# Northwest Center for Small Fruits Research

## 2003 Annual Conference

Welcome to the 12th 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 Patrick Gleeson, Executive Director for the American Vineyard Foundation (AVF). His talk will focus on the importance of networking and national dialogue between research organizations.

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# BERRY / GRAPE PROCESSING

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

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

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The goal of this research is to understand how spatial variability within a commercial vineyard influences wine chemistry with an emphasis on phenolics. The specific objectives are to study the relationship between vineyard variability and wine style in order to identify relevant environmental and viticultural aspects related to wine chemistry (Year 1-2). The second objective is to determine the technical feasibility of using Precision Viticulture tools to manage wine style in cool climate vineyards. Precision Viticulture tools include GIS (geographic information systems), GPS (global- positioning systems) and remote sensing techniques. The study is being done in two commercial vineyards where blocks within each vineyard consist of the same clone, rootstock, age, and vineyard management practices. Monitored parameters in the vineyard include soil characteristics (type, depth, nutrients and pH), water relations, vine growth and crop load. Fruit and wine parameters include cluster and berry weights, seed color, number and weight, complete grape composition (pH, TA, sugar, phenolics, nutrient status), wine composition and assessment by the cooperating winery. These measurements were taken on a grid pattern and mapped out according to spatial distribution in the vineyard. Preliminary data on soil profiles, shoot growth, trunk circumference, leaf color, and vine fruitfulness indicate that a significant degree of variability exists within each of the study sites. Spatial maps of vine vigor and percent fruit color (at vèraison) were used to segregate vines into different wine lots. Differences in fruit composition (pH, TA, and Brix) were found at vèraison and harvest for these wine lots. Preliminary data on the wines show differences in yeast assimilable nitrogen content (YANC) and fermentation rates.

## Can *Escherichia coli* and *Salmonellae* Contaminate Harvested Berries and Do They Survive in Fresh and Frozen Berry Juices/Purees?

Mark Daeschel and YanYun Zhao - OSU

Until recently, it was widely accepted that most low pH, high acid foods such as fruit were of minimal concern for food poisoning outbreaks. However, the appearance of acid resistant strains of pathogens in our food supply has prompted a reexamination of how fresh fruits are grown, harvested, stored and processed. This study has thus far generated two important observations. 1) Pathogens such as Salmonella and E. coli can survive for short periods of time if introduced into berry juices or purees.

This would be of greatest concern with fresh products that are destined for immediate consumption. 2 ) Studies to examine the incidence of pathogen contamination in fresh berries have revealed no significant contamination either with freshly harvested berries or berries offered for sale through retail markets.

## Potential New Crops—Composition and Quality

Ronald Wrolstad, Yanyun Zhao, Bob Durst - Food Science and Technology, OSU

The objective of this project is to determine the critical compositional and quality indices for new small fruit crops having commercial potential for the Pacific Northwest. Priorities were given to the following fruits: Blue Honeysuckle (*Lonicera caerulea*), Chokeberries (*Aronia melanocarpa)*, Pacific Northwest native Huckleberries (*Vaccinium ovatum, V. membranaceum, V. ovalifolium,* and *V. deliciosum*), Lingonberries (*Vaccinium vitis-idaea*), Hardy Kiwifruit (*Actinidia arguta*), and native Elderberries (*Sambucus cerulea*, and *S. racemosa*). Anthocyanin pigment, total phenolic and antioxidant measurements were completed for blue honeysuckle fruits and PNW Huckleberries collected in the 2002 season. Analyses of blue honeysuckle, chokeberry, lingonberry, hardy kiwifruit and elderberry samples collected in 2003 are in progress.

## Impact of Blackberry Polyphenolics on Juice Quality

Ronald Wrolstad, Thanyaporn Siriwoharn (GRA), Bob Durst - Food Science & Technology, OSU

Funding: NCSFR (final year)

The anthocyanin pigment, polyphenolic composition, and antioxidant properties (as measured by ORAC and FRAP) have been determined for 11 blackberry selections, and for three maturity levels of Marion and Evergreen blackberries. While anthocyanin pigment content increases markedly with ripening, total phenolics do not. Antioxidant properties increase but not in proportion to anthocyanins. Ellagitannins have been identified in blackberry seeds and juice. The sediment in a commercial blackberry juice concentrate sample has been identified as ellagic acid. It is believed that ellagic acid is formed during storage by hydrolysis of the more water-soluble ellagitannins.

## Enhancement of Storability and Nutritional Values of Strawberries (*Fragaria ananassa*) by Nutraceutical Integrated Edible Coatings

Yanyun Zhao - Dept. of Food Science and Technology, OSU

Sensory quality of chitosan-coated strawberries (*Fragaria ananassa*) immediately after coating and during 3-weeks of storage at 2.0oC and 89% RH were determined though the use of both consumer panel and free-choice profiling trained panel. Three chitosan coatings were evaluated, including acetic acid dissolved chitosan, lactic acid dissolved chitosan, and lactic acid dissolved chitosan containing vitamin E. Fresh, uncoated strawberries were used as a control. Results from both consumer and trained panel studies showed that chitosan-based coatings didn't change the flavor, sweetness, and firmness of the strawberries in comparison with uncoated fruits. Lactic and acetic acid dissolved chitosan coatings increased the appearance acceptance and the overall liking of the strawberries, and vitamin E fortified coatings improved the attribute of overall strawberry flavor compared to other treatments at the same storage time. Chitosan coating extended the shelf-life of fresh strawberries to 3 weeks in the cold storage, while uncoated ones can only last for 1-week as a results of molds growth and loss of surface appearance.

## Factors Influencing Shelf-Life and Flavor Quality Retention in Fresh Raspberries

John Fellman, D.S. Mattinson, C. Edwards, Todd Edgington - WSU-Pullman

Cooperator: P. Moore - WSU-Puyallup

Funding: NCSFR

A relatively short extension of shelf life and dessert quality could allow shipment of fresh raspberries by surface means instead of air freight, as marketing of fresh raspberries is hindered by their brief shelf-life, manifested by high respiration and transpiration rates, morphological features that predispose them to crushing, and susceptibility to grey mold rot. In addition, fresh raspberries provide substantially larger returns to the producer compared to those grown for the processing market. Our overall objective is to not only extend the marketable shelf-life of fresh raspberries by using modified atmosphere packaging in conjunction with antifungal treatments, but to preserve as much just-picked quality as possible. In most highly-perishable fruit crops, color and texture preservation is less challenging than flavor retention, hence we are now concentration on these aspects of Postharvest preservation. Progress since our initial experiments revealed a mixture of biological control organisms to be very effective in controlling postharvest *Botrytis* infections. Raspberries were harvested and placed under the following atmospheres: Severe modification (8 - 12 % $O_2$ 3-5% $CO_2$) and No modification at 0,5,15 and 25°C. Antifungal treatments were: No treatment; Lactic acid bacteria/ *Cryptococcus* sp. (a patented low-temperature biocontrol organism); Lactic acid bacteria or *Cryptococcus* alone. At 0, 4 or 8 days, fresh raspberries were removed from storage & analyzed for % salable berries, color, titratable acidity, moisture, pH, and flavor volatile content. The biocontrol organism mixture was effective at all holding temperatures although 15 and 25°C modified atmosphere treatments produced off flavors, attributable to high levels of ethanol. Biocontrol treatments had little to no affect on dessert quality, but berries held at higher temperatures lost more weight than controls. Modified atmosphere-stored berries retained more flavor, and had brighter color, higher moisture content, and more acidity compared to control treatments. Use of a proprietary clay product to control free moisture seemed to "scalp" aroma compounds from stored berries. Temperature studies demonstrated the risk associated with use of modified atmosphere packaging under temperature abuse situations. Lower constant temperature maintained higher quality berries whereas temperature abuse and high constant temperatures decreased raspberry shelf-life and dessert quality (flavor) rendering the berries unmarketable. Studies show that the proper combination of modified atmosphere, temperature and biocontrol makes it possible to extend the shelf-life and dessert quality of fresh red raspberries.

# GENETICS

## Objective Characterization of 'Marion' Blackberry Flavor and Comparison with Thornless Advanced Selections

Michael Qian

Cooperator: Chad Finn

This study is to develop objective measurements of blackberry flavor to assist USDA-ARS breeding program, particularly in request to develop thornless, winter-hardy cultivars with "Marion" or superior flavor. The goal of this year is to determine the chemical composition of "Marionberry" and compare with thornless advanced selections, and correlate the chemical composition with sensory attributes.

'Marion' and 'Thornless Evergreen' blackberry aromas were analyzed with dynamic headspace-GC/Osme (published on *J. Food Sci.* **2003**, *68*, 697-700) and aroma extract dilution analysis (published on *J. Agric. Food Chem.* **2003,** 51,3436-3441). Eighty-four compounds were identified; seventy-seven were in 'Marion', and sixty-

eight in 'Thornless Evergreen'. Fourteen volatiles out of eighty-four were described with aroma descriptors specific to bramble fruit (berry, blackberry, bramble, raspberry).

The volatile composition of Marion and other 17 blackberry cultivars (among them, 11 were advanced thornless selections) were determined by GC and GC/MS analysis. A total of one hundred and eight volatile compounds were identified, including alcohols, terpenes, aldehydes, esters, ketones, phenols, allo-ocimene, theaspiranes A and B. The quantitative data show that for the different blackberry cultivars, the volatile profiles differ in volatile proportions rather than the chemical classes and numbers. Sugar and acids were also analyzed for all of the cultivars. Fruits from 2003 growing season have been collected, sensory and chemical comparison with Marionberry is underway.

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

Michael Qian - Department of Food Science and Technology, OSU

Cooperator: Robert Martin - USDA-ARS HCRL

Several transgenic raspberry lines with good resistance to RBDV have been developed. Fruits from five transgenic plants were collected in the summer of 2003. In addition, wild type Meeker fruits were collected from both Oregon and Washington states. The initial sensory evaluation shown there were major flavor differences among these transgenic fruits. Initial research is to isolate, identify, and compare the volatiles of these transgenic 'Meeker' red raspberries to that of 'Meeker' cultivars from Oregon and Washington states. Solvent extracted red raspberry volatiles were analyzed with gas chromatography-mass-spectrometry (GC-MS) technique. Seventy-six compounds were identified by mass spectral data, and were common to all seven cultivars. Quantification of the compounds was made by comparing each compound's peak area to the peak area of an internal standard (ethyl undecanoate). The majority of the compounds have been previously reported in red raspberry. Generally, there is little variation in compound concentrations between the cultivars studied. However, several trends were noticed. The Washington 'Meeker' appears to have atypical amounts of hexanal, *t*-3-hexenoic acid, and d-decalactone compared to the other samples. The wild Oregon fruit appears to have less vanillin, while transgenic 2174BS9-7 has a large amount of d-decalactone. Transgenic 2172BJ has a large amount of a-pinene, but no detectible amount of the raspberry ketone (4(*p*-hydroxyphenyl)-2-butanone). Finally, transgenic 2174BH5-6 appears to have larger amounts of hexanal and acetic acid than the other samples. The next phase of research will utilize GC/O to refine this data, confirm the major odor active compounds in each cultivar, and refine their concentrations through mass spectral selected ion monitoring.

## Edible-Fruited Blue Honeysuckle (Lonicera caerulea L.): Germplasm Evaluation and Cultivar Development

Maxine Thompson - OSU and Danny L. Barney - ISU

Each year new seed-lots are sown in spring and a few thousand seedlings are transplanted to field plots in September. After 4 year's observations, it has been concluded that, although the Russian subspecies are poorly adapted, the Japanese and Kurile Island sources are well adapted to western Oregon conditions. At first, open-pollinated seeds of selections from these sources were grown. Next, a second generation of open-pollinated seeds from local selections were planted. Finally, because superior selections have been identified to use as parents, this year all seeds were produced from controlled pollinations. Parents were chosen for high yield potential, large fruit size, attractive, tasty fruits, and upright growth habit.

Annually, all progenies are evaluated for plant vigor, growth habit, dates of phenological phases, flower density, estimated yield, crop weight, and berry traits such as size, shape, appearance, and taste. This year

berry samples were collected for chemical analyses; for 10 samples, anthocyanins, total phenolics, antioxidant capacity, and vitamin C, and for an additional 150 samples soluble solids and adidity only will be evaluated. Comparable plants of selected seed lots are being planted in both Corvallis, OR and Sandpoint, ID in order to compare plant performance in 2 distinctly different environments. Several outstanding selections of Japanese origin were propagated by softwood cuttings this year, and several more identified for propagation next year. These are being placed in advanced trial plots and will be considered as parents or possible cultivars.

## Identifying Winter Tolerant Thornless Blackberry Selections and Cultivars

Derek Peacock, Research and Development Manager - Enfield Farms, Lynden; Chad Finn, Res. Geneticist - USDA-ARS; Mary Peterson, Res. Assistant -USDA-ARS

'Marion' blackberry's lack of winter tolerance and its thorniness are consistently cited as two of the major problems facing the Northwest's trailing blackberry industry. The USDA-ARS breeding program needs to have a method to identify selections and breeding material that are more winter tolerant if they are going to make progress towards developing winter hardy cultivars. Waiting for a test winter and artificial freezing runs are two approaches to identification of tolerant plants, but they feel at this point in time that these are unsatisfactory approaches. Placing the genotypes in an environment such as northern Washington where they are more likely going to receive a test winter in a commercial setting should help address several challenges. The objectives of this work are to identify winter tolerant, primarily thornless trailing blackberry genotypes in the USDA-ARS breeding program and to determine whether these thornless selections are machine harvestable.

Thirty-four 2001 planted USDA blackberry selections and standards and forty-seven 2002 planted USDA blackberry selections were trained up in August 2002 to maximize exposure to winter temperatures, and were evaluated for bud break spring 2003. Unfortunately, we had another mild winter. Lows only got down to the low 20's on occasion and sometimes were accompanied by high winds (20-35 mph), but no significant cold injury was noted in any of the germplasm. Machine harvestability and machine harvest yield potential was also thoroughly examined. Some new selections, including ORUS1324-1 and NZ9373-1, had yields almost twice that of the standard 'Marion' with yields reaching over 10 tons / acre. Most selections were rated as acceptable for machine harvestability, but some were poor and had problems including a fairly high pedicel count (poor release), too many red berries (especially at the tip), and hard to remove berries (left on bush after several attempts). In continuation of this project, an additional 33 USDA blackberry selections and 2 standards were planted this spring 2003 and will be evaluated next year for both winter hardiness and machine harvest potential. The previous 81 USDA selections will be trained up for one last exposure to the northern winter climate in hopes of having a brutal winter and then the most promising selections will undergo yet another year of extensive machine harvestability and yield trials.

## Domestication of Western Huckleberries

Danny Barney, Professor - University of Idaho, Department of Plant, Soil & Entomological Sciences

Germplasm representing nine huckleberry, bilberry, and blueberry species in genus *Vaccinium* has been collected from throughout the western and northwestern United States and Alaska. Additional related germplasm has been obtained from northern Asia and Europe. Germplasm evaluations have resulted in the selection of 20 black huckleberry (*V. membranaceum*), 12 oval-leaf blueberry (*V. ovalifolium*), and one bilberry (*V. myrtillus*) prospective cultivars. Breeding for cultivar development is underway for Cascade huckleberry (*V. deliciosum*), black huckleberry, and oval-leaf blueberry, including reciprocal crosses with highbush, lowbush, and half-high blueberries. Methodologies for seed and *in vitro* propagation have been developed and are being refined. Trials to determine acceptable soil types and shading requirements for commercial production are underway, as are efforts to develop models for commercial cultivation in fields and managed production in naturally-occurring,

forest stands of black and Cascade huckleberries and oval-leaf blueberry. Flavor biochemical profiles have been determined for black and Cascade huckleberries, oval-leaf blueberry, and highbush blueberry (*V. corymbosum*). Anthocyanin and antioxidant biochemical profiles have been determined for these four species, plus alpine bilberry (*V. uliginosum*), red huckleberry (*V. parvifolium*), evergreen huckleberry (*V. ovatum*), small cranberry (*V. oxycoccus*), and half-high blueberries (*V. corymbosum* x *V. angustifolium*).

## Fruit and Seed Production Following Intra- and Intersectional Cross-Pollination and Self-Pollination using *Vaccinium* Section *Cyanococcus* and Section *Myrtillus* species

Danny Barney, Professor - University of Idaho, Department of Plant, Soil & Entomological Sciences

The objective of this phase of the project, *Domestication of Western Huckleberries*, is to develop intra- and interspecific progeny using *Vaccinium* section *Myrtillus* species Cascade huckleberry (*V. deliciosum*), black huckleberry (*V. membranaceum*), and oval-leaf blueberry (*V. ovalifolium*), as well as interspecific hybrids between these species and section *Cyanococcus* highbush (*V. corymbosum*), lowbush (*V. angustifolium*), and half-high (*V. corymbosum* x *V. angustifolium*) blueberries. In crosses with *V. membranaceum*, section *Cyanococcus* species set no fruits when used as seed parents. Conversely, *V. membranaceum* set and ripened fruits in more than half the crosses where *Cyanococcus* species served as pollen donors. *Vaccinium ovalifolium* set no fruit when used as a seed parent in interspecific crosses, regardless of the pollen donor. When *V. ovalifolium* was used as a pollen donor, however, 80% of crosses with 'Bluecrop' and 40% of crosses with 'Jersey' produced ripe fruits. When pollinated by *V. ovalifolium*, *V. membranaceum* set few fruits. Self-fruitfulness varied according to genotype in *V. membranaceum*, ranging from 0 to 33%. *Vaccinium ovalifolium* genotypes failed to set fruit when self-pollinated during both 2002 and 2003. The number of seeds per berry was low for all interspecific crosses and self-pollinations. These results provide a baseline of information for breeders attempting to create intra- and intersectional hybrids with black huckleberry and oval-leaf blueberry. Backcrossing to an original black huckleberry or oval-leaf blueberry genotype may be problematical due to low self-fruitfulness and viable seed production.

## Identifying Blueberry Diversity Using DNA Fingerprints

Peter Boches[1], K. Hummer[1], J. Rowland[2], and N. Bassil[1]

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A new type of blueberry DNA markers can now be used to verify the identity of blueberries. Our program used DNA sequences of gene ends found in blueberry flower buds to detect sequence repeats that are 1 to 6 units long. The number of repeated units changes greatly between different blueberries, forming a microsatellite or simple sequence repeat (SSR) marker. We initially checked for size variation in twelve samples of wild blueberry relatives and species using thirty of these microsatellite sequences. Five sequences exhibited length variation and resulted in a clear distinction between the twelve types of wild blueberry. We used these five SSR markers to differentiate between 72 blueberry types that included: 6 wild *V. corymbosum,* 13 historically important cultivars of known pedigree, 17 economically important cultivars (northern highbush, southern highbush, rabbiteye, and lowbush), 22 representatives of 20 *Vaccinium* species, as well as parents and 13 individuals from a segregating population named 'ORUS 49'. These microsatellite markers were able to distinguish between all 72 varieties, and the fingerprint of each variety reflected its origin. The success of these markers in generating unique fingerprints for each variety indicates that they will be useful in determining diversity and in verifying identity of many modern cultivars.

## Reaction of Red Raspberry Genotypes to Phytophthora Root Rot

Peter R. Bristow, Associate Plant Pathologist and Patrick P. Moore, Horticulturist - WSU

The objectives are 1) to evaluate the reaction of cultivars and advanced selections to root rot caused by the fungus *Phytophthora fragariae* var. *rubi* under field and greenhouse conditions and 2) vary the density of inoculum used in greenhouse tests to see if it is possible to get better agreement between field and greenhouse evaluation methods. Two field plantings were established in 2003 (WSU-Puyallup and WSU-Vancouver) in soils naturally infested with the root rot fungus Phytophthora fragariae var. rubi. Plants of 15 cultivars and advanced selections were included in each replicated plantings. Plants were set on flat beds (not on raised beds) to encourage disease development. Cane growth will be evaluated at the end of the first growing season. During the second and third growing seasons disease incidence and severity data will be taken. Primocanes and fruiting canes will be evaluated separately. Canes will be trained to the trellis but plots will not be harvested for yield. In greenhouse experiments small tissue culture propagated plants of each cultivar and selection will be inoculated by injecting a suspension of the fungus into the soil around the roots. Inoculated and control plants will be held at 68 °F or slightly cooler and soil moisture will be kept high to favor disease development. Plants will be monitored for several weeks and the onset of symptoms recorded. At the end of the experiment, soil will be washed from the roots, the roots scored for damage and then dried and weighed. The aboveground portion of the plants will also be dried and weighed. In each green house experiment, a range of inoculum concentrations will be compared to achieve different levels of disease pressure.

## Propagation of WSU Strawberry and Raspberry Selections for Testing

Patrick P. Moore, Scientist - WSU, Puyallup Research and Extension Center

Cooperator: Robert R. Martin, Virologist - USDA-ARS

Project Initiated: Fall 2003

In 2002-2003, strawberry selections were micropropagated at WSU Puyallup, transferred to Bob Martin's (USDA-ARS, Corvallis, OR) laboratory where they were heat-treated and meristemmed for virus elimination, then returned to WSU Puyallup where they were multiplied in tissue culture and planted at WSU Puyallup.

All strawberry selections made in 2002 have been propagated at WSU Puyallup Research and Extension Center and transferred to Bob Martin's (USDA-ARS, Corvallis, OR) laboratory where they have been or will be heat-treated and meristemmed. Thirty-three WSU strawberry selections were planted in replicated yield plots at WSU Puyallup in spring 2003. In the past three years, 67 WSU strawberry selections have been propagated, heat-treated, meristemmed and planted in field plots. Sixty strawberry selections have been made in the seedling planting in 2003 and are being tissue culture propagated. Runners have been collected from selections that did not establish in tissue culture and will be grown in the greenhouse and runner tips collected and plants established in tissue culture.

Fifty-three WSU raspberry selections were tissue culture propagated and planted in the field in 2003. Selections that did not have enough plants for field planting in 2003 are being tissue culture propagated and should be ready for field planting in 2004. In 2003, 82 raspberry selections were made in the 2000 and 2001 seedling fields, and will be tissue culture propagated for field plantings. In the past three years, 157 raspberry selections have been propagated and planted in field plots.

# PEST MANAGEMENT

## Determining the Feasibility of Controlling the Raspberry Crown Borer with Entomopathogenic Nematodes

Roger Williams and Dan Fickle, Dept. of Entomology - Ohio Agricultural Research and Development Center, Ohio State University

The raspberry crown borer (RCB) is a serious pest of cane berries throughout North America. The larval stage of this pest destroys fruiting canes and increases the plants susceptibility to disease and other non-beneficial organisms. Control of this pest is difficult since it spends most of its life feeding within the crown of the plant. Pesticides primarily organophosphates have been the primary means of controlling this pest. However, the EPA has recently banned organophosphates on brambles in the Eastern US leaving growers with few alternative methods of control for this pest. This report covers preliminary research into determining the feasibility of utilizing parasitic nematodes as a means of controlling the raspberry crown borer.

The susceptibility of raspberry crown borer larvae to five species/strains of parasitic nematodes was evaluated in a laboratory bioassay. Species/strains included *Heterorhabditis zealandica*, *H. bacteriophora* (GPS11 strain), *H. indica*, *Steinernema carpocapsae*, and S. feltiae. All species/strains of nematodes tested produced a high rate of infectivity with *H. zealandica* and *H. bacteriophora* (GPS11 strain) producing the highest rate at 100%. Larval mortality within treatments ranged from 20% to 100%.

## Sudden Oak Death in Cultivated Blueberries and Cranberries: Evaluating the Potential for Disease, Detection, and Control

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*Phytophthora ramorum,* cause of sudden oak death and ramorum foliar blight in California, Oregon, and Europe, has a broad range of natural hosts, including *Vaccinium ovatum* (evergreen huckleberry). We are using a detached leaf assay and whole plant assays to screen *Vaccinium* species and multiple cultivars of blueberry and cranberry for resistance to this new pathogen. Over 75 *Vaccinium* accessions from the National Clonal Germplasm Repository have been tested to date in detached leaf assays. A wide range of disease phenotypes within the genus has been observed, from highly susceptible to highly resistant. *Vaccinium corymbosum* cultivars also differ in susceptibility. Detached leaf and whole plant inoculations on *V. macrocarpon* cultivars Stevens, Early Black, and Ben Lear indicate that cranberry is highly resistant to this pathogen. In 2003, *P. ramorum* was inadvertently introduced into Portland-area nurseries on rhododendrons. The isolates were discovered to be of the European genotype, with a different mating type (A1) than what was previously present in N. America (A2 mating type). In addition to the possibility of sexual reproduction between the compatible mating types, differences in pathogen fitness are being explored. In whole plant inoculations with *V. ovatum*, we compared the virulence of three nursery isolates (European genotype, A1 mating type) to three forest isolates (N. American genotype, A2 mating type). The nursery isolates were more virulent than the forest isolates. Both nursery and forest isolates are now being used in the resistance screening assays. We have also initiated tests to compare disease management strategies for *P. ramorum*. Eight fungicides have been tested on *V. ovatum*: Truban, Aliette, Subdue Maxx, fenamidone, Stature, Biophos, Fosphite, and 545 Ranman. Preliminary results suggest that Subdue Maxx, fenamidone, and Stature provide the most effective disease control under our conditions.

## The Interactions of Irrigation, Fertilization, and Soil on the Expression of Symptoms and Damage in Winegrape Infested with Grape Phylloxera (*Daktulosphaira vitifoliae* [Fitch])

James Fisher, Research Entomologist - USDA/ARS/PWA HCRL; Courtesy Professor of Horticulture – OSU; Rebecca Chitkowski, Graduate Research Assistant, Entomology Graduate Program, Department of Horticulture - OSU

This project was/is designed as a three-year study on the effect of irrigation and fertilization under different soils. In year one, this year, funding was not available until June 2003, Between June and the submission of this report, Oct. 17, 2003 we established a field site in Corvallis, OR, obtained plants and soil, and pot supplies, designed a pot in pot system for the field, and set up irrigation equipment. Likewise, we have just established plants in the greenhouse, set up a drip irrigation system for them and have infested the plants. Thus, both field and greenhouse experimental designs have been completed and first year measurements (all items for greenhouse and insect data for field) will be taken. The modified experimental design, will provide good insight into the effects of phylloxera on plant health and the effect of vigor and irrigation on phylloxera numbers over a three-year period. We have exhausted the funds for the project as most was committed before we received the funding.

## Effects of Supra-Optimal Temperatures on Infection and Sporulation of Grape Powdery Mildew

Walter Mahaffee - USDA-ARS and Gary Grove - WSU, Irrigated Ag. Research & Extension Center

Since this is a new project and funding was uncertain, no action was taken until we were notified that we would receive funding. Due to the delay in notice of funding (May 6, 2003 receive May 26, 2003 ) the prime opportunity for recruiting a graduate student to work on this project was missed. We have not been successful in recruiting a student to date, thus we have made arrangements to pay for part of a Post-doc to work on this project until a suitable graduate student can be found. The Post-doc will begin working on the project November 1, 2003. All supplies, growth chambers, and plant material have been obtained for this project.

## Differentiation and Detection of Blueberry Scorch Strains

Robert Martin - USDA-ARS HCRL

Blueberry scorch virus (BlScV) was first identified in Oregon and Washington in 1987. At that time a survey of blueberry fields in Oregon, Washington and British Columbia was carried out and the virus was only found in 5 fields in OR and WA and was not found in B.C. BlScV was not observed in B.C. until 2000 and since that time has been detected in more than 100 blueberry fields on the B.C. side of the Fraser Valley. Based on symptoms it appears that the strain of the virus most prevalent in B.C. is similar to that observed in New Jersey rather than that observed in OR/WA. In a survey carried out in OR and WA in 2000-2002 there was no evidence of the "New Jersey" strain of BlScV in these states. Also, there were no new fields of BlSV in OR and WA in this survey from what was observed in 1988 suggesting that the movement of BlSV is quite slow in OR/WA compared to what has been seen in B.C. and recently reported in New Jersey. The purpose of this project is to sequence 'Northwest' strains of BlScV and coordinate this with a project to sequence severe strains in B.C. An additional goal is to understand the differences in the rates of spread in B.C. compared to OR/WA and use this information to improve control and prevention of the more aggressive strain into OR/WA. Primers have been designed to give complete coverage of the genome of BlScV in short fragments that can be sequenced in a single run without

cloning. Also, alternate hosts are being tested for the presence of BlScV that may explain the dramatic epidemic in B.C. and the relative slow or non-movement of the virus in OR/WA. Cranberry has been identified as host of BlScV and approximately 25% of the genome of BlScV isolates from blueberry and cranberry have been sequenced.

## Detection and Epidemiology of Tomato Ringspot Virus and *Xiphinema americanum* in Red Raspberry

Kraus, J. Pinkerton, J. N. and Martin, R. R. - USDA-ARS HCRL

*Xiphinema americanum* is the nematode vector for *Tomato ringspot virus* (ToRSV). In a raspberry field monitored for four years, *X. americanum* population densities were the highest in early winter, declined to very low levels in the summer, and increased in early fall. The age structure of the *Xiphinema* populations stayed fairly constant through the year. Soil samples from this study site were planted with cucumber seedlings as bait plants in a controlled environment. After 6 weeks, the plants were tested for ToRSV with an Enzyme-Linked Immunoadsorbent Assay (ELISA). Soil collected in November, December and January did not transmit ToRSV to cucumber assay plants, while soil collected in spring and summer transmitted ToRSV. This shows that *X. americanum* can be damaging at very low population levels. Raspberry plants grafted with ToRSV infected scions, or planted in ToRSV carrying soils had the highest rates of systemic movement in the summer, whereas in the winter, virus levels in some plant parts decreased to below detection. This suggests seasonal variation of virus concentration in plant tissues. This could explain the high transmission rates by low densities of nematodes in the summer. A Reverse-Transcriptase Polymerase Chain Reaction (RT-PCR) assay has been developed for ToRSV in both plant tissues and nematodes. This assay will be used to quantify ToRSV in nematodes and plant tissues in the next year of this study.

## Soil Solarization as a Component of an Integrated Program to Control Phytophthora Root Rot of Red Raspberry

Peter Bristow - WSU, Puyallup and Jack Pinkerton - USDA-ARS, HCRL

The objective is to evaluate soil solarization alone and in combination with raised beds and gypsum soil amendment in an integrated plan for controlling raspberry root rot. Soil at the test site is naturally infested with *Phytophthora fragariae* var. *rubi.* Six treatments were initiated in mid summer 2000: 1) flat bed, no solarization (untreated check), 2) raised bed, no solarization, 3) flat bed, solarization, 4) raised bed, solarization, 5) raised bed, gypsum incorporated (into the soil at the rate of 6 tons/A), and 6) raised bed, gypsum incorporated, solarization. Gypsum was added and raised beds were formed prior to solarization. Plots to be solarized were covered with clear polyethylene tarps from late July 2000 through just before planting in May 2001. Tissue culture propagated plants of the root rot susceptible varieties Malahat and Willamette were planted. In fall 2002 the most vigorous primocanes (up to 12 per plant) were tied to the trellis for harvesting in 2003. Only plots with solarized soil on raised beds had adequate numbers of primocanes. In spring 2003, a higher proportion of fruiting canes survived in plots with raised beds and solarized soil. For Malahat the only treatment to significantly increase yield included solarized soil with gypsum on raised beds. Numerically, the yield for Willamette plants in solarized soil on raise beds were the highest, but differences were not significant. The results indicate that the benefits of solarization last for about two years.

## Biological Control of Spider Mites in Washington Viticulture

David James - Irrigated Agriculture Research and Extension Center, WSU

Sampling sites for spider mites and natural enemies were established in June 2001 at a number of conventional, low-input and abandoned vineyards in south central Washington. These sites were visited monthly from June until September in 2001 and 2002 for leaf and vacuum sampling of arthropods. Samples were examined in the laboratory and mites and natural enemies of mites were identified and recorded. Impacts of fungicides on natural enemies of mites were evaluated in 2003 in two field experiments

Results to date indicate spider mite populations overall were generally small in most vineyards. However, they were larger in vineyards using fungicides alone or fungicides and insecticides, than in unsprayed or abandoned vineyards. Predatory mite (Phytoseiidae) populations were larger in unsprayed vineyards than in sprayed vineyards. A correlation between an increasing number of applications of sulfur and increased populations of spider mites was observed. Spider mite populations in 2002 peaked in August (4/leaf, mean of all sites), but rarely reached damaging levels, except at a few sites that used insecticides. Non-phytoseiid predators of spider mites were more diverse and common on unsprayed than on sprayed vines.

## Biology and Management of Cutworms in Washington Vineyards

David James - Irrigated Agriculture Research and Extension Center, WSU

The identity of cutworm species and their natural enemies in vineyards in the Yakima Valley was studied using a variety of sampling techniques including attractant-baited traps for adults and pitfall traps for larvae. Timed searches and collection of larvae/beneficials from vineyards with differing ground covers were also conducted.

A number of cutworm species were found to be present in vineyards and their identities are currently being resolved. Larvae damaging grapevine buds were found to represent a number of genera including *Abagrotis* and *Euxoa.* Most damage appeared to occur in vineyards with little ground cover or ground cover dominated by grasses. Vineyards with a moderate-high density of broad-leaved weeds tended to have minimal damage despite sometimes large numbers of cutworms.

## Cranberry Pest Management

Kim Patten[1], Associate Horticulturist and Peter Bristow[2], Associate Plant Pathologist - WSU, Long Beach[1] and Puyallup[2]

Field trials on commercial beds were carried out to test the efficacy of “reduced risk” insecticides, herbicides and fungicides. Diluted vinegar (1.4 to 2% acetic acid) applied as a soil drench at rate of 10 to 13 l/$m^2$ just prior to bud break (mid- to late April) resulted in excellent control of False Lily-of-the-Valley (*Maianthemum dilatatum*). Earlier timings or lower rates were not successful. Crop damage was minor, especially if irrigation to wash the vinegar off cranberry leaves immediately followed an application. Mesotrione (Callisto) controlled most annual broadleaf cranberry weed species at the 0.28 kg a.i./ha rate, while perennial broadleaf species required at least two 0.28 kg a.i./ha applications. No crop damage, yield reduction or tissue bleaching was observed on new or established plantings at 0.56 kg a.i./ha. Admire applied on peat beds on 3/22/02 at 16 oz/ac reduced Blackvine Weevil larvae populations from 42/$m^2$ to 3.3/$m^2$. Results confirmed previous year’s findings. Imidacloprid and thiamethoxam failed to control Cranberry Girdler. Indar and Abound were effective in reducing the incidence of fruit rots (both at harvest and after several weeks of refrigerated storage. Reducing the anticipated label rates

for these two reduced risk fungicides did not significantly lower performance. Both fungicides were as effective in controlling twig blight as the standard sequence of two Bravo applications followed by one of Dithane DF. Fall fruitworm fruit storage pest, *Lotisma trigonana*, was best controlled by multiple applications of an insecticide throughout the summer.

## Epidemiology and Management of Plant-Parasitic Nematodes in Winegrapes

Ekaterini Riga, Nematologist - WSU, IAREC; Jack Pinkerton - USDA-ARS, Horticultural Research Lab

A field experiment was established in May 2002 in a vineyard, WA that was replanted in nematode infested soil after the 1996 freeze. Vines were slow to establish and soil tests revealed populations of six different plant-parasitic nematode genera, with root-knot nematode densities very high. Therefore a study was conducted to control plant parasitic nematodes. Five-vine plots were arranged in a randomized block design with five replicates. Treatments, rates, and application timing are listed in the proposal: (Nemacur at 2 gal/acre; Vydate at 1 gal/acre; Oxycom at 1.5ml/emmiter; Enzone at 800 ppm; Ditera at 1.78 lb/acre; and Control). Nematicide applications were made via cups suspended under drip emitters or via buckets draining under emitters. Nematode population data were collected in April, August, and after harvest. Plant response was evaluated by fruit and pruning. Nematicides will be applied and data collected for two or more years. Distributions of nematodes were highly variable in the vineyard which resulted in non-significant treatment differences. Population densities of dagger and ring nematodes were particularly variable. However, several trends were evident:

1) Root-knot nematode population densities were lowest in Nemacur and Vydate plots after harvest and below pre-treatment population densities in April.

2) Dagger nematode densities were lowest in Nemacur, Vydate, and Enzone plots after harvest but only below pre-treatment population densities in Nemacur plots.

3) There were no significant differences between grape yields from different treatments. Only root-knot nematode densities were negatively correlated with yield ($P$ = 0.006, R2 = 0.28).

**Conclusion:** Although several nematicide treatments reduced nematode population densities, yields did not differ between treatments. However, perennials do not respond to nematicides the first year of application. Treatments will be applied for two more years, and plant growth and yield will be monitored.

| | Nematode genus | | | | | |
|---|---|---|---|---|---|---|
| | Root-knot | | | Dagger | | |
| Treatment | # 250/g soil[y] | | % change[x] | #250/g soil | % change | yield (kg/plot) |
| Nemacur | 194 a | | 56 a | 28 a | 58 a | 92 a |
| Vydate | 118 a | | 64 a | 20 a | 839 a | 63 a |
| Oxycom | 514 a | | 676 ab | 190 b | 1320 b | 53 a |
| Enzone | 6 76 a | | 676 ab | 36 a | 460 a | 76 a |
| Control | 488 a | | 1256 b | 84 a | 433 a | 68 a |

[x]Percent difference between population densities in soil sampled in April 2002 before nematicide application and after harvest in November 2002: ((November density/April density)x 100)

[y]Numbers in columns followed by different letters are significantly different ($P$= 0.05) according to Fishers LSD procedure.

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

Lynell Tanigoshi - WSU

Root weevils are on of the primary insect pests on strawberries and raspberries in the Pacific Northwest. Annually, thousand of acres of these berries are chemically treated to prevent either actual plant damage by root weevil larvae as in strawberries, clay-colored weevil in red raspberries or to prevent harvest contamination by root weevil adults in red raspberries. Grower understanding of the seasonal phenology of the black vine weevil, *Otiorhynchus sulcatus*, has resulted in excellent statewide reduction of their population levels and economic management of adults below economic standards in red raspberry and strawberry for the most part. However, regional research and our understanding about aspects of life history, seasonal occurrence, reproductive potential, population dynamics and insecticide efficacy for the 'other' root weevil species is less understood. Furthermore, our field observations suggest that controls and biological understanding of the black vine weevil does not necessarily translate across to these other species. However, EPA/IR-4 protocols for chemical registrations have created a strong reason to intensify our efforts to evaluate new chemistries, particularly the reduced risk and OP alternative insecticides for which EPA has expedited registration guidelines to replace our preharvest contaminant and postharvest cleanup treatments with Brigade/Capture.

# PRODUCTION / PHYSIOLOGY

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

Diane Kaufman, District Extension Agent - OSU, NWREC

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

Progress: The experiment was originally designed with the intention of conducting it in an established planting at NWREC in which we have been studying purple blotch for the past two years. However, because that planting was confirmed to have Raspberry Bushy Dwarf Virus (RBDV) in 2002 and we have decided to remove all RBDV infected plantings from NWREC, we will have to establish a new planting for this experiment. Our plants arrived late in the summer of 2002 and were transplanted into gallon-size pots in which we will keep them over winter. The planting will be established at NWREC during spring, 2003. New primocanes will be trained that spring and a baby crop will be produced in 2004. Suppression treatments (Aim herbicide) will be applied to primocanes emerging in spring, 2004 and the first year of data for this experiment will be collected in late summer, 2004 (cane growth measurements), late winter-early spring, 2005 (purple blotch lesion counts), and summer, 2005 (yield data).

## Alternative Production Systems for 'Marion' Blackberry

Bernadine Strik and Gil Buller, Professor and Research Assistant - Department of Horticulture, OSU

The objectives of this study are to determine the impact of high-density planting and primocane training methods, as compared to an industry standard on: 1) yield in every-year and alternate year production; 2) cold hardiness; 3) possibilities for machine training of primocanes in the off-year of alternate year production systems; and 4) the impact of alternative training methods on thorn contamination in machine-harvested fruit. A planting was established at the NWREC in May 2000 with the following treatments: A) 2' spacing (in-row), alternate year (AY), primocanes topped at 6' once they reach the wire during the growing season; B) 2' spacing, AY, primocanes not topped during the growing season; C) 3' spacing, AY, primocanes not topped (trained on 2 wires one at 6', the other at 4'); D) 5' spacing, AY, primocanes not topped; and E) 5', EY (every-year), primocanes not topped (industry standard). The AY plots are designed such that half of each plot will be in the on-year and the other half in the off-year in any given year. In the EY treatment, primocanes are trained in February, as is more common in the industry. There are 5 replicates arranged in a randomized complete block design. Plots are 20' long. Plants were not cropped in 2001and primocanes were trained as they grew. In 2002, the 2' and 3' in-row spacing produced 9 to10 tons/a compared to 7 tons/a at the 5' spacing. In 2003, the highest yield was produced by the 2' AY, topped and the 5' AY treatments, 9.4 and 9.2 tons/acre, respectively. The 5' EY, February-trained plants had the lowest yield at 4.8 tons/acre but the largest berry weight. There was no treatment effect on the number of brambles per kg of machine-harvested fruit.

## Impact of Nitrogen (N) Fertilization Rate on N Uptake, Growth, and Yield of Blueberry as Affected by In-Row Spacing

Pilar Banados and Bernadine Strik*, Ph.D graduate student and Professor - Department of Horticulture, 4017 ALS, OSU

This study is designed to determine the effects of N fertilization rate on fertilizer N uptake and partitioning in blueberry and the impact of in-row spacing on N use/uptake. We are using $^{15}N$ (depleted ammonium sulfate) that can be traced in the plant, for this study. In-row spacing treatments for this experiment are 1.5' and 4'. Nitrogen rates within each spacing are 0, 100, or 200 lb N/a applied as a triple split (1/3 just after bud break; 1/3 at bloom; and 1/3 in June). The no nitrogen treatment allows us to look at the impact of only having N available from the soil or organic matter pool. A mature planting of 'Bluecrop' at the North Willamette Research and Extension Center is being used for this project that involves digging up plants. Plants were fertilized (100 or 200 kg N/ha) with $^{15}N$-depleted ammonium sulfate in spring, 2002. In 2003, plants were fertilized with the same N rate treatments, but only un-labeled N was applied. This allows us to look at use of stored N (from fertilizer applied the previous season). Plants were destructively harvested (dug up) on 9 dates from February 2002 to January 2004 to evaluate dry weight, total nitrogen content, % NDFF (nitrogen derived from fertilizer), % fertilizer recovery (amount of fertilizer taken up) in different plant parts, and yield. Not all data have been analyzed for 2003. Total plant dry weight in 2002 and 2003 was more affected by in-row plant spacing than N fertilization rate. By the end of the season, in September 2002, the percentage of total plant N that came from the fertilizer applied was 20 to 29%, with a further increase to 35% in January 2003 for the 1.5' spacing and 200 Kg N/ha. Two weeks after the first split of fertilizer N was applied (April, 25 2002), plants had recovered or taken up only 1 to 2% of the applied fertilizer. Fertilizer recovery increased to 4 % in May (two of the three splits applied), 12 to 17% in July (two weeks after last split applied), and 22 to 43% in September 2002 at the end of the season. Plants spaced at 1.5' and fertilized with 100 kg N/ha took up 43% of the fertilizer by the end September 2002 compared to 23% for plants at 4' fertilized with either 100 or 200 kg N/ha. In the first year of this study, plants spaced at 4' took up or "used" 23 to 46 kg N/ha at the 100 and 200 kg N/ha fertilizer application rates, respectively. The higher fertilizer uptake at the 200 kg N/ha rate may have been "luxury" uptake. Plants spaced at 1.5' in the row took up or used 43 kg N/ha at the 100 kg N/ha application rate and 63 kg N/ha at the 200 kg N/ha fertilization rate. The amount of fertilizer N in the fruit averaged 11 kg N/ha at 1.5' and 8 kg N/ha at 4'. In 2002 (the first year N fertilization treatments were imposed), yield was NOT affected by N rate,

only by in-row spacing. The high-density planting (1.5') had 40% more yield per acre than the 4' spacing, 14 t/ha compared to 10 t/ha (averaged over fertilization rate). A similar trend in yield was detected in 2003, however there was large variation between plants; data have not yet been analyzed.

## Evaluation of Viticultural characteristics of Phylloxera-Resistant Rootstocks for the Cultivars Pinot noir, Chardonnay, Pinot gris, and Merlot

Tiago Sampaio and Carmo Vasconcelos -OSU, Dept. of Horticulture

Rootstocks are the only practical way to overcome problems such as phylloxera, nematodes or site difficulties. They can also control vigor, yield, and fruit composition, playing a fundamental role in overall success of vineyard operations.

This trial was planted at the OSU Woodhall research vineyard in 1997 and includes two experiments: Experiment one includes Pinot noir, Chardonnay, Pinot gris and Merlot grafted to 9 rootstocks and ungrafted, in a split-plot design. In experiment two, Pinot noir was grafted to 10 additional rootstock selections, in a completely randomized block design. Vines are now fully established and the data presented reports the 5$^{th}$ full crop.

Both plant physiological performance and fruit composition were dramatically affected by the different rootstocks.

In experiment one, Riparia Gloire had the lowest photosynthetic rates, and highest levels of water stress. Vines grafted to 101-14 Mgt and Gravesac also had high levels of water stress.

In experiment one, Riparia Gloire had the lowest photosynthetic rates. Vines grafted to this same rootstock also suffered the highest water stress, followed closely by vines grafted to 101-14 Mgt and Gravesac. Higher transpiration rates were observed in vines where the scion was grafted to 3309 C and 5 BB, while Riparia Gloire and 101-14 Mgt had the lowest transpiration rates. The four varieties differed in their water use efficiency, transpiration rates and water relations.

Vines grafted to Riparia Gloire had overall higher soluble solids, and pH levels, lower acidity, and yields. 5 BB and 420 A rootstocks imposed the highest yields, lowest pH levels and highest acidity to the juice. Ungrafted vines and those grafted to 5 BB had lower soluble solids when compared to the other rootstocks, but still at a satisfactory level (~ 24º Brix).

Results from experiment two were slightly different from those of experiment one. No difference in water use efficiency was found across all rootstocks. However, changes in photosynthesis, transpiration and water relations indicated a dramatic rootstock effect. Pinot noir vines grafted to 101-14 Mgt and Börner suffered the highest water stress, and consequently presented lower photosynthetic rates. Rootstocks with increased drought tolerance, like 1103-P, 125 AA and 5 BB had in overall a better photosynthetic performance.

Rootstocks also altered fruit composition and yield components. On average, vines grafted to 125 AA had 5.8 times more fruit than those grafted to Riparia Gloire. These latter ones had higher juice soluble solids and pH levels, and lower acidity. In contrast, vines on 1616-C and 125 AA had lower Brix levels, but again still at a very satisfactory level (~ 24º Brix). Juices from vines grafted to 420 A had higher titratable acidity, whereas in 5C lower pH levels were found.

## Effect of Irrigation on Pinot noir Performance in the Willamette Valley

M. Carmo Vasconcelos - OSU, Dept. of Horticulture

In most of the cool climate growing regions in the world, there is sufficient precipitation during the summer months to maintain adequate vine development. In the Willamette Valley, precipitation is unevenly distributed during the year unlike other wine growing regions at equivalent latitudes. The wet springs are followed by dry summers. There is presently little documentation available concerning the need to irrigate mature vines in Oregon and this research is a first attempt towards filling this gap of knowledge.

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 50% 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.

Chlorophyll content, stomata conductance to water vapor, and stem water potential were lower for NI (control). There were no significant differences between PRD and RDI vines. Photosynthesis during mid ripening was highest for PRD vines, followed by RDI and NI. Later in the season, both RDI and PRD vines had similar rates of photosynthesis, which were higher than NI vines.

Vines were harvested on September 30. Fruit composition and yield components analysis have not been completed at the time of this report. There were no significant differences in yield per vine and clusters per vine in response to treatment. Non-irrigated vines tended to have smaller clusters. Juice soluble solids, pH and titratable acidity did not differ among any of the treatments.

## Determine the Seasonal Water Requirement and Optimal Water Rates Applied by Overhead Irrigation for Highbush Blueberry Production

Wei Yang and Bernadine Strik - OSU&NWREC; David Bryla - USDA-ARS

The goal of this project is to develop ETc for mature blueberries. The study will be conducted in a 10-acre, 9-year-old highbush blueberry field. This mature field is already under overhead irrigation with sprinklers spaced at 40'x 40'. There are three cultivars (Bluejay, Bluecrop, Jersey) with maturity ranging from early, mid- to later season. TDR wave-guides probes have been installed in the fall 2003. Soil moisture readings from TDR probes will be monitored daily throughout next growing season. Using the onsite weather station and soil moisture data, crop ET will be determined.

## Evaluation of Wine Grape Cultivars Under Desert Conditions

Esmaeil "Essie" Fallahi, Project Leader, Professor of Fruit Physiology - University of Idaho, Parma Research and Extension Center

Objectives were:1. To evaluate cold tolerance of wine grape cultivars under cool desert conditions, similar to those of Southwest Idaho, Eastern Oregon, and Washington; 2. To determine adaptation, nutritional physiology and requirement, fruit maturity, and vine and berry physiological characteristics of each cultivar under cool desert conditions; 3. Canopy management, and irrigation requirements of different varieties of wine grapes.

A wine grape vineyard has been established at the University of Idaho Parma Research and Extension Center. The vineyard ground was plowed and prepared in spring of 1997. The spacing is 7 x 9 ft. Cuttings from several varieties/clones were rooted and planted in each spring of 1997, 1998, 1999, 2000, and 2001 in four replications of eight vines per plot. A drip irrigation system was installed in 1997 and 1998.

Planted cultivars in the first phase of this experiment are: Cabernet Franc, Cabernet Sauvignon, Carignane, Dijon Clone (any Dijon), Chardonnay 29, 30 or 31, Dolcetto, Grenache, Limberger, Malbec (cot), Merlot, Meunier, Nebbiolo, Petit Verdot, Petite Sirah (Durif), Sangiovese, Valdepenas, Viognier, Pinot Noir - 18, Gamay Beaujolais, and Pinot Gris. In the second phase, Barbera 02, Cabernet Franc 04, Cabernet Sauvignon 02, Cabernet Sauvignon 04, Merlot 01, Merlot 15, Muscat of Alexandria, Pinot Gris 04, Shiraz 07, and Chardonnay 37 were planted in 1998. In 1999, Chardonnay 38, Blauer Portugieser 01, Pinotage 01, Tempranillo 02, and Flora 01 were added to this experiment. In the Spring of year 2000, Chardonnay 49, Flora 01, Pinotage 01, Souzao 01, Shiraz 07, Touriga 02, Chardonnay 38, Tempanillo 02, Cabonett Franc 04, Primitivo, Blauer Portugieser 02, and Pinot Gris 04 were planted to complete and/or add to the previous cultivars/selections. Several additional new cultivars was added to this experimental vineyard in 2001. Cabernet Franc 01 and Malbec 06 were more seriously damaged by winter or spring freeze, thus had a higher number of vines with new growth from mid-trunk area than other cultivars in 1999. Chardonnay 29 and 49 were the first ones to ripen and harvested and Dolcetto was the latest one. Seventeen cultivars had sufficient fruit in 2000 and over 25 cultivars were harvested in 2001. Fruit from all varieties were harvested according to their sugar content every year. Wines were made by Saw tooth winery in 1999, by Parma Ridge Winery in 2000, and by Ste Chapelle in 2001. In year 2000, Carignane, and Grenache had high higher yield and large clusters but Chardonay 49 and Petite Verdot had smaller clusters and lower yield. Merlot 01 and Dolcteto had higher sugar but Carinane had lower sugar. Harvest dates (maturity) for 2001 are presented in Table 1. Chardonnay 49 was the earliest cultivar but Carignane 06,Dolcetto 01,Muscat of Alexandria 02, Petite Sirah 03 Petite Verdot 01, Shiraz were the latest ones to mature under conditions of this experiment during 2001. Significant differences were observed in petiole nitrogen concentrations (units in ppm) in different cultivars in 1999 and 2000. In general, degree days ranged from 2981 to 3462 for most cultivars.

## Blueberry Performance on Marginal Soils with Short Growing Season Conditions

Cindy Kinder - University of Idaho, Camas County Extension Educator; Jo Ann Robbins - University of Idaho, Jerome County Extension Educator

Camas County is typical of many high altitude, cold climate, and short season areas throughout the Pacific Northwest. The growing season in Camas County is short, 60-85 days. Nine cultivars of blueberries were planted at two sites with three replicates in May 2001. Cultivars selected were a combination of winter hardiness (short and half high bushes) and early to mid season flower and fruiting. Cultivars selected were 'Bluetta', 'Chippewa', 'Hardyblue', 'Meader', 'Northblue', 'Northland', 'Patriot', 'Polaris', and 'St. Cloud'. Soils at the planting site have a pH of 6.1. These were the lowest pH soils located, which is not unusual for southern Idaho - an area with predominantly highly alkaline soils. Fences were built around the plots and an irrigation pump was purchased for one of the sites. Objectives of the project are: 1) to determine whether blueberries will survive cold winters typical of high altitude Idaho locations, 2) to determine whether blueberries will grow in marginal soils, and 3) to determine whether blueberries will flower and fruit to produce an economic yield in areas with cold winters and spring frost. Cultivars 'Meader' and 'Polaris' plants died during the season of planting. Other plants died during the winter of 2001 and 2002. Overall, five of six plants died of cultivars 'Meader' 'Polaris' and 'St. Cloud'. Three of 6 'Northland', 2 of 6 'Patriot' and 1 of 6 of 'Bluetta', 'Chippewa', 'Hardyblue' and 'Northblue' plants died. Remaining plants began leafing out May 14th, 2003. The 'Northblue' 'Chippewa' and 'Bluetta' cultivars received a higher winter hardiness rating than the other six cultivars, based on stem and bud evaluation. In 2003, one site had no cultivars bloomed. At the other site, cultivars 'Northblue', 'Chippewa', and 'St. Cloud' bloomed the second season after establishment, with an average of 2 flowers per plant (range 2 to 5 flowers per plant). Fruit were present on 'Northblue' plants. 'Hardyblue', 'Bluetta' and 'Chippewa' rated highest in growth and vigor. All plants within the trial have an upward plant habit and are about 1 foot tall. Those plants not flowering tended to winterkill the old growth.

## Water Management to Optimize Canopy, Yield, and Quality of 'Cabernet Sauvignon'

Krista Shellie - USDA-ARS

Different amounts of water were applied in 2002 and 2003 to a 1-acre trial established spring 2002 within a 30 acre block of own-rooted, 4th leaf, *'Merlot'* at Skyline Vineyards (southern Idaho). Weekly irrigations were varied in duration to deliver an amount of water equal to: 1) full vine evapotranspiration (FVET), 2) 70% FVET, 3) 35-70% FVET (35% FVET until veraison then 70% FVET until harvest), or 4) 35% FVET until harvest. Canopy size and crop load were similar among treatments (~ 20 buds per vine, ~36 in cane length). Separate lots of wine were made from 150 lbs of fruit from each trial plot and analyzed for quality. Irrigation treatments began in 2002 at flowering (leaf water potential -1.0 to -1.2 MPa) and in 2003 at fruit set (leaf water potential -1.3 MPa). In 2002, 13.5 acre inches of water were applied to FVET irrigated vines. Yield from vines irrigated at 35% FVET was ~30% lower (~ 4 t/acre) than vines irrigated at 70% or FVET (~6 t/acre) due to reduced berry size and cluster weight. Must pH corresponded inversely with irrigation amount. Vines irrigated at 35% FVET produced fruit with lowest tartaric acid, highest skin and wine phenols and anthocyanins, and highest wine color intensity. Irrigation affected content of glucose, fructose, and malic acid in exposed berries differently depending on location of the exposed cluster in the vine canopy. West exposed clusters contained less glucose, fructose, and malic acid than east exposed clusters, regardless of irrigation. East exposed berries from vines irrigated at 35-70% FVET or FVET contained more glucose and fructose than vines irrigated at 35% or 70% FVET, and malic acid content declined in direct relation to irrigation amount. Exposed cluster quality between opposites sides of the canopy was most similar for vines irrigated at 35-70% FVET.

Results to date suggest that increasing the amount of water from 35% to 70% FVET at veraison produces fruit with similar levels of glucose, fructose and tartaric acid as vines irrigated at FVET, and maintains a similarly high level of total phenols and monomeric anthocyanins as vines irrigated at 35% FVET. Results also suggest that irrigating at 35-70% FVET minimizes differences among exposed clusters on opposite sides of the canopy, resulting in more uniform quality.

## Using Whole-Vine Photosynthesis to Understand the Effects of Water Stress on Premium Wine Grapes

Jorge Perez Peña and Julie Tarara* - *USDA-ARS

A six-chamber, mobile field laboratory was used to record measurements of whole-vine photosynthesis from mature, field-grown *Vitis vinifera* cv. Cabernet Sauvignon under three regimes of regulated deficit irrigation (RDI): 1) standard RDI, in which 70% of vine evapotranspiration (ET) is replaced weekly; 2) early deficit, in which 50% of vine ET is replaced weekly between fruit set and veraison; and 3) veraison deficit, in which 50% of vine ET is replaced weekly between veraison and harvest. When not under 50% deficit, vines in scenarios #2 and #3 were irrigated according to standard RDI practice. Irrigation was delivered by drip. Vines were own-rooted, planted in 1992 in rows oriented N-S, with spacing of 6 feet between vines and 9 feet between rows, at the Canoe Ridge vineyard of Stimson Lane Vineyards & Estates, west of Paterson, WA. Whole-vine chambers were deployed for 7 to 8-day measurement runs during physiologically important stages: fruit set, pre- and post-veraison, and pre- and post-harvest. Chambers were installed on two vines per treatment, data collected for 24 to 48 hours, then the chambers moved to nearby vines until six vines per treatment were sampled. On adjacent non-chambered vines, single-leaf measurements of photosynthesis were collected at the same time as the whole-vine measurements. Leaf tissue was collected for laboratory analysis of the diurnal dynamics of starch and sugar concentrations. Periodic measurements of chlorophyll fluorescence and the photosynthetic light response in individual leaves also were recorded. Leaf area per vine was estimated at the end of each week-long measurement run. Large differences were observed in net carbon exchange and in transpiration between vines under the standard RDI practice and those under the additional water stress. In the pre-veraison period, 'early

deficit' vines fixed up to 40% less carbon during the middle of the day than did vines under standard RDI. A similar reduction was observed in sunlit, single leaves measured independently of the whole-vine chambers. Vines under early deficit transpired up to 62% less than those under standard RDI. Such results are not unexpected, as other research has suggested drought-induced downregulation of both transpiration and net carbon assimilation, and that an increase in water use efficiency can be computed when the decrease in net carbon exchange is dominated by stomatal closure. Differences in net carbon exchange and transpiration were smaller after harvest, when all vines were watered more liberally to encourage late-season storage reserves and cold acclimation.

## Investigation of Potential Climatic and Nutritional Causes of Grape Chlorosis

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

Every year Concord grape in the Yakima Valley show a leaf yellowing symptom known as grape chlorosis. The severity of this disorder varies from year to year and from vineyard to vineyard. However, leaves of grape plants that develop this symptom eventually die and fall off resulting in a reduction of productivity and, in time, can result in vine death. Historically grape chlorosis was thought to be due to a deficiency in the plant nutrient iron. However, research looking at iron supplements has had little to no positive effect on the disorder. Foliar iron sprays have been shown to green existing affected leaves with no effect on leaves produced after the spray. The fact that the disorder appears around bloom and varies from year to year indicate that there may be a relationship with annual weather (climatic) patterns. There is also a possibility of a nutritional relationship. The objective of this project is to evaluate plant nutrition and climatic conditions for their roles as environmental stress factors in causing chlorosis in Concord Grape. We hypothesize that the possible causes of grape chlorosis are a single element nutrient deficiency, a multiple element nutrient insufficiency, high concentration of one nutrient element causing the exclusion of uptake of other nutrient elements, plant water stress affecting roots ability to access nutrients, or a combination of these factors. In 2001 we established study sites in 6 commercial vineyards that vary from having chlorosis never to some years to every year. We mapped the incidence of the disorder and monitored nutrients (soil and tissue Ca, Mg, K, Na, Fe, and Al), soil moisture, soil temperature, and macro level climatic factors (e.g. air temperature).. The monitoring was continued in 2002 and 2003 as was chlorosis mapping. High soil moisture near bloom appears to be the most consistent factor related to the disorder. Chlorotic occurrence is also associated with high soil Ca and low tissue Mn. Mn would be expected to be more available in the wetter conditions associated with chlorosis. It is possible that the wet soil conditions impede new root development and subsequent nutrient uptake. Alternatively, high concentrations of soil Ca may interfere with Mn uptake and/or metabolism.

## Rootstock and Varietal Effects on the Variability in Cluster Initiation and Development

Markus Keller, Associate Horticulturist/Viticulturist - WSU-Prosser

A modified air conditioning system was used to test the impact of air temperature on flower initiation and development of mature, field-grown Cabernet Sauvignon vines. Four temperature regimes were applied directly to exposed buds during budbreak (in 2002 and 2003) and to inflorescences during bloom (in 2002): ambient, cool (ambient-5°C), warm (ambient+5°C), and hot (ambient+10°C). In both seasons, heating buds advanced budbreak and dramatically accelerated shoot growth, whereas cooling buds delayed budbreak and retarded shoot growth compared with ambient temperatures. Although bud temperature had no effect on flower numbers per cluster, fruit set and berry weights were increased by bud heating, which markedly increased yield per shoot. Fruit composition at harvest was not noticeably affected in 2002, but 2003 data have not been analyzed yet. Heating clusters during bloom reduced shoot growth and shortened bloom time compared with the cool treatment, but did not affect fruit set or composition.

A rootstock field trial planted at WSU-Prosser in 1999 and 2000 with Merlot, Chardonnay, and Syrah on their own roots or the rootstocks Teleki 5C, MGT 101-14, Couderc 3309, Ruggeri 140-2, Richter 110, and 1103 Paulsen was field-grafted in 2002. Yield components could not be investigated in 2003, because scions suffered severe cold damage during an early freeze in October 2002 and had to be re-grafted in 2003. Two root pressure chambers for use with pot-grown vines have been received from our Australian collaborator (National Wine and Grape Industry Centre, NWGIC, Wagga Wagga, NSW, Australia). A pot experiment was conducted at the NWGIC with Syrah grafted on three different rootstocks (5BB, Mgt 101-14, Ramsey) in addition to self-grafted vines. Analysis of plant hormones (cytokinins) in xylem sap collected using the pressure chambers suggested that cytokinins at budbreak were influenced by rootstock, with the highest yielding rootstock (Ramsey) having the highest cytokinin content and the lowest-yielding (5BB) having the lowest cytokinin content.

## Dynamics of Grape Berry Growth and Physiology of Fruit Volume Change

Markus Keller, Associate Horticulturist/Viticulturist - WSU-Prosser

Two-year-old, pot-grown Merlot, Chardonnay, and Concord vines were used for this study. Soil moisture was altered using drip irrigation, whereas cluster humidity was manipulated by immersing clusters in distilled water to determine whether water moved into the berries via root uptake or by direct absorption through the berry cuticle. In addition, varying soil moisture stress was applied to pot-grown Merlot during bloom and early berry development to modify the xylem connection between the berries and the rest of the vine. Irrigation treatments included partial rootzone drying (PRD), regulated deficit irrigation (RDI), and standard drip irrigation (no water stress). Preliminary data suggest that late-season (post-veraison) water uptake by the roots appears to be a significant factor contributing to changes in berry volume in *Vitis labruscana* (Concord) grapes, but not in *Vitis vinifera* wine grape cultivars. Concord also absorbed water directly through the berry cuticle. Initial cluster transpiration measurements suggested that berry transpiration decreases markedly during veraison and berries loose very little water through the cuticle during the maturation phase. However, these results are very preliminary and require more detailed investigation during the 2004 season.

## Cover Crops to Supply N for Organic Grape Production

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

The intent of this research is to develop a strategy for using legumes, which convert atmospheric nitrogen (N) into plant available N, as cover crops in organic grape production systems. The project evaluates two different legume crops (vetch and yellow sweet clover) for their N capture and subsequent N release at different incorporation timings. The legumes are either fall planted for spring incorporation or spring planted for fall incorportation. In addition, controlled plots with and without conventional fertilizer are being compared to the legume N source treatments. During the 2003 growing season, plot sites were established, soil and tissue collected regularly to monitor plant availability of N, and ion exchange membranes (Plant Root Simulators, PRS) place within the plots to monitor cummulative N release. Plots were harvested for yield and BRIX to establish baseline data.

# WINE PROCESSING

## Off-Flavors in Oregon Wine: Sulfides, Uta (atypical aging), and Stressed Vine Syndrome

Mina McDaniel - Dept. Food Science and Technology, OSU

Collaborators: 1. Barney Watson - FST Dept, OSU; 2. Michael Qian - FST Dept, OSU

Specific Objectives:
1. To monitor the off-notes in wines from a range of commercial Pinot noir vineyard blocks in Oregon.
2. To relate sulfur off-notes to content of specific volatile sulfur compounds in these wines.
3. To develop an understanding of the sensory consequences of atypical aging (Uta) in Oregon white wines.
4. To develop an understanding of the sensory consequences of stressed vine syndrome in Oregon red wines.

Procedures:
We are currently working to develop methodology to determine thresholds and power functions for a number of important sulfur compounds in wine. We will be working with Michael Qian who is analyzing wines determined to have off-flavors or off-aromas.

Results: We have not begun data collection yet as our funding has not yet arrived.

## Characterization of Formation of Off-Flavor in Oregon Wines

Michael Qian - Department of Food Sci & Tech, OSU

Collaborators: Barney Watson and Mina McDaniel - OSU

We investigated problematic wines and wineries throughout Oregon. Although the most widely occurred off-flavor problems are sulfide related issues, we found increased off-flavor concerns related to UTA and other vine stress related off-flavor issues. Researches have been carried out in several wineries to mitigate those off-flavor problems. In cooperation with the wine industry in Oregon, we have collected more than 100 problematic wine and Must samples in 2003. The Must nutrients have been analyzed and we saw a wide range of variability in amino acid composition, fermentable nitrogen and other nutrient contents. The causes for the viability and their impacts on wine flavor quality are under investigation.

Since sulfide off-flavor is the number one concern in Oregon, our research efforts in the first year has been devoted to develop a quick method to quantify volatile sulfur compounds in wine. Under the financial support of Oregon State university research office (equipment reserve fund) and flavor chemistry startup fund, a new gas chromatography with a pulsed flame photometric detector (PFDP) for sulfur was purchased and installed in the flavor chemistry lab for this project. By using a static headspace technique, we are able to detect volatile sulfur components in Pinot noir wines. In problematic wine sample, we detected elevated level of sulfur compounds. Identification of these volatile sulfur compounds and quantification are under way.

## Effect of Nitrogen, Irrigation, and Soil Management Practices on Fruit Composition, Yeast Assimilable Nitrogen Content, Fermentation Behavior, and Wine Composition and Quality

Barney Watson - Department of Food Science and Technology, OSU

Collaborators: Micheal Qian, Mina McDaniel, Olga Martin, James Kennedy, Alan Bakalinsky, Anne Connelly - OSU, Department of Horticulture

Vineyard cultural practices including nitrogen fertilization, irrigation, and soil cultivation treatments were evaluated for their effects on juice nutrient composition in the first part of this trial in 2001-2002 at a mature commercial Pinot noir vineyard in the south Willamette Valley in collaboration with the Department of Horticulture. Tilled treatments had the greatest effect on nutrient composition during ripening and at harvest. Tilling was done in early spring to encourage nitrogen utilization and to reduce nutrient and water competition with the vines. The tilled treatments averaged a 39% increase in yeast assimilable nitrogen compared to untilled treatments in 2001 and wines were observed to ferment more rapidly in tilled treatments compared to non tilled treatments. During the 2002 vintage approximately 200 juice samples were collected from 20 cooperating Oregon wineries. The samples represented several varieties and numerous specific vineyard block/sites. The juice samples were analyzed for ammonia content, alpha amino acid content by the NOPA assay, and for complete amino acid profiles by HPLC. The concentration of ammonia and amino acids in juice at harvest varied considerably in fruit from different vineyard sites in 2002. Vineyard information is being collected on each vineyard block in the trial. Vineyard factors which may affect juice nutritional composition include degree of fruit maturity, crop yields, irrigation and fertilization practices, rootstocks, soil type/depth, vine age, and trellis type.

## Impact of Selected Vitamins on Alcoholic Fermentations Induce by Saccharomyces

C.G. Edwards, Food Scientist/Professor – WSU, Pullman

A comprehensive and systematic research approach has been applied to minimize problem alcoholic fermentations. Specifically, the laboratory is investigating how changes in availability of one nutrient important for yeast growth (*e.g.*, assimilable nitrogen) affects the cell's need for other nutrients such as vitamins. To do this, a chemically defined fermentation medium was developed based on the amino acid composition of Cabernet Sauvignon grape musts from Washington. The project initially focused on two vitamins, biotin and pantothenic acid, given their roles in the metabolism of *Saccharomyces*. A 2 x 3 factorial experimental design was employed with the concentrations of "yeast assimilable nitrogen" or YAN (60 and 250 mg/l) and biotin (0, 1, or 10 µg/l) or pantothenic acid (10, 50, and 250 µg/l) as variables. Yeast growth and $H_2S$ production were significantly influenced by biotin, pantothenic acid, and nitrogen, synthesis of other molecules important for odor and flavor (esters, alcohols, etc.) were also altered. Interestingly, an increase in the concentration of pantothenic acid (10 to 250 µg/L) resulted in a dramatic decrease in $H_2S$ production under conditions of low or high nitrogen. If fermentations containing the same amount of pantothenic acid (10 or 50 µg/L) but different amounts of nitrogen, higher amounts of $H_2S$ were produced under high levels of nitrogen. This finding may help explain why some wineries experience an increase in the amount of $H_2S$ evolution when extra nitrogen is added. This study has important implications for the winemaking industry where a better understanding of the nutritional requirements of *Saccharomyces* is necessary to reduce fermentation problems and to improve final product quality.

## Inducement of Malolactic Fermentation in Musts from the Pacific Northwest

C.G. Edwards, Food Scientist/Professor – WSU, Pullman

Alcoholic fermentations were induced in a synthetic grape juice using different yeast strains. During primary fermentation, samples were periodically removed, sterile filtered, and inoculated with *O. oeni* to induce malolac-

tic fermentation (MLF). Prior to inoculation with *O. oeni*, some samples were treated with a protease or a concentrated solution of nutrients. *S. cerevisiae* strain V1116 produced the highest levels of $SO_2$ during fermentation and these media were highly inhibitory to MLF. The addition of nutrients did not lessen the inhibition; however, MLF was enhanced in protease-treated samples removed two days after the start of alcoholic fermentation. Addition of the protease did not affect MLF in media fermented by other yeast strains, namely Saint Georges or EC1118. Despite similar amounts of total $SO_2$ produced, MLF was highly inhibited in media fermented by RubyFERM but not EC1118. The addition of nutrients to the RubyFERM fermented media did not decrease bacterial inhibition. These findings suggest that the inhibition of MLF by *S. cerevisiae* is caused by a number of mechanisms including the synthesis of $SO_2$ and/or antibacterial peptides/proteins.

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

Gary Moulton, Senior Scientific Assistant, Mount Vernon Research & Extension Unit, WSU

The potential for wine grape production in maritime climate areas of western Washington and Oregon are already being explored for similarity to classic wine growing areas of northern France and Germany. Grapes grown here can produce 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.

The effects of certain grape rootstocks in advancing ripeness, reducing vigor, or improving the quality of grafted wine grape varieties are being tested in a trial comparing Pinot Noir grafted on seven different rootstocks. Own-rooted plants are used as the control. Already differences in ripening 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 will include bud break, bloom time, 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 from the 2002 crop will be evaluated in 2003-04, and the 2003 crop is currently being harvested.

## A New Technology for Simultaneous Tannin and Pigments Analysis in the Pacific NW Wine Industry

Moris L. Silber, Research Professor - NRS, WSU-Pullman

Year: 2003-04
Funding: $30,000

The main objective of this research is to provide the Pacific NW wine industry with a relevant laboratory and “in-the-field” quality control technology for further improving the quality of red wine. Until present, two separate and tedious analytical procedures for tannin and pigments in wine have been used (Adams, 2000). We succeeded in developing a new high-sensitive, rapid, accurate, and low-cost technology for simultaneous quantification of both, tannin and polymeric pigments, in one sample. Furthermore, bleaching of the wine sample with $SO_2$ before the tannin/pigment bioassay allows separate the total pigments into individual classes, i.e., monomeric, small and large polymeric pigments (MMP, SPP, LPP). The new technology was tested on a series of red wine samples of certain varieties, obtained under different water-deficit irrigation practices. A database information on tannin/pigments content in these wines was started. Currently, our new technology is undergoing modifi-

cation for in-the-field use. In addition, by complementing this technology with a micro-colorimetric assay for redox (oxidative) capacity, a new technology is being developed for monitoring the effect of oxygen availability on tannin/pigment ratio and its related health benefit via quantification of the antioxidant index of red wine, all in one analytical procedure.

The actual results of the research are supporting the original goals. They indicate at the high efficacy of the new technology for simultaneous quantification of tannin/pigments in red wine and its application for improving quality monitoring in wine industry. At the same time, our success in complementing the tannin/pigment technology with the micro-colorimetric quantification of the redox (oxidative) capacity in red wine, substantially exceeds the original goals of this research.

## Cabernet Sauvignon: Impact of Irrigation and Crop Load Strategies of Flavor and Phenolic Profiles of Grapes and Wines

S.E. Spayd, Food Scientist - WSU-Prosser; Russell Smithyman, Research Viticulturist - Stimson Lane

Cooperators: Stimson Lane Vineyards and Estates: Doug Gore, Vice-President of Winemaking and Mimi Nye, Manager Canoe Ridge Vineyard; USDA-ARS: Julie Tarara, Research Horticulturist, Horticultural Crops Unit; WSU: John Fellman, Associate Professor; Technical Support: J. Stults, Res. Tech III - WSU-Prosser; M. Mireles, Res. Tech I - WSU-Prosser

In 2001, Cabernet Sauvignon vines were irrigated under three regimes: 1) standard irrigation (weekly irrigation based on water use and loss), 2) during period of berry cell division weekly irrigation to replace 50% of water consumed (early deficit), and 3) standard irrigation until veraison when only 50% of water replaced (veraison deficit). The treatments were replicated four times. In 2001, all vines were cropped to about 3 tons/acre due to difficulties in previous seasons in establishing a higher crop level treatment. Wines were prepared at the Stimson Lane research winery. Wines were subjected to difference testing using faculty and staff at WSU-Prosser. As in 1999, no aroma or flavor differences were detected between the wines. Phenolic profiles, as determined by HPLC, also did not differ between the wines (Table 1).

DON'T FORGET TO ADD THE PRIORITES TO THE PRE-PROCEEDINGS IN THE FUTURE.

THEY GO HERE IN THE BACK---ALL PRIORITIES.