho, Department of Plant, Soil, & Entomological Sciences

We completed seed germination trials and developed seed propagation protocols for dwarf huckleberry (*Vaccinium caespitosum*), Cascade huckleberry (*V. deliciosum*), oval-leaved bilberry (*V. ovalifolium*), and red huckleberry (*V. parvifolium*). The trials included developing germination models for each of the species using a logistic regression model, which was previously used to describe mountain huckleberry (*V. membranaceum*) seed germination as part of this program. We also completed evaluations of various formulations of basal salts for in vitro propagation of Cascade huckleberry, mountain huckleberry, and oval-leaved bilberry. Shade physiology trials continued, and should be completed in 2007. We obtained seed from controlled intraspecific crosses in mountain huckleberry and oval-leaved bilberry, and interspecific crosses using Cascade huckleberry and oval-leaved bilberry. We added 23 advanced and 42 early selections to the cultivar development program, making a total of 97 selections of dwarf huckleberry, Cascade huckleberry, mountain huckleberry, bilberry, oval-leaved bilberry, and alpine bilberry. F1 progeny from intersectional crosses between mountain huckleberry and oval-leaved bilberry with highbush and half-high blueberries began bearing fruit in 2006 and demonstrate unique morphological characteristics. Two oval-leaved bilberry selections will be shipped to cooperators for testing in early 2007 and planting stock is being propagated for the remaining nine genotypes of Cascade huckleberry, mountain huckleberry, bilberry, and oval-leaved bilberry selected for cooperator trials.

Developing Genetic Fingerprints for Cranberry

Nahla Bassil and Kim Hummer, USDA-ARS

Forty-six blueberry simple sequence repeat (SSR) markers or microsatellites were tested for the ability to amplify a polymorphic marker in eight American cranberry accessions. Sixteen SSRs resulted in informative and polymorphic SSR primer pairs and were used to fingerprint 16 economically important cranberry cultivars. They distinguished between the cultivars and grouped them based on pedigree. Two 'Searles' accessions collected from Jacob Searles Cranberry Co. in Wisconsin had different genetic profiles. They were differentiated from each other based on the proportion of shared allele distance generated using these SSRs, thus demonstrating the power of these markers in identifying genetically different cranberry plants that share the same cultivar name. These blueberry SSR markers will be used to fingerprint the remaining 31 cranberry accessions making up the core collection at the National Clonal Germplasm Repository (NCGR), to evaluate genetic variation of important cultivars growing in Oregon and Washington bogs, and to provide Web-access to these markers and fingerprints to the entire cranberry community.

Genotype x Environment Interaction in Elderberry (*Sambucus* sp.) Cultivars and Selections Grown in Oregon and Missouri

Chad Finn; USDA-ARS, HCRL

Patrick Byers, SW Missouri State University Fruit Experiment Station

Andrew Thomas, University of Missouri, Southwest Center

This project examined the performance of 50 elderberry genotypes, primarily the North American elderberry (*Sambucus canadensis*) but four European elderberries *(Sambucus nigra)* as well, at sites that represented the Midwest (Mt. Vernon and Mtn. Grove, Mo.) and Pacific Northwest (Corvallis, Ore.) environments. One purpose of this study was to determine whether the best performing elderberry (*Sambucus* sp.) cultivars and selections identified in a collaborative program in Missouri would also be the best performers in the Pacific Northwest. The genotypes were established either in a replicated trial with three replications or in a single observation plot. While the genotypes included in replicated trial at each location were not identical, 'Adams II', 'Johns', 'Netzer', and 'Gordon B' were in all plantings. The plants were evaluated for vegetative, reproductive and phenological traits and yield was determined. While not initially part of the study, Dr. Jungmin Lee with USDA-ARS in Parma analyzed the anthocyanins and polyphenolics. The plants grew extremely well and had excellent crops. Some of the genotypes suffered severe winter injury during a freeze-thaw incident in winter 2006 after the research concluded. The Midwest selections of *S. canadensis* uniformly suffered more severely than either the eastern *S. canadensis* or the *S. nigra* genotypes. 'York', 'Nova Scotia', and 'Johns' were the highest producers. Eastern *S. canadensis* tended to be earlier (7-14 d) flowering and fruiting than Midwestern *S. canadensis*. The *S. nigra* clones tended to break bud and flower much earlier than the other two types, but they ripened in a similar time frame. In general, the best performing *S. canadensis* genotypes in the Midwest were the best genotypes in Oregon. All samples of *S. canadensis* [cyanidin 3-(E)-*p*-coumaroyl-sambubioside-5-glucoside and cyanidin 3-sambubioside-5-glucoside are major pigments] had similar anthocyanin profiles from one another, but were distinctly different from *S. nigra* (cyanidin 3-glucoside and cyanidin 3-sambubioside are the major pigments). The polyphenolics of both species were mainly composed of cinnamic acids and flavonol glycosides (eight polyphenolic compounds). The major polyphenolic compounds present in *S. canadensis* were neochlorogenic acid, chlorogenic acid, rutin, and isorhamnetin 3-rutinoside; in *S. nigra*: chlorogenic acid and rutin.

Inheritance of Vegetative and Reproductive Traits in Black Raspberry (*R. occidentalis*)

Chad Finn, USDA-ARS, HCRL

Black raspberry (*Rubus occidentalis* L.) is a major crop for the processing industry in Oregon. The industry relies on 'Munger', which was developed in Ohio in 1890 and seldom produces for more than two to three years before succumbing to an array of fungal and viral pathogens. In the late 1990s, all available cultivars of black raspberry were evaluated at the Oregon State University (OSU) North Willamette Research and Extension Center. Based on these trials, parents were chosen for an incomplete partial diallel, consisting of 10 parents and 26 sibling families, for the study of variation and inheritance of vegetative and reproductive traits in black raspberry. Sibling families of one to eight plants were planted at the OSU Lewis Brown Farm in Corvallis, Oregon, and were arranged in a randomized complete block design with four blocks. Flowering and ripening seasons were recorded for each plant as well as average fruit weight from samples of 25 randomly collected non-primary fruit and vigor was rated on a numerical scale from 1-9 as part of an ongoing study on variation and inheritance. In the spring of 2006, cane death over the winter was also scored. Differences were observed in primocane vigor as well as bloom date, ripening dates, fruit weight and the number of nodes at which fruit was present on fruiting laterals. In addition, frozen fruit samples were also analyzed for their anthocyanin profiles, total anthocyanins, total phenolics, brix, pH, and titratable acidity. Differences in these traits were also observed between crosses and will be discussed as they relate to parentage.

Small Fruit Breeding for the Pacific Northwest at Washington State University Puyallup (Small Fruits Initiative - Plant Improvement)

Patrick Moore,WSU, Puyallup Research & Extension Center

Objectives**:**

1) To develop processing red raspberry cultivars that are adapted to the PNW and that are machine harvestable. Additional traits to incorporate into new cultivars are RBDV resistance and root rot tolerance.

2) To develop strawberry cultivars that are adapted to the PNW and that have higher picking efficiency than current industry standards. Additional traits to incorporate into new cultivars are: fruit firmness and disease resistance.

After raspberry selections are made, the next evaluation is planting 10 plant plots with a cooperating grower. These plantings are managed commercially and evaluations of the machine harvestability of the selections are made by the breeding program. In 2006, a planting was established with 77 WSU selections, 20 BC selections and 3 cultivars. This planting will be machine harvested in 2008 and 2009.

The machine harvesting planting established in 2004 with 51 WSU selections was harvested for the first time in 2006. Eight of the WSU selections appear to machine harvest well. Two plantings of WSU advanced selections (selections that appeared to machine harvest well in the 2002 and 2003 plantings) were established in 2005. One of these plantings had sufficient growth for it to be machine harvested in 2006. All of the advanced selections machine harvested well in the new planting. For the first time, as part of the evaluation process, samples from some selections were frozen in an IQF tunnel. It was possible to track samples through the processing plant and make observations with samples of less than one flat. Two selections from the 2004 machine harvesting trial and two selections from the advanced selections appear to have potential for IQF (Individual Quick Frozen) use. These selections may be propagated for possible distribution to commercial propagators.

Nine thousand six hundred raspberry seedlings were planted in 2006 from crosses made in 2005. Selections will be made in this planting in 2008 and 2009. The selections that have been identified in the machine harvesting trials have been used extensively as parents in crosses.

Strawberry crosses have used parents chosen for large fruit size, firm fruit and productivity. Thirty-five selections were made in 2006 among the 5,300 seedlings planted in 2005. BC 99-51-2 in particular produced seedlings in the 2005 planting with large fruit size. These 35 selections will be propagated for planting in yield plots. The yield planting established in 2005 was harvested for the first time in 2006. The performance of this planting was very good with many productive, large fruited, firm selections. There were six selections with yields over 11 tons/acre, average fruit weight over 12 g, and average fruit firmness over 220 g. WSU 2634, WSU 2638, WSU 2688 and WSU 2694 had erect growth with fruit held up off of the ground. This should make the fruit easier to see and pick, improving picking efficiency. Having the fruit off the ground as it ripens also could reduce the amount of fruit rot. All four of these selections had below average amounts of fruit rot and three of them were among the 5 clones with the lowest fruit rot. The average fruit rot for these four selections was 22% and the average for the planting was 39%. This planting will be evaluated again in 2007.

The breeding efforts are supported by Washington State University, Northwest Center for Small Fruit Research (Small Fruit Initiative Funding), Washington Red Raspberry Commission, Oregon Raspberry and Blackberry Commission, Washington Strawberry Commission and Oregon Strawberry Commission.

Evaluation of Wine Grape Cultivars and Selections for a Cool Maritime Climate

G.A. Moulton and J. King, WSU

Wine grape production is already established in maritime climate areas of Oregon and is expanding rapidly in western Washington. The climate of these areas is similar to classic wine growing areas of northern France and Germany, and vineyards here are capable of producing. high quality wines with fruitiness and extraordinary full flavor.

New varieties adapted to cooler climates, with unique qualities for varietal and blended wines, broaden the product range and increase the sales potential of local wineries. A replicated variety trial has been established in paired vineyard plots, located in a higher heat range area and also in a lower heat area. First harvest evaluations were begun in 2002, and will continue until 2011. A number of promising varieties and clones have already been identified and some new ones are being added to the varietal pretest.

The effects of certain grape rootstocks in advancing ripeness, reducing vigor, or improving the quality of grafted wine grape varieties have been evaluated in a trial comparing Pinot Noir clone 2A grafted on seven different rootstocks. Own-rooted plants are used as the control. Differences in ripening and vigor are evident between the different rootstocks. A vine spacing trial planted in 2003 will test the effects of close planting on productivity and canopy management. Data collected in the above trials include harvest fruit analysis (Brix and titratable acid), harvest date and yield. Cooperation of area winemakers is being utilized in wine production and the post-harvest evaluation of varieties. Wines produced in 2003-2005 are being evaluated, and the 2006 crop is currently being harvested.

Evaluation of New Cranberry Germplasm for Fresh Fruit Production in the Pacific Northwest

Kim Patten, WSU, Long Beach Research and Extension Unit

A replicated field planting of advanced selection of cranberries from the breeding program at Rutgers University was established in 2003. Comparisons were made to standard cultivars. Numerous variables have been collected to date (Table 1). Based on these parameters, none of the germplasm selections has yet to distinguish itself as being superior to the current varieties in production. Other variables measured for which there

were no major differences between selections included incidence of rose bloom and other diseases, keeping quality, vigor and fruit color.

Table 1. Fruit size, yield and percent rot at harvest cranberry variety trials – Long Beach, Washington

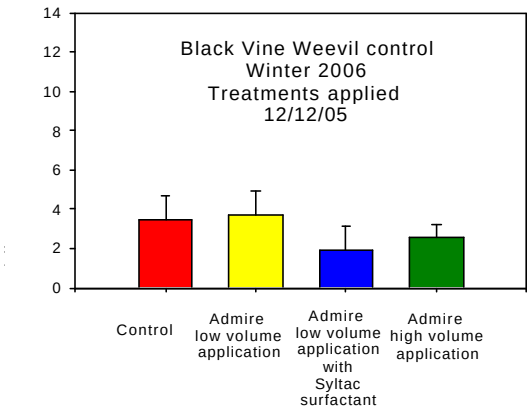
Variety	Fruit Size (g/fruit)		Bbl/acre		% rot at harvest	
	2005	2006	2005	2006	2005	2006
NJS98-23	2.03 ab	1.87 abc	77 c	179 ab	6.43 a	1.94 a
NJS95-37	1.44 bcd	1.48 d	85 c	277 a	2.49 a	0.48 a
CNJ97-105-4		1.97 a	1 c	74 bc		2.87 a
CNJ96-44-83	1.94 abc	1.90 abc	77 c	149 abc	3.70 a	1.00 a
CNJ95-20-20	1.57 a-d	1.44 d	32 c	181 ab	2.98 a	1.22 a
CNJ93-9-42	1.62 a-d	1.53 d	61 c	187 ab	4.13 a	1.17 a
CNJ93-13-100	1.40 cd	1.52 d	46 c	136 abc	1.21 a	1.18 a
BE4	1.20 d	1.23 e	150 b	217 a	2.22 a	0.68 a
AR2	1.91 abc	1.69 a-d	16 c	223 a	9.10 a	1.02 a
Bain Favorite #1	2.08 a	1.89 abc	46 c	178 ab	3.15 a	0.71 a
Pilgrim	2.14 a	1.89 abc	257 a	202 ab	5.49 a	0.65 a
Stevens		1.62 cd	3 c	49 c		4.24 a
NJS98-65	2.11 a	1.93 ab	11 c	201 ab	3.03 a	0.69 a
NJS98-28	1.58 a-d	1.65 bcd	27 c	171 ab	4.26 a	3.06 a

Means followed by same letter do not significantly differ (P=.05, Student-Newman-Keuls)

Applications of New Pest Strategies in Cranberries

Kim Patten and Chase Metzger, WSU, Long Beach Research and Extension Unit

Weed control: Trials to control of false lily-of-the-valley (*Maianthemum dilatatum*) were conducted using 3, 4, and 5% acetic acid as a soil drench at rates of 7500 gpa, followed by 5000 gpa leaf rinse with water just prior to budbreak. Efficacy and crop damage were not consistent on peat or muck soils, especially if they were saturated, while on sandy soils good control with only moderate crop damage was observed. Multiple applications of Callisto or combinations of Callisto in late spring and summer and 2,4-D in the spring, provided excellent control of silverleaf. Two applications of Matrix provided good control of yellow loosestrife, with no appreciable crop damage. The herbicides Balance, Outlook, Chateau, Matrix, and Raptor were not efficacious. *Blackvine weevil control:* The use of a surfactant or higher rate spray volumes did not improve the efficacy of Admire as a weevil larvicide. Summer application of Nemasys L nematodes provided better control of weevil larvae than similar timings of applications of imidacloprid, clothianidin or dinotefuran. As adulticides, a single application of Thiomethoxam (Actara) reduced adults by 76%, while dinotefuran (Venom) or a combination of dinotefuran and clothianidin reduced adults by 62% and 80%, respectively. *Fruit rot:* Treatments were made at numerous sites to compare traditional grower fungicide applications (Bravo at fruit set followed by Maneb in 14 days) against earlier and more aggressive applications of fungicides. Overall there was no significant treatment effect on fruit rot or yield across all sites. However, there was a trend for reduced rot with Bravo application during bloom, without any effect on yield.



PEST MANAGEMENT

An In-depth Study of the Biology and Life Cycle of Blueberry Gall Midge

Wei Yang, OSU, NWREC; and Thomas Peerbolt, Peerbolt Crop Management

The presence of blueberry gall midge (BGM) in commercial blueberry fields was confirmed by conducting field surveys in Oregon and SW Washington,. The characteristics of BGM infestation was blacken and aborted young shoot tips. It was found that the peak of BGM infestation appears to coincide with the 'flush' growth pattern of blueberry plants. The BGM present in the northwest was identified as *Dasineura oxycoccana* Johnson (Diptera: Cecidomyiidae) by Dr. Blair Sampson from the USDA. The life cycle of BGM was completed for the first time in the northwest. A simple, easy to use, and effective technique to observe BGM rearing *in-situ* was developed. Using this rearing technique, we have observed that it takes about two weeks for the midge larva to become an adult fly. There may be up to four generations during the growing season. The correlations between the BGM larvae counts and the shoot tip damage were poor. Further monitoring of We conclude that BGM is a potential new pest and warrants further studies.

Characterization and Detection of a Virus Associated with Blueberry Fruit Drop Disease

Robert Martin, Virologist, USDA-ARS, HCRL

Blueberry fruit drop is a new disease of blueberry in which the fruit drops after it reaches about the size of a BB (2-3 mm). In 2003, we observed bushes during bloom and they had reddish streaks in the flowers and reddish leaves. The flower symptom looks like the candy striping symptom observed with *Blueberry shoestring virus*. The plants with fruit drop all tested negative for *Blueberry shoestring*, *Blueberry scorch*, *Blueberry shock*, *Blueberry leaf mottle*, *Tomato ringspot*, and *Tobacco ringspot viruses*. We have been able to identify a virus in the infected plants. Blueberry fruit drop is spreading in fields where it occurs, though the vector is unknown. Thus far, symptomatic plants observed in the field have been Bluecrop and the yield loss usually exceeds 90%. The virus is related most closely to fungal viruses rather than plant viruses, thus efforts have been made to free plants of fungal contaminants before virus testing. These plants still test positive for the virus. We have recently identified similar viruses in black raspberry, tomato and redbud.

Characterization and Control of Aphid-Borne Viruses in Red and Black Raspberry Associated with Decline and Crumbly Fruit

Robert Martin, Virologist, USDA-ARS, HCRL

(Goals met, plus a few surprises to keep it interesting)

Vector transmissions with one the virus(es) from black raspberry (Black raspberry necrosis virus) were completed and it was shown that the large raspberry aphid (*Amphorophora agathonica*) and the green peach aphid (*Myzus persicae*) can transmit the virus efficiently with feeding times of 1 hour but poorly with short feeding times. The large raspberry aphid was a much better vector (from a researcher's point of view – more

transmission) than the green peach aphid. Also, in field transmission studies the virus was transmitted primarily early in the season (May and June) with very little transmission after early July. After numerous efforts at obtaining more information on virus 2 in black raspberry it was discovered that the sequence we had from the "second" virus was actually in insert of unrelated viral sequence into the Black raspberry necrosis virus.

In red raspberry of one of the two new viruses has been transmitted by large raspberry aphid. Transmission studies with the second virus in red raspberry have not been completed. The aphid transmitted virus has been identified in material from Scotland as well as from Washington and Oregon.

Evaluation of Nematode Resistant Grape Rootstock for Managing *Mesocriconema xenoplax*

R. Paul Schreiner, Research Plant Physiologist, USDA-ARS-HCRL

John Pinkerton, Research Plant Pathologist, USDA-ARS-HCRL

David Bryla, Research Horticulturalist, USDA-ARS-HCRL

Grafted grapevines were planted on May 3 in microplots (25 gallon pot-n-pot) that were inoculated with arbuscular mycorrhizal fungi (AMF). Half of the plots received 100,000 ring nematodes (M. xenoplax) at planting. Vines were thinned to 1 shoot on June 8, which was trained upright on a bamboo stake. All plots have received ample water throughout the summer, by maintaining soil moisture above 15% volumetric water content. Leaf samples for nutrient analysis were collected the week of August 21 (veraison), and soil samples for estimating nematode populations, root length, and AMF colonization were collected in October. Results thus far indicate that the presence of ring nematodes in plots is not yet influencing shoot growth or gas exchange of vines, although differences between rootstocks have been significant. The total shoot length (main shoot plus laterals) of Pinot noir was initially (June 23) lower on 420A and 110R rootstocks compared to 1103P and 101-14. Later in the summer (August 2), 420A was significantly lower than 1103P and 3309C. Leaf area (August 2) was also lower on 420A compared to 1103P and 3309C, with the other rootstocks (110R, 101-14, self) being intermediate. Interestingly, stomatal conductance on August 17 and 18 was highest in 420A and lowest in 3309C and 1103P vines, indicating a compensation for lower leaf area with higher gas exchange per unit of leaf area among rootstocks.

Improved Precision of Grapevine Powdery Mildew Models

Gary Grove, Professor of Plant Pathology and Director, Washington Ag Weather Network, WSU-IAREC

A polymerase chain reaction (PCR) assay employing species-specific primers was developed to differentiate *Erysiphe necator* from other powdery mildews common in the northwest United States. DNA was extracted from mycelia, conidia, and/or cleistothecia that were collected from grape leaves using a Burked cyclonic surface sampler. To differentiate *E. necator* from other erysiphaeceous fungi, primer pairs Uncin144 and Uncin511 were developed to select unique sequences of the internal transcribed spacer (ITS) regions of *E. necator*. Using these primers in PCR amplifications a 367 bp amplicon specific to *E. necator* was generated, but no amplicons were generated from other erysiphaceous species collected from 48 disparate hosts representing 26 vascular plant families. The PCR limit of detection was 1 to 5 conidia of *E. necator* placed directly into reaction mixtures or 100 to 500 conidia placed on glass rods coated with silicon grease. During field studies, this PCR assay facilitated the detection of *E. necator* inoculum in air samples within hours of collection prior to disease onset. Amplification of *E. necator* DNA did not occur when the PCR assay was conducted on vineyard air samples collected while

grapes were dormant or during periods when vine growth occurred but *E. necator* remained dormant. The initial PCR detection of *E. necator* of the season occurred during seasonal ascospore releases caused by precipitation events between bud burst and the prebloom period during the three years of the study. Detection ceased for 7 to 11 days following ascospore release and then resumed several days prior to the observance of microscopic symptoms and signs of powdery mildew. Results of this study represent the initial step toward the goal of incorporating an inoculum availability component into current and future grapevine powdery mildew risk assessment models. Incorporation will improve model precision through verification of pathogen activity.

Herbivore-Induced Plant Volatiles as an Aid to Conservation Biological Control in Grapes

David James, Irrigated Agriculture Research and Extension Center, WSU

Conservation biological control (CBC) is an important component of integrated pest management strategies being developed for vineyards in Washington. CBC is based on recruitment and maintenance of specific and general-feeding natural enemies in vineyards. When attacked by pests, grapevines emit volatile chemicals which serve as 'alarm signals'. Natural enemies of pests 'hear' these cries for help and are attracted to the distressed plants. One of these alarm signals is methyl salicylate (MeSA), which is being field-tested in this project for its efficacy as a natural enemy attractant and aid to improving CBC in grapes.

The deployment of MeSA dispensers in commercial vineyards in WA has resulted in significant increases in population densities of some important natural enemies of grape pests including mite-eating ladybeetles and *Anagrus* parasitoids of leafhoppers. It is expected that larger populations of natural enemies in vineyards will lead to improved CBC.

Attraction and Retention of Beneficial Insects Through Enhanced Plant Biodiversity in Irrigated Vineyards (*Vitis vinifera* L.)

David James, Research Entomologist

Mercy A. Olmstead, Extension Viticulturist

Tessa Grasswitz, Research Associate (Entomology)

WSU, Irrigated Agriculture Research and Extension Center

This project examined the effect of four different ground cover treatments on the attraction and retention of beneficial insects in two irrigated vineyards (one organic and one conventional). The treatments were established in autumn, 2005, and consisted of cereal rye, resident vegetation ('weeds'), a drought-tolerant medic and clover mix, and an 'insectary' blend of five different flowering annuals and two grasses. Cutworm damage was assessed in spring, 2006, and populations of other key pests (e.g. Western grape leafhopper (WGLH)/Virginia creeper leafhopper (VCLH)) and their natural enemies were monitored throughout the 2006 growing season. Various agronomic measurements were also made, including percentage establishment, cover crop height, soil moisture, soil nutrient flux, vine shoot length, berry number and berry weight. Good establishment was achieved with cereal rye and some of the flowering annuals (particularly Californian bluebell (*Phacelia campanularia*) and dwarf cornflower (*Centurea cyanus)*; however, the medic and clover mix performed poorly. Pest pressure was low in the conventional site, while the organic site had much higher levels of both WGLH and VCLH. In general, however, few treatment effects were observed on pests or beneficials.

Further Evaluation of Control Strategies for Root Weevils in Strawberries and Red Raspberries

Lynell Tanigoshi and Jeanette Bergen, WSU-Vancouver Research & Extension Unit

A root weevil complex of the black vine weevil, rough strawberry root weevil, strawberry root weevil and the clay colored weevil are primary insect pests on red raspberries and strawberries in the Pacific Northwest. Annually, thousands of acres of these small fruits are chemically treated to control adult damage to foliage, prevent their egg deposition in the soil and eliminate contamination in machine harvested red raspberries.

Brigade remains an effective contact and stomach poison for all four root weevil species over a 4-6 day interval if they forage on treated strawberry and red raspberry foliage. Because of dense, strawberry foliage at harvest and their quiescent state during postharvest renovation, we've learned that rough strawberry root weevil do not expose themselves to conventional foliar applications during those control windows effective for the more active foraging species. The most effective way to deliver Brigade for good coverage within the strawberry canopy is to retrofit ones boom sprayer to suspend a 2" by 6" board about 3 ft long over each row. These are suspended above the strawberry crown and positioned in front of each nozzle to allow good penetration of the spray interface immediately behind the opening canopy. The recent registration of the systemic, neonicotinoid class pesticides for both foliar and soil application opens up our program for the control of root weevil larvae during early fall. Our early research indicate control mortality of 40-50 percent when these neonicotinoids are applied as drench or chemigation treatments. However, the heavy PNW soils have been problematic for economic control and efforts are being researched to enhance their movement to the root zones at effective concentrations.

PRODUCTION / PHYSIOLOGY

Leaf Chlorosis of 'Concord' Grapevines: Physiological Mechanisms and Practical Solutions

Lailiang Cheng[1], Brandon Smith[1], Markus Keller[2] and Joan Davenport[2]

[1]Department of Horticulture, Cornell University; [2]WSU, IAREC

The overall objective of this project was to understand the underlying physiological mechanism of leaf chlorosis in Concord vines and develop practical measures for growers to overcome the problem in WA vineyards. During the first year of the project, we have 1) collected leaf samples from three vineyards in central WA that have consistently had chlorosis problems to determine the Fe status in chlorotic leaves; 2) set up a controlled pH experiment to determine the effect of pH on leaf function and chlorosis of Concord vines; and 3) conducted an experiment on potted vines to determine the effectiveness of FeEDDHA (a chelated form of Fe) application in alleviating Fe-deficiency-induced leaf chlorosis at a high soil pH (7.6). Our results clearly indicate that 1) chlorotic leaves from WA vineyards have significantly lower active Fe compared with green leaves; 2) high soil pH induces leaf chlorosis in Concord vines; 3) roots of Concord vines are able to increase the activity of ferric chelate reductase, the key enzyme in Fe assimilation, to compensate for the decreased Fe availability at high soil pH whereas leaf ferric chelate reductase activity is decreased by high soil pH; and 4) FeEDDHA is very effective in alleviating leaf chlorosis induced by high soil pH, which strongly suggests that FeEDDHA, a fertilizer commercially available, may have a good potential in combating the chlorosis problem.

Effect of Primocane Suppression on Plant Vigor and Purple Blotch Management in EY Marion Blackberries

Diane Kaufman, OSU, NWREC

Objectives: Evaluate the effect of chemical primocane suppression on plant vigor and incidence of purple blotch disease on Marion blackberries cropped every year (EY).

Progress: A new planting for this experiment was established in 2003, with plants set at both a 6 and 3-foot in-row spacing. Treatments were applied to primocanes from mid-April to late June in 2004 and 2006. The herbicide Aim was applied to the base of plants when primocanes were initially 2 to 12 inches high, and again when the second flush attained 2 to 12 inches of height. In some plots, a third treatment of Aim was applied. The fungicide Pristine was applied 1 to 2 times to new flushes of primocanes that appeared after the final application of Aim. The fungicide only treatment (no primocane suppression with Aim) received sprays when primocanes were 2-12, 12-18, and 18-36 inches high. The fungicide rotation for this treatment was Quadris, then Kocide, finishing with Pristine. Instead of receiving treatments in 2005, all plants were inoculated with *Septocyta ruborum* spores using a CO_2 pressured back-pack sprayer, in an attempt to increase disease pressure. Plant vigor in response to treatments was evaluated by counting and measuring primocanes prior to training them in August, 2004 and 2006. Treatment effect on purple blotch disease was evaluated in March, 2005 by counting purple blotch lesions on the bottom 3 feet of each cane. Yield data was collected in July, 2005 from a hand-picked 6-foot length of row per plot.

Primocane Management Systems for Increased Yield and Hardiness in 'Marion' Blackberry

Bernadine Strik and Gil Buller, Professor & Senior Research Assistant, Dept. of Horticulture, NWREC, OSU

The objectives of this study are to determine the impact of primocane suppression date on yield, quality, and hardiness of 'Marion' blackberry planted at different in-row spacings. This study is being conducted in a mature 'Marion' blackberry planting established at the North Willamette Research and Extension Center. In an earlier study we found that cumulative yield was 57% higher for 5'EY than 5' AY treatments from 2002 through 2004 (with half the AY plots fruiting in a given year). The 2' AY treatments had 17% higher cumulative yield than the 5' AY plots. Our results indicated that all treatments were sensitive to cold injury, depending on when canes were trained and when the cold event occurred. However, in our earlier work, we did not do any primocane suppression.

In this study, our treatments are: 2' AY, no suppression, but primocanes topped at 6'; 2' AY, primocanes suppressed (re-cut in off year) in June; 3' AY, primocanes suppressed in May; 5' AY, primocanes suppressed in April; and 5' EY with no suppression, trained in February.

The recorded temperature at the NWREC for the winter of 2004-05 never fell below 30°F. There was no significant treatment effect on yield in 2005, which averaged 5.6 tons/acre.

The lowest recorded temperature at the NWREC for the winter of 2005-06 was 19°F (sheltered) on Dec. 15-17, 2005 and 19.5 to 22.5 °F on Feb. 16-20, 2006. There was an effect of primocane suppression date/spacing on yield in 2006. The 2' AY, 3' AY, 5' AY, and 5'EY yielded 5, 4.4, 4.5, and 2.5 tons/acre, respectively. The 5' EY had only 38% bud break compared to a high of 69% bud break in the 2' AY treatment. However, the 5' EY treatment produced much larger berries (6.1 g) than the AY treatments (4.4 to 5.1 g) – some of this effect was likely due to the low yield in the 5' EY.

Effect of Irrigation on Pinot Noir Performance in the Willamette Valley

M. Carmo Vasconcelos, Associate Professor, Viticulture, OSU, Dept. of Horticulture

In the Willamette Valley there is abundant soil moisture during the period of active growth and vines tend to develop a large canopy requiring a considerable amount of water. Soil water content reaches critical values during the ripening period. Three irrigation strategies were compared in a commercial Pinot Noir vineyard in the Willamette Valley. Non-irrigated controls (NI) were compared to 1) vines irrigated to replace 50% ETc (RDI, regulated deficit irrigation) on both sides of the root system and 2) vines irrigated to replace 25% of ETc (crop evapo-transpiration) on one side of the root system switched every two weeks (PRD, partial root-zone drying). Each treatment was replicated five times in groups of twelve vines in a complete randomized experimental design. Irrigation treatments were implemented when vines reached a midday leaf water potential of –1MPa (first week of August of 2003 and 2004, threshold never reached in 2005), and continued until mid ripening.

Although vines did not receive irrigation during the 2005 season, there were still measurable effects of the previous years' irrigation treatments. Vines that were not irrigated during the previous two seasons had higher stomatal conductance, transpiration rates, and lower intrinsic water use efficiency during the hottest part of the summer. These vines also showed a higher level of water stress as assessed by mid-day leaf water potential. No effects of previous seasons' irrigation were seen on leaf chlorophyll content and photosynthesis. There were no significant differences between vines that had received 25% or 50% of Etc previously.

There were no significant differences in fruit yield and composition, vine vigor, and wood carbohydrate reserves. Wine color intensity, hue, and total anthocyanins did not differ among treatments in any of the three years. Wine phenolic profiles did not change with irrigation. Wine total phenols, monomeric proanthocyanidins and tannins were more concentrated in 2005, followed by 2003 and did not change with irrigation.

During the summer of 2006, leaf water potential reached values of 0.95 M Pa in late August but stayed below the threshold for the onset of irrigation. In two out four seasons, irrigation was not required. In view of the results, it seems that mature vines can be grown successfully in the Willamette Valley without irrigation. However, a four-year period of evaluation is not sufficient to rule out the need for irrigation, especially in view of the threat of global warming.

Using Grafted Blueberries to Improve Mechanical Harvesting for Fresh Market Quality Berries

Wei Yang, NWREC

A ¼ acre blueberry rootstock plot was established at the North Willamette Research and Extension Center (NWREC) in 2005. The plot was fertilized with 20 lbs N, P, K using triple 16 fertilizer and applied 3" deep saw-dust mulch to control weeds within the planting row. The plot is under drip irrigation. The three rootstocks (NC2845, NC8232, and NC8248) were from *Vaccinium elliottii* selections from Dr. James Ballington's breeding program. The growth of three rootstock selections in 2006 indicated no differences in stem diameter among three selections. NC2845 exhibited longer shoot length compared to NC8232 with NC8248 had the shortest shoot length. NC 2845 also was the tallest plant. NC8248 had the most sucker produced after one growing season. The goal was to evaluate these and other *Vaccinium arboremum* materials for selecting vigorous and less sucker-producing ones to develop grafted blueberry plants.

Table Grape Variety Evaluation and Improving Berry Quality, Size, and Yield under Desert Conditions of the Pacific Northwest

Esmaeil Fallahi, Principal Investigator, Professor of Fruit Physiology, University of Idaho

The increasing gas prices and high cost of labor in the United States and technological and internet advances worldwide, have created challenges for growers particularly fruit growers in the USA. These factors have contributed to the popularity of table grapes produced in the Pacific Northwest (PNW). As a result of the long-term University of Idaho Pomology Program research efforts, a brand new table grape industry has been established in Idaho and a large number of buyers from overseas have ordered table grape from Idaho. In the current project, 22 promising grapes from the University of Arkansas Table Grape Breeding Program are selected and planted at the University of Idaho vineyard. Also, we have been studying the effects of GAs, girdling and cluster cutting and thinning practice on vine survival and berry quality, including berry size, soluble solid concentrations, berry color, berry size, cluster size, peel and berry texture and vine survival in the promising cultivars out of our first phase of evaluation. Our preliminary tests indicate that we in the PNW can increase berry size of some table grapes and make them comparable and even larger than those in California. Yet, these cultivars mature later under our conditions, when California grapes are slowed down or finished, making table grape an outstanding alternative fruit crop. 'Alborz' vines that received cluster removal (cluster thinning) but not cluster shortening treatment as well and those with cluster removal plus cluster shortening and girdling treatment had larger cluster weights than controlled vines. Alborz vines that received cluster shortening and cluster removal plus girdling had significantly larger berries than control vines. Alborz vines that received no treatment (control) as well as those with cluster removal but not shortened had significantly longer clusters than all other treatments. In 'Emerald', vines that received cluster removal but not cluster shortening had heavier clusters than those with cluster removal and cluster shortening. Vines that received girdling plus cluster removal and shortening had larger berries than control vines and showed advanced maturity but these practices did not help the over-all berry quality and marketability as compared to control. A-2486, A-2412, A-2494, A-2514, A-2640, and A-2310 had excellent berry quality and size.

Irrigation Management Practices for Improving Growth and Production of Blueberry

David Bryla, USDA ARS Horticultural Crops Research Laboratory

Bernadine Strik, Department of Horticulture, OSU

A study was done to determine the effects of irrigation method and level on growth and establishment of highbush blueberry. Two cultivars, 'Duke' and 'Elliott', were irrigated by overhead sprinklers, microsprays, or drip at 50, 100, and 150% of the estimated crop evapotranspiration requirement. During the first two years after planting, plants irrigated by microsprays required 12-36% more water as those irrigated by drip, while those irrigated by sprinklers required 117-138% more water. Interestingly, drip significantly increased growth in 'Elliott' compared to sprinklers and microsprays, but significantly decreased it in 'Duke'. The benefit of drip in 'Elliott' was likely due to higher soil water content in this treatment, which probably enhanced plant water status over sprinklers and microsprays. However, in 'Duke', higher soil water content with drip increased the incidence of *Phytophthora* and *Pythium* root rot, which then led to weakened and smaller plants. Growth was similar in plants irrigated by sprinklers and microsprays in both 'Duke' and 'Elliott'.

Water and Nutrient Competition with Cover Crops in Willamette Valley Vineyards

R. Paul Schreiner, Research Plant Physiologist, USDA-ARS-HCRL

Rebecca Sweet, Graduate Student, Dept. of Horticulture, OSU

Seven cover crop treatments were applied in the alleys (between rows of vines) at two commercial vineyards in the northern Willamette Valley in the fall of 2003 and monitored for establishment and impact on Pinot noir grapevines in 2004 and 2005. Treatments applied were: winter annuals (oats, rye and vetch), clover mix (subclovers, clovers and medic), native grass mix (Willamette Valley upland prairie species), native meadow mix (forbs plus grasses), perennial grass and clover mix (sheep fescue, dwarf perennial rye, hard fescue, subclovers, clovers and medic), resident vegetation, and a clean-cultivated control. Cover crops were mowed in the spring and summer according to growers' practices. Cover crops had little measurable influence on the growth or fruit quality of Pinot noir grapevines. While the different cover crop treatments sometimes had effects on the vineyard (soil moisture in the alley, leaf [N] at veraison, juice YANC), there was no case where any of the cover crop treatments were significantly different from the clean-cultivated control or resident vegetation treatments. This two year study conducted under fairly normal rainfall and temperature patterns for the region, showed very little competition between cover crops and vines for water or nutrients. Since a clean-cultivated control was used in this study, it can be concluded that use of cover crops will not interfere with growth or nutrient and water uptake of established Pinot noir grapevines when cover crops are mowed in the spring and summer. Therefore, advantages of using cover crops (like protecting soil from erosion, adding organic matter to soil, providing plant diversity in the vineyard) may be more important considerations than the potential disadvantage of competition with vines when growers evaluate the use of cover crops in Willamette Valley vineyards.

Identifying Optimal Nutrient Concentrations for Premium Winegrape Production Based on Physiological Needs and Fruit Quality

R. Paul Schreiner, Research Plant Physiologist, USDA-ARS-HCRL

Cooperators: Jungmin Lee, USDA-ARS-HCRL

James Kennedy, Department of Food Science, OSU

Michael Qian, Department of Food Science, OSU

Self-rooted Pinot noir (clone UCD2A, Pommard) vines were grown in a coarse, sand medium in a pot-n-pot system supplied with complete mineral nutrient solution for 3 years (2003-2005). Beginning in May 2006, different nutrient treatments (4 levels of each N, P or K with all nutrients held constant) were applied to vines by fertigating 1-3 times per week. Shoot growth of Pinot noir, leaf N concentrations, and leaf SPAD readings were reduced by the low N treatments, but not by the low P or low K treatments. Nutrient treatments did not affect chlorophyll fluorescence, stomatal conductance or soil moisture on any given sampling dates in 2006. Unfortunately, a high level of inflorescence necrosis (IN) occurred in this vineyard at the end of the bloom period in 2006. Because IN was both highly variable from vine to vine and affected by nutrient treatment (IN was significantly reduced in the two lowest N treatments), we chose to remove all clusters from experimental vines to preserve uniformity and start over again next year. Even though IN was reduced by the lowest N treatments in these vines, the high level of IN observed this year was probably a result of waterlogged conditions that occurred over the winter as opposed to the application of too much N in our fertilizer, because leaf N concentrations of these vines at bloom and veraison were actually lower than typically found in Oregon vineyards. Roots in some pots had blocked the drain holes resulting in waterlogged (anoxic) conditions over the winter. All pots were retrofitted with copper screen (to inhibit root growth on pot bottoms) in March 2006, which was successful in inhibiting roots from growing on the bottom of pots (examined in October, 2006).

Cover Crops to Supply N for Organic Grape Production

Robert Stevens and Joan Davenport, WSU, Irrigated Agriculture Research and Extension Center

Cover crops have many potential roles in vineyard management. If a plant material with the ability to turn the nitrogen (N) in air into plant available N (called fixing N) is used, this has the potential to serve as an organic fertilizer for the vineyard. In this study we have compared two different leguminous plants that fix N to soluble organic and conventional N fertilizers in Concord grape vineyards. We also looked at timing of planting – either fall or spring – and time of mowing and or incorporating the plant material to how well it supplied N relative to the grape plant's need. Both of the legumes we used, yellow sweet clover and common vetch, were able to supply sufficient N to support grape production. The data suggests that by mowing and incorporating the cover crop at bloom, it will supply sufficient N to support grape productivity. However, due to the relatively short duration of the study (3 growing seasons), monitoring crop yield and plant N status is recommended to ensure against vine decline if this approach is used over the long term.

Dynamics of Grape Berry Growth and Physiology of Fruit Volume Change

Markus Keller, Associate Horticulturist/Viticulturist, WSU

Winemakers often complain about a "dilution of grape quality" or even cracking of berries from volume increase due to late-season irrigation or rainfall. It is unclear whether this change in berry size is due to an increase in soil moisture or to absorption of water directly through the berry skin. We used large pressure chambers to pressurize the root system of pot-grown Merlot and Concord vines, enabling us to determine the influence of soil moisture on changes in berry volume. In addition, soil moisture was altered using drip irrigation and dry-down/rewatering cycles. We also used a chemical dye to trace water movement in the vines' xylem (water conduits) and immersed berries in water to test if water could be absorbed through the skin. We found that the volume of pre-veraison berries fluctuated rapidly with changing soil moisture. Post-veraison berries, on the other hand, responded little to soil moisture. Application of irrigation water after veraison merely prevented berry shrinkage. Post-veraison Concord, but not Merlot, berries cracked when root pressure was applied. We also found that the xylem connection between the berries and the shoot remains intact after veraison, but the berries stop using this pathway for water influx and instead use it to recycle excess phloem (sugar conduits) water back to the shoot (overflow mechanism). We were able to reverse this trend by applying pressure to the shoots. We also demonstrated that water could be absorbed through the berry skin. Our results have direct practical implications, since they suggest that late-season drip or flood irrigation should have little effect on berry size and sugar concentration, whereas overhead sprinkler irrigation or rainfall might effectively dilute berry solutes. Growers may apply irrigation water to the soil late in the season to maintain productive leaves without interfering with fruit water content. This could enable them to leave the fruit on the vine longer for flavor development without compromising replenishment of storage reserves and cold hardiness.

WINE PROCESSING

Enhancing Red Wine Texture by Aging on the Yeast Lees

Alan Bakalinsky, OSU; Jim Harbertson, WSU

Graduate Research Assistant: Jeff Rowe, OSU

Cooperator: Jim Kennedy, OSU

Wine tannins have profound effects on red wine quality as they contribute color, bitterness, and astringency. Winemakers modify the amounts and quality of tannins in red wines by controlling extraction (pre-fermentation maceration, timing of pressing), post-fermentation oxygenation, addition of fining agents and wood extracts, and aging practices. The broader term "texture" is often used to describe the quality of astringency and has been defined as the cumulative affect of all wine components on the perception of astringency. Understanding and controlling wine texture is a fundamental interest of winemakers because this characteristic is central to the sensory quality of wine. Unfortunately, because our scientific understanding of texture is poor, modification of this important parameter by winemakers is usually limited to empirical approaches. This proposal seeks to provide winemakers with a practical and objective tool to assess and to modify wine texture through detection of the interactions that occur between grape tannins and yeast mannoproteins. Our central hypothesis is that aging red wine on the yeast lees results in a desirable reduction in astringency due to formation of complexes between grape tannins and yeast-derived mannoproteins.

Because we are interested in the interactions that occur between grape tannins and a subclass of wine proteins—yeast-derived mannoproteins—we evaluated different methods for isolating and assaying wine proteins. The procedure described by Vincenzi et al. (2005) for isolating and measuring wine proteins in both red and white wines was found to be sensitive (1 µg detection limit), reproducible, and convenient. Protein recovery was found to be at least 90%. In order to choose a representative yeast mannoprotein for use in developing an assay for detecting tannin-mannoprotein interactions, we identified a number of wine proteins—three originating from yeast and two from grape. All of the yeast proteins are mannoproteins and one of them, invertase, is available commercially. Yeast invertase was therefore chosen as a model for developing the grape tannin-mannnoprotein assay. We are using the well-established Harbertson tannin assay as a starting point for detecting tannin-yeast mannoprotein interactions. The Harbertson assay measures tannin based on its ability to combine with the protein bovine serum albumin (BSA). Experiments have been initiated that compare the tannin-binding ability of yeast invertase (our model mannoprotein) to that of BSA under a variety of conditions.

Grape Phenolics and Wine Quality: Measuring Spatial Variability in a Commercial Vineyard Using Precision Agriculture Tools

Jessica M. Cortell[1], John Baham[2], Anne Connelly[3], Andrew V. Gallagher[4], Michael D. Halbleib[5], John N. Pinkerton[6], Timothy L. Righetti[3], R. Paul Schreiner[6], Barney T. Watson[1], James A. Kennedy[1,*]

[1]Department of Food Science and Technology, [2]Department of Crop and Soil Science, and [3]Department of Horticulture; Oregon State University, [4]Red Hill Soils, Corvallis, Oregon, [5]Aerial Photography, Corvallis, Oregon

In 2003 and 2004 vigor zones were delineated in two commercial vineyard sites based on vine growth variation to assess fruit and wine phenolic chemistry. In 2004, the effects of shading on the accumulation of phenolic compounds were also investigated. Model extractions were done from the shading experiment and the vigor zones in 2004. Wine and extracts were analyzed by HPLC and spectrophotometry.

Berry weight, dry skin weight, °Brix, pH and anthocyanin content were higher and titratable acidity and the proportion of malvidin-3-O-glucoside was lower in 2003 compared to 2004. High vigor zones had lower °Brix and higher titratable acidity and a trend for lower anthocyanin content per berry in both years. Site A had proportionally higher peonidin and lower malvidin than site B. While there were minimal differences in seed proanthocyanidin, large increases were found in low vigor zones for skin proanthocyanidin, proportion of (-)-epigallocatechin, and pigmented polymer content in fruit. In 2004, the shade treatment had lower accumulation of flavonols, lower skin proanthocyanidin, minimal differences in anthocyanins, a large proportional increase in peonidin glucosides, and proanthocyanidin compositional differences.

The model extractions from the shade experiment paralleled treatment differences in the fruit except that skin proanthocyanidin percent extraction was found to be ~ 17% higher in the exposed treatment. For the vigor zone model extractions, there were no differences in pomace weight. Site A model extracts tended to have a higher anthocyanin concentration and a lower proportion of malvidin-3-O-glucoside than those from site B.

The 2003 wines had a higher anthocyanin concentration and a lower proportion of malvidin-3- O-glucoside than in 2004. The same response was seen in the fruit. The medium vigor zone wines had higher anthocyanin concentrations than either high or low vigor zones. In both years, there were higher proportions of delphinidin and petunidin glucosides in wines made from low vigor zone fruit. Low vigor zone wines had ~ a two-fold increase in pigmented polymer concentration, a large increase in the proportion of skin proanthocyanidin, greater sulfite resistant pigments, higher color density and lower flavan-3-ol monomer concentration. Differences found in the wines magnified variation in the fruit.

Characterization of Tannin Isolated From Red Wine During Maceration

James Kennedy and Patricia Aron, Department of Food Science and Technology, OSU

Tannins are grape-derived compounds that are extracted into the must/wine during maceration and are an important part of red wine quality, providing it with astringency. Anecdotally it is generally accepted that tannins have different sensory properties depending on their origin (skin or seed tissue). It is also generally accepted that differences in wine astringency quality can be traced to the vineyard.

Wine texture is a much broader term than astringency and encompasses not only the sensory properties of tannins, but also that of other wine components and their affect on our perception of tannins. Texture is an important aspect of overall red wine quality, yet our understanding of how to control it is limited due in part to our poor understanding of what precisely wine texture is. It is accepted though that tannins play a central role in wine texture, and again, from a qualitative standpoint, it is thought that the vineyard is an important aspect of this variability.

A considerable amount of work has been directed to the understanding of tannin chemistry in grapes to provide a partial explanation of the observed differences in wine texture. Although temporal differences in tannin composition during the development of grapes have been observed, these changes alone do not explain textural differences perceived in wine. A possible explanation for this may be due to the selective extraction of tannins that occurs during red wine production.

The goals of this project are to understand how the composition of tannins change with respect to variety, apparent quality, and maceration time, and to compare this compositional information with that from grapes. Out of this project, a better understanding of how tannins are “selected” during maceration will be made, and furthermore, information on how these tannins interact with proteins will be determined.

The information from this research will help winemakers to better understand the extent to which tannins play a role in texture and to determine how and what type of tannin molecules should be selected for.

Characterization and Formation of Off-Flavor in Oregon Wine

Michael Qian, Dept. Food Science & Technology, OSU

Most volatile sulfur compounds are undesired in wine due to their low sensory thresholds. However, at low concentrations, sulfur compounds can be positive to contribute a more complex aroma profile. The effects of nitrogen fertilization, tilling and irrigation on contents of volatile sulfur compounds in Pinot noir wines were studied. Wines were made from two field blocks of twelve combinations of irrigation (dry or irrigated), tillage (tilled or not tilled) and fertilization (none, foliar nitrogen supplementation or soil applied nitrogen) from three vintages (1999, 2000 and 2001) of *Vitis vinifera cv*. Pinot noir. The multivariate analysis of variance (MANOVA) results showed that year, irrigation, and nitrogen had significant effects on concentrations of these target sulfur compounds ($p<0.01$). Results performed by analysis of variance (ANOVA) and Principal Components Analysis (PCA) showed that nitrogen fertilization had a major impact on levels of hydrogen sulfide (H_2S) and methanethiol (MeSH). Foliar nitrogen supplementation or soil nitrogen application significantly increased contents of H_2S ($p<0.01$) and MeSH ($p<0.01$) in Pinot noir wines. Dimethyl sulfide (DMS), methionol, methyl thioacetate (MeSOAc), and ethyl thioacetate (EtSOAc) were mainly affected by the vintage years. The results demonstrate that volatile sulfur formation is affected by vineyard practice.

Limiting Reductive Character Formation in Wines from the Pacific Northwest

C.G. Edwards, Department of Food Science and Human Nutrition, WSU,

Cooperators: J.C. Bohlscheid, J.K. Fellman, D. Gore, J. Maloney, C. Ross, and G. Specht

Alternative methods to reduce H_2S formation were studied. Active dry forms of commonly utilized yeast strains have been prepared at a commercial pilot processing plant under newly devised conditions based on the yeast nutritional research performed. These yeasts ("YESO") have been fermented under both laboratory and commercial conditions. Grape musts were inoculated with (a) standard-prepared active dry yeast, (b) standard yeast + nutritional supplement in the form of Fermaid K, or (c) YESO yeasts. Overall, fermentation rates and yeast viability varied between experiments but all completed fermentation. In general, H_2S evolution by YESO yeasts was lower than those ferments with added nutrients. Preliminary sensory analysis indicated that the wines made with the YESO yeast possessed enhanced fresh fruit (cherry, blueberry, and strawberry) and more spicy/black pepper character than the other treatments.

Grape (Table, Wine & Juice) Viticulture Research Priorities 2005-2006

1) A) Evaluation of rootstocks for cold hardiness, vigor, water requirements, effect of edaphic factors, nutritional status, yield parameters, and grape quality attributes.

B) Evaluation of table grape varieties for cold hardiness, vigor, water requirements, effect of edaphic factors, nutritional status, yield parameters, and grape quality attributes

C) Development of integrated/sustainable production systems

D) Effect of viticulture practices (e.g. nutrient management, canopy management, crop load, water management, vegetation management, cover crops) on the quality of table juice and wine grapes

E) Biology and management of powdery mildew, viruses and vectors, spider mites, nematodes, cutworms, mealy bug, leaf hoppers and Asian lady beetle.

2) A) Yield Estimation/Modeling/Yield Prediction

B) Organic production

C) Biology and control of Botrytis bunch rot and sour rot, Thrips, crown gall, weeds, Glassy-winged Sharpshooter, Eutypa fungal disease, and nematodes

D) Evaluation of winegrape varieties and clones

3) A) Phylloxera

B) Biodynamic production

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Wine Processing Research Priorities 2005-2006

1) Effects of vineyard cultural practices, rootstocks and clones on grape and wine quality including nutritional status, fermentation behavior, water management, cover crops, and fruit maturation composition.

Problem Fermentations

- Yeast/bacterial interactions
- Reductive character
- Yeast and bacterial spoilage organisms
- Stuck/sluggish fermentations
- Tannin management in the winery and vineyard

Managing fermentations to optimize wine quality

2) Winery waste management and utilization for value added products

3) Ethyl carbamate

Organic processing

Processing Technology (high pressure, filtration)

*The subheadings under each priority are not presented in any order and simply represent key areas to be investigated.

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Blueberry Research Priorities 2005-2006

1) Establishment of a Northwest breeding program to develop and evaluate adapted cultivars for season extension, disease resistance, mechanical harvesting, and improved fruit characteristics

Improve or extend fresh market (quality or timing) through mechanical harvesting, plant architecture, harvester engineering, post-harvest handling, cultural inputs or changes, physical coverings or chemicals

Better utilization of inputs through improved management of nutrients, irrigation, weeds, soil amendments, integrated soil health and organic production systems

Biology and control of diseases (e.g. SOD, scorch, shock mummyberry, viruses, and fruit rot complex)

Biology and control insect and arthropods e.g. root weevil gall midge, winter moth, and insect contamination

2) Alternative weed control methods including organic production systems

Biology and control of vertebrate, e.g. birds, deer, etc.

Develop added-value products e.g. nutraceutical, controlled atmosphere storage, packaging, and health benefits

Biology and greater understanding of Mycorrhizal Relationships in a production system

Genotyping

3) Investigation of critical pollination issues affecting blueberry production

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Cranberry Research Priorities 2005-2006

1) Weeds
Cranberry girdler
Genotyping – Identity certification benefit research
New cultivar development for fresh fruit production
Keeping quality (storage of fresh fruit)

2) Market expansion through nutraceuticals/health
Pollination/fruit set
Fall Fruit worm
Tipworm
Black vine weevil

3) Dieback
Vine overgrowth
Cottonball
Twig Blight
“Monkey face” – physiologic disorder?

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Strawberry Research Priorities 2005-2006

1) Phytophthora

Aphid borne virus complex

Develop cultivars with processed and fresh market potential, including earlier and later ripening cultivar

Nutritional/Nutraceutical benefits

Alternate production systems for economic efficiency (e.g. harvest efficiency), increased yield and cultivar management

2) Weeds

Development of research programs to define and enhance strawberry quality related to marketability

Symphylans

Root weevil

Fruit rots - botrytis

3) Food safety/sanitation/security

Mites – Twospotted, Cyclamen

Irrigation Management

Powdery Mildew

Value added products

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Blackberry Research Priorities 2005-2006

1) Blackberry rust control - *Phragmidium violaceum*

Breeding cultivars that are summer bearing, thornless, high-yielding, winter hardy, machine harvestable, disease resistant, and that have superior fruit quality

Botrytis control to be done with an emphasis on efficacy work to meet Food Quality Protection Act standards for reduced risk and biorational control

Purple blotch control

New chemistries to address harvest contaminants and other problems stemming from the loss of long-standing insecticides and nematacides, e.g., Raspberry Crown Borer control

2) Develop and improve cultural, chemical and biological practices to improve cold hardiness

Soil ecology effect on plant health and yield

Thorn management and reduction systems

Fruit composition and nutraceutical properties

Dry Cell Syndrome

3) Fresh market – season extension, protection of fruit shelf life

Primocane management/systems approach

Color stability study – post harvest storage and processing

Raspberry Bushy Dwarf Virus in blackberries

Plant nutrition and nitrogen use

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Red/Black Raspberry Research Priorities 2005-2006

1) Develop cultivars that are summer-bearing, high-yielding, winter hardy, machine-harvestable, disease resistant, virus resistant and have superior processed fruit quality

Soil ecology effect on plant health and yield

Virus complex control strategies

Root rot control strategies

New chemistries to address harvest contaminants and other problems stemming from the loss of long standing insecticides and nematodes.

2) Nutraceutical/nutritional benefits for product development

Cane management (including trellising systems and primocanes control)

Fruit rot including pre-harvest, post-harvest and/or shelf-life

Yellow Rust control strategies

Nutrient/irrigation management

3) Season extension: improve viability for fresh marketing, protection of fruit shelf life

Food safety and sanitation from field through processing

Development of technologies leading to value added raspberry products

Weed control

Optimal soil fumigation techniques

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Minor Crops Research Priorities 2005-2006

Lonicera, Bilberry, Schisandra chinensis Baill, Gooseberry, Currants, Hardy Kiwifruit, Lingon Berry, Huckleberry, Chokeberry (Aronia melanocarpa), Elderberry, Sea Buckthorn Berry (Hippophae), Buffalo Berry (Shepherdia)

Note: Priorities ranked "1" (five of them) apply to all minor berry crops; those ranked "2" & "3" are commodity specific.

1) Pesticide tracking, registration and re-registration issues for new up-and-coming crops

Cultivar Development: Germplasm collection, improvement, evaluation, and introduction

Develop a production system (how do we grow these crops?)

New product development/marketing

Nutraceuticals

2) Foliar disease Ribes

Fresh market storage of Hardy Kiwifruit

Investigation of mycorrhizal associations in Huckleberry

Pollination/fruit set Hardy Kiwifruit

3) Quality of Hardy Kiwifruit

Currant fruit fly (also called gooseberry maggot)

Nutrition of Hardy Kiwifruit plants (fertilization)

Irrigation of Hardy Kiwifruit

Phytophthora in Hardy Kiwifruit

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IR-4 Priorities

From Joe DeFrancesco (http://ir4.rutgers.edu/FUW2005.html)

"A" priorities that resulted from the IR-4 Food Use Workshop in September 2005

"A" priority projects will get funded, initiated and completed in the 2006 field season; the residue data collected from these projects will lead to a pesticide registration (barring any unforeseen circumstances). There were no 'A' priorities for grapes or kiwi for the 2006 field season. Currant and gooseberry registrations are generally covered by blueberry residue projects (blueberry data covers the bushberry subgroup, of which currant and gooseberry are a part of).

- Blueberry/V-10116 for mummy berry control
- Blueberry /spirodiclofen (Evindor) for bud mite control
- Blueberry/halosulfuron (Sandea) nutsedge and broadleaf weed control
- Caneberry/oxamyl (Vydate) for nematode control
- Caneberry/E2Y45 for raspberry crown borer control
- Strawberry/oxyfluorfen (Goal) broadleaf and grass weed control

Weed Science Priorities for 2006

"A" Priorities

Blueberry Halosulfuron
Strawberry (Annual) Oxyfluorfen

"B" Priorities

Blueberry Oxyfluorfen
Blueberry Rimsulfuron
Caneberry (Raspberry) Oxyfluorfen
Caneberry (Raspberry) Rimsulfuron

Disease Priorities for 2006

"A" Priorities

Blueberry Spirodiclofen
Blueberry Spirodiclofen

"B" Priorities

Blueberry Spirodiclofen
Blueberry Spirodiclofen

Insect Priorities for 2006

"A" Priorities

Blueberry Spirodiclofen
Blueberry Spirodiclofen

"B" Priorities

Blueberry Spirodiclofen

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Pest Management Strategic Plan
Blueberry Production in Washington and Oregon March 2004

http://pestdata.ncsu.edu/pmsp/index.cfm

Most Critical Pest Management Needs

The following priority areas must be addressed to maintain the long-term viability of the blueberry industry in Oregon and Washington.

RESEARCH

- Identify and develop economically feasible organic pest management alternatives.
- Address bird control.
- Develop prediction models for fruit and cane diseases.
- Determine economic thresholds for nematodes and insect pests.
- Maintain full funding for Extension and research programs at land-grant universities. Recent budgetary cutbacks and personnel layoffs threaten the viability of IPM research.

REGULATORY

- Expedite the full registration of fenbuconazole (Indar) and propiconazole (Orbit) for mummy berry disease control and iodomethane (Midas) for soil fumigation.
- Encourage EPA to allow multiple Section 18 (emergency exemption) registrations for the same pest/crop complex for resistance management.
- Develop a certification program for blueberry diseases and viruses for the entire United States.
- Expedite registration of any insecticide that has the potential to be a replacement for diazinon.
- Continue to allow multiple applications of diazinon.

EDUCATION

- Maintain full funding for Extension and research programs at land-grant universities, as well as personnel and programs at the USDA Northwest Center for Small Fruits Research facility. Recent budgetary cutbacks and personnel layoffs at the university level threaten the viability of IPM implementation and the dispersal of information between publicly funded agencies and the blueberry industry.
- Develop materials, such as pocket guides and CDs, to educate growers about scouting and other IPM tactics in blueberry production.
- Continue to educate growers about the importance of proper timing and application techniques (e.g., adequate coverage) when making a pesticide application.
- Continue to educate growers, via printed material, CDs, or video, about the principles of resistance management and techniques to avoid resistance.

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Pest Management Strategic Plan
Caneberry Production in Washington and Oregon July 2003

http://pestdata.ncsu.edu/pmsp/index.cfm

Summary of the Most Critical Needs

The following priority areas must be addressed in order to maintain the long-term viability of the caneberry industry.

RESEARCH

- Develop methods for control of insect contaminants in machine harvested fields. .
  A unique problem for caneberry growers is the presence of insect contaminants in harvested fruit caused by the mechanical harvesting methods. Vibrating rods move through the plant canopy causing ripe fruit, along with any insects present, to drop on to a conveyer belt. Many of these insects can be removed by mechanical or visual methods, but some species have characteristics that make this very difficult. The method of choice to prevent this contamination has been broad spectrum insecticide application prior to and during harvest.

- Develop and evaluate economic thresholds for incorporation into forecast models that will predict pest occurrence and severity
  Much work remains to be done to help in the decision-making process for pest management control.

- Develop strategies, which may include resistant cultivars, for control of raspberry bushy dwarf virus.
  Bushy dwarf virus is the direct cause of major economic losses for raspberry growers. It causes fruit to become crumbly and unfit for high-end uses. Fields that would normally be productive for ten to twelve years must be removed after four to six years. The virus is vectored by pollinating bees, making control very difficult.

- Identify replacements for diazinon, fenamiphos (Nemacur), methyl bromide, and azinphos-methyl (Guthion).
  After EPA completes its review of these compounds, they may no longer be available for use in caneberries or have a limited use pattern.

- Need insecticides with shorter PHIs and REIs for use as a clean up spray to control insect contaminants just prior to or during harvest

- Develop strategies, which may include resistant cultivars, for control of Phytophthora (root rot)
  Root rot is a major limiting factor in caneberry production, especially in raspberries

- Develop control strategies for perennial weeds.
  Quackgrass, thistle, equisetum, nutsedge, and bindweed are particularly difficult to control with current weed management methods.

- Develop long range investment in new technologies.
  In order to remain economically viable in a global marketplace, it will be necessary to develop practical and realistic long-range goals that include innovative technologies to reduce cost, improve quality and increase yields.

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Pest Management Strategic Plan
Cranberry Production in Washington and Oregon May 2004

http://pestdata.ncsu.edu/pmsp/index.cfm

Cranberry Pest Management Plan Summary

Pesticides

- OP's are critical to the continued production of cranberries in the US:
- Chlorpyrifos and diazinon are the most widely used insecticides in cranberry production
- The only insecticide to control Sparganothis spanworm and cranberry weevil in Massachusetts is chlorpyrifos
- Carbaryl is not as effective as chlorpyrifos or diazinon for some pests
- Phosmet is a new registration and needs further research to determine full spectrum of control.
- Bt. is limited by short persistence, application systems (e.g., by irrigation in MA) and timing considerations
- Cost is an increasingly important consideration in the choice of control due to a precipitous decline in cranberry price. While OP insecticides are favored by this economic climate, the use of "no cost" or low-cost controls, including innovative floods, is also favored

IPM

- IPM practices are currently implemented on 94% of cranberry acres. Programs involve the use of scouting techniques, pheromone traps, economic thresholds, cultural practices such as flooding and sanding, augmentation of predaceous nematode populations, biopesticides and pheromones, and the use of traditional insecticides (procedures have been developed to improve timing of pest controls to coincide with critical stages of the pests life cycle). The extent of use of these tools varies between pest, season and region.

OP's and IPM

- Organophosphate use is an integral part of successful cranberry IPM programs. Few alternatives to OP's exist for the control of most cranberry pests. Tebufenozide and a carbamate (carbaryl) are the only alternatives. Until other chemistries are registered (e.g., spinosad, thiamethoxam and methoxyfenozide), the OP's will continue to play a critical role in cranberry pest control and production.

Alternatives

- The cranberry commodity has invested heavily over recent years (±$225,000; 1996-9), with grower and handler funding, in the identification, field development and registration of new reduced risk alternatives to the OP's and carbamate insecticides currently registered. Some of these products are now registered and available as Section 18's, but grower education must occur to facilitate broad implementation in the near future. Safer products include tebufenozide, spinosad, methoxyfenozide, thiamethoxam, two mating disruption pheromone products (for Sparganothis and Blackheaded fireworm), natural pyrethrins, and synthetic Cryolite bait. These products will be incorporated into existing cranberry IPM programs.

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Pest Management Strategic Plan
Washington State Wine Grape Production May 2004

http://pestdata.ncsu.edu/pmsp/index.cfm

Priority List of Critical Needs

The following priority areas must be addressed in order to maintain the long-term viability of the wine grape industry in Washington. Economic sustainability must be considered with respect to any pest management measure if it is to be viable.

RESEARCH

- Determine virus-vector relationships.
- Refine disease modeling, including powdery mildew and botrytis bunch rot.
- Study cover crop management and IPM impacts on all pests.
- Develop economic thresholds for insects, mites, and nematodes.
- Develop control/management strategies for thrips.
- Research use of green manures/cover crops for management of nematodes and soilborne insects.
- Conduct phylloxera rootstock trials and industry surveys on pest prevalence.

REGULATORY

- Address quarantine issues, including:
    - Phylloxera quarantine, need new surveys (WSDA);
    - Virus quarantines, need new surveys (WSDA);
    - Vine mealybug inclusion in current quarantine description.
- Register flumioxazin (Chateau), zeta-cypermethrin (Mustang Max), lambdacyhalothrin (Warrior), cyprodinil + fludioxynil (Switch).
- Add wound-protectant use against Eutypa dieback to the thiophanate methyl (Topsin) label.
- Expedite “List of 54” review (EPA).
- Increase enforcement efforts at home & garden centers for grapes/ornamentals (WSDA).

EDUCATION

- Develop scouting field guide for all pests, including identification, timing, and links to Web-based information.
- Explain thresholds and how they relate to choice of pest control methods.
- Emphasize importance of certified planting material and proper importation protocols.
- Teach systems approach to pest management.
- Explain use of predictive models for disease management.
- Instruct growers on identifying and reporting off-target herbicide spray drift from other crops onto grapes.
- Emphasize importance of sanitation (equipment, plants, workers, etc.) for prevention of pests in the field.